AIRO

ASSOCIAZIONE ITALIANA DI RICERCA OPERATIVA
OPTIMIZATION AND DECISION SCIENCE

International Conference on

Optimization and Decision Science

Taormina, September 10th – 13th, 2018

INTERNATIONAL CONFERENCE ON OPTIMIZATION AND DECISION SCIENCE - ODS 2018

Book of Abstracts of the XLVIII Annual Meeting Italian Operations Research Society

Contents

Welcome

Dear ODS2018 Participants,

On behalf of the Department of Mathematics and Computer Science (DMI) of the University of Catania, I am glad and honored to welcome you to ODS2018, XLVllI Annual Meeting of AIRO, Italian Operations Research Society.

Our Department gathers about 85 professors and researchers in the fields of Mathematics, Applied Mathematics and Computer Science, covering many relevant topics both in basic research and in applications.

We have a broad perception of our academic mission: alongside the fundamental activities of education and research, we work hard to contribute to the cultural and economic development of our region and of our country. In this effort we are proud to cooperate in important projects with several, middle sized to very large, public and private, enterprises.

Within this general framework the Operations Research Group active in our Department is involved in teaching activity at undergraduate and graduate levels. Their research activity is mainly focused on convex optimization with applications in real life situations, producing high quality research.

The ODS2018 Conference has been organized by our professors and researchers with great enthusiasm and a lot of hard work. It is a great opportunity for our OR Group and for our Department to be part of this event in order to enhance cooperation with the top experts of this field. ODS conference, indeed, are known to be able to attract hundreds of researchers and practitioners and is an ideal forum for presenting high quality theoretical and applied work, promoting interdisciplinary research and establishing contacts amongst researchers with common interests.

I wish to all the colleagues and scientist convened in Sicily for this event to have rewarding days of working, sharing ideas and results, begin new projects and enjoy our wonderful environment and climate. Welcome and good work!

Giovanni Gallo
Director of the Department of Mathematics and Computer Science
University of Catania

Welcome

Dear ODS2018 Participants,

I am very happy to welcome you on behalf of AIRO, the Italian Society for Operations Research, to the Optimization and Decision Science ODS2018 conference. This is the XLVIII annual meeting of AIRO and is organized by the colleagues of the University of Catania in the beautiful Taormina: one of the most precious corners of Sicily.

As usual, ODS conference will be an important scientific event for the Italian and international Operations Research community, bringing together researchers, students and practitioners to discuss the various aspects of our rich discipline. Following the great success of the new ODS format of AIRO conferences, launched last year in Sorrento, the organizers and the Program Committee worked hard to consolidate and enrich the new conference style which is aimed at attracting a higher participation of international speakers and creating a forum for Operations Research practice. The first objective has been successfully achieved with about one quarter of the participants from international research institutions and more than 180 presentations and 50 short papers in the conference volume, appearing in the new AIRO-Springer volume series.

The promotion of the practice of Operations Research, which is the vital fluid of our discipline, is becoming an important component of our conferences. This year an entire day of the conference is devoted the presentation of case studies and will host a round table on Quantitative Tools in Health Care and contributions from the Sportello Matematico per l'Industria Italiana and from the Euro Working Group on Practice of Operations Research.

An important part of the scientific program is represented by the numerous invited sessions organized by our very active thematic sessions on Health Care, Logistics, Optimization in Public Transport, Stochastic Optimization and by the AIROYoung (who this year have also organized their second conference and gave life to a European Working Group for young operations researchers). In addition, I am very happy that also this year a session on teaching OR is present in the program. With such an interesting and varied program, every participant will have several opportunities to exchange views and ideas with leading experts and will find new motivations and challenges from the interaction with practitioners and companies present at ODS2018.

In wishing you a fruitful and pleasant participation to ODS2018 I want to express my deep gratitude to all who contributed to the organization of the conference, of the many social activities and of the rich scientific program which will made ODS2018 an useful and unforgettable event.

Daniele Vigo
AIRO President

Organizational Support

ODS2018 Conference has been organized with support, cooperation and patronage of the following institutions and companies:

Presentation of ODS2018

In our globalized world, Operations Research methodologies are excellent tools to provide effective solutions to more and more complex decision-making problems. Operations Research is extensively intertwined with several different disciplines, ranging from engineering and physics to statistics and economics, as witnessed by the large number of real-life applications. Conferences and workshops are fruitful opportunities to share ideas and present innovative advances.

This book contains the abstracts of the contributions presented at the International Conference on Optimization and Decision Science (ODS2018), Taormina (Messina), Italy, September 10^{th} - 13^{th}, 2018. ODS2018 is the 48^{th} annual meeting of AIRO, the Italian Operations Research Society, and is organized in cooperation with the Department of Mathematics and Computer Science (DMI) of the University of Catania. ODS2018 is addressed to the entire Operations Research community working in the field of optimization, problem-solving, and decision-making methods. Its aim is to bring together scholars and decision-makers from both the academic and the industrial domain in order to present results with the potential to solve concrete problems and to provide new insights, bridging the researcher-practitioner gap.

Within ODS2018 contributions were received from four continents, attesting to the success and the global dimension of the conference. Some papers were selected for publication as full papers and some were accepted as short presentations. The peer-review process was conducted by experts in Operations Research and related fields. All the contributions can be found in the conference e-book available at the website: http://www.airoconference.it/ods2018/.

We are proud that the program also includes three plenary lectures given by internationally distinguished professors:

INFORMS, Analytics, Research and Challenges, given by Prof. Nicholas Hall, Ohio State University, USA.

On the Limits of Computation in Non-convex Optimization, given by Prof. Panos Pardalos, University of Florida, USA.

Operations research in transportation and supply chain management, given by Prof. M.Grazia Speranza, University of Brescia, Italy.

Their contributions greatly increase the overall quality of the conference and provide a deeper understanding of the conference fields of interest.

Moreover, ODS2018 includes the mini-workshop *Operations Research towards Technology Transfer: from Data to Actionable Knowledge* to bring together researchers and practitioners to exchange ideas, knowledge and expertise about ways to develop and improve practice in OR and establishing new collaborations. The mini-workshop includes two sessions:

1. *Sportello Matematico: Experiences, Perspectives and Success Stories of Technology Transfer and Operational Research* (Chair: A. Sgalambro)

2. *Practice of OR - Having Impact on the Outside World: Spin-off and Start-up Experiences in Italy* (Chair: L. Palagi)

ODS2018 also organizes the round table

Quantitative Tools in Health Care: Case Studies and Opportunities for Improvement (Chair: P. Cappanera).

The round table will address crucial and pushing topics in the management of public hospitals.The aim is to foster discussions and collaborations between operations management scientists and clinicians.

This book presents state of the art knowledge relating to optimization, decisions science, and problem-solving methods, as well as a large variety of applications of extreme importance in relation to computer science, mathematical physics, engineering, statistics, and economics. It highlights real-life problems that are challenging and worthwhile, and also includes results on optimal design of photovoltaic installations, parking pricing problems, industrial IoT networks, cybersecurity investments, and autonomous driving. The topics are addressed not only to researchers and practitioners working in these areas, but also to the Operations Research community.

Finally, we would like to express our thanks to the invited speakers for their invaluable contributions, to the authors for their work and dedication, and to all members of the Program Committee and auxiliary reviewers who helped by offering their expertise and time. Special gratitude should be addressed to Springer for strongly supporting us during the publishing process of ODS2018 papers in a Special Volume of the AIRO Springer Series, which will be available after the Conference. We also extend our thanks to the Ph.D. students Gabriella Colajanni and Giorgia Cappello and to the students of the Department of Mathematics and Computer Science, who actively helped in making ODS2018 possible.

We are greatly indebted to the following institutions, agencies, and enterprises for their sponsorship of the conference:

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Patrizia Daniele and Laura Scrimali
ODS2018 Co-Chairs
Department of Mathematics and Computer Science
University of Catania

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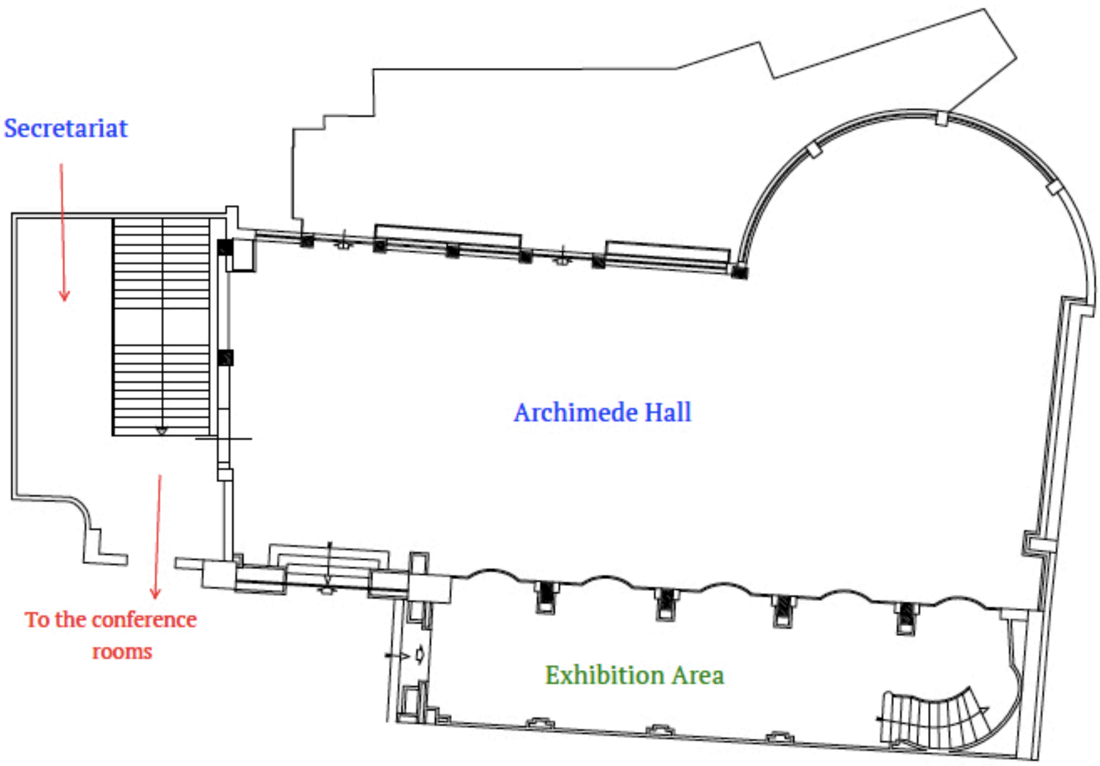
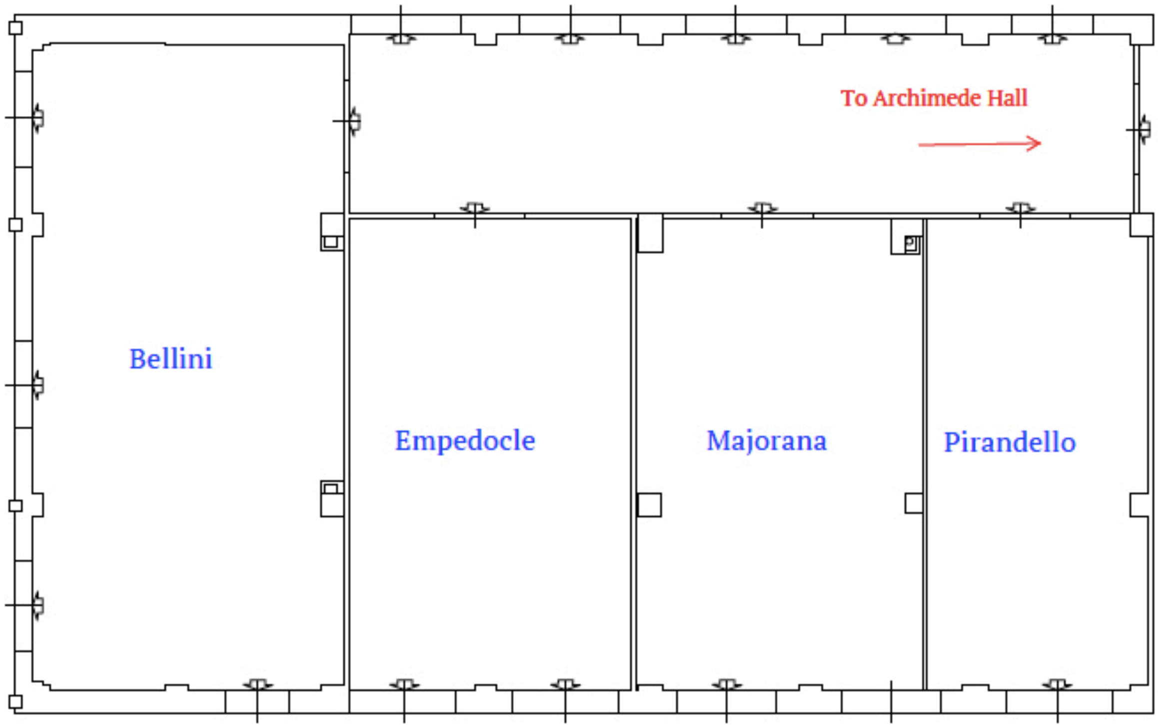
Conference Venue and Maps of the Meeting Rooms

The conference will be hosted at the Hotel Villa Diodoro. Villa Diodoro is located just a few steps from the idyllic center of Taormina.




To Archimede Hall
Bellini
Empedocle
Majorana
Pirandello

Plenary Speakers

Nicholas G. Hall

Bibliography

Nicholas G. Hall is the Fisher College of Business Distinguished Professor at The Ohio State University. He holds a Ph.D. (Management Science, University of California, Berkeley, 1986), and B.A., M.A. (Economics, University of Cambridge). His research and teaching interests include project management, scheduling, and pricing. He has published 82 articles in *Operations Research*, *Management Science*, *Mathematics of Operations Research*, *Mathematical Programming*, *Games and Economic Behavior*, *Interfaces*, and other journals. He has served as Associate Editor of *Operations Research* (1991-) and *Management Science* (1993-2008). His 335 presentations include 11 keynote addresses, 8 INFORMS tutorials, and 98 invited talks in 23 countries. A 2008 citation study ranked him 13th among 1,376 operations management scholars. He won the Fisher College Faculty Research Award (1998, 2005). He served as President of MSOM (1999-2000), Treasurer of INFORMS (2011-2014), and on the Ohio Steel Industry Advisory Council (1997-2002).

Panos Pardalos

Bibliography

Panos M. Pardalos serves as Distinguished Professor of Industrial and Systems Engineering at the University of Florida. Additionally, he is the Paul and Heidi Brown Preeminent Professor of Industrial and Systems Engineering. He is also an affiliated faculty member of the Computer and Information Science Department, the Hellenic Studies Center, and the Biomedical Engineering Program. He is also the Director of the Center for Applied Optimization. He is a world leading expert in global and combinatorial optimization. His recent research interests include network design problems, optimization in telecommunications, e-commerce, data mining, biomedical applications, and massive computing. He was the Founding Editor and Editor-in-Chief of the J*ournal of Global Optimization*, *Optimization Letters*, and the *Journal of Computational Management Science*. Currently he is Editor-in-Chief of the Journal of *Energy Systems* and *SpringerPlus*. He also serves as a member of the Editorial Board of numerous internationally highly reputable scholarly journals. He has received numerous awards and honors.

Maria Grazia Speranza

Bibliography

M. Grazia Speranza received a degree in mathematics and a Ph.D. degree in applied mathematics in 1980 and 1983, respectively, from the University of Milan. Since 1994, she has been a Full Professor of operations research at the University of Brescia. She was the President of the Research Council (1998-2000) and Vice- President of the University of Brescia (2000-2002), and the Dean of the Faculty of Economics and Business (2002?2008). She was President of EURO (Association of European Operational Research Societies) in 2011-12 and of TSL (Transportation Science & Logistics Society of INFORMS) in 2014. Her main scientific interests are optimization models and algorithms for transportation and logistics. Other scientific interests include scheduling, combinatorial optimization, and optimization models in finance. She has published more than 150 papers on these topics in international journals and volumes. She has also edited international volumes and special issues of journals. She serves as Associate Editor of *RAIRO-Operations Research*, *Transportation Science*, *EURO Journal on Transportation and Logistics*, *4OR*, *EURO Journal on Computational Optizamization*, *International Journal of Portfolio Optimization*, *Mexican Journal of Operations Research*, and *Advances in Operations Research*. She has organized several international conferences. She has been a Member of the Scientific Committee and an Invited Speaker at several international conferences.

Mini Workshop

Operations Research towards Technology Transfer: from Data to Actionable Knowledge

Operations Research (OR) analysts use advanced mathematical and analytical methods to help organizations investigate complex issues, identify and solve problems, and make better decisions. AIRO, the Italian Operations Research Society since its creation in 1961 actively promotes the collaboration between academics and practitioners in the field. The goal of this mini-workshop is to bring together researchers and practitioners to exchange ideas, knowledge and expertise about ways to develop and improve practice in OR and establishing new collaborations.

Practitioners and transfer facilitators in OR and Analytics, from academia, OR start-up/spin-off and intermediary organizations, will discuss their experiences in exploiting the synergy of Operations Research with data analytics, artificial intelligence and machine learning to enable more effective decisions and more productive systems.

The mini-workshop includes two sessions:

Session I: 11.30-13.00 (Chair: Antonino Sgalambro) *Sportello Matematico: Experiences, Perspectives and Success Stories of Technology Transfer and Operational Research*

This session is focused on the possibilities that Sportello Matematico offers to Companies and Research Centers (Departments, public and private Research Institutes of excellence, Spin-Offs), also providing concrete examples of the facilitation role secured by the project team - through direct testimonies, and discussing future directions.

Session II: 14.30-16.00 and 16.30-18.30 (Chair: Laura Palagi) *Practice of OR - Having Impact on the Outside World: Spin-off and Start-up Experiences in Italy*

In this session, spin-off and start-up operating on OR topics will present some best practice in applying OR tools for developing business and industrial applications. The goal is to exchange ideas, grounded on experience, and stimulate the discussion about the key competences and skills required to develop innovative products and services in the era of big data.

Round Table

Quantitative Tools in Heath Care: Case Studies and Opportunities for Improvement

The aim of this round table on Operations Management in Health Care is to bring together medical staff and operations management people to (i) share knowledge, (ii) share perspectives – often different and possibly conflicting, with the aim of finally (iii) come to a problem solution. The round table will address crucial and pushing topics in the management of public hospitals. All the contributions will be presented by clinicians and experts who are in charge of management tasks inside a hospital and they witness the importance of introducing quantitative methods in the complex decision processes arising in this setting. The ultimate aim of the round table is to foster discussions and collaborations between operations management scientists and clinicians.

The round table will be in Italian and includes two main sessions.

Part I: 8.30-10.00 (Chair: Paola Cappanera)

- **C. Bianciardi**, Azienda Ospedaliera Universitaria Senese. *Riorganizzazione del Pronto Soccorso alla luce della nuova delibera*
- **M. De Natale**, Azienda Ospedaliera per l'Emergenza Cannizzaro di Catania. *Bed Management in un ospedale dedicato alle emergenze*

Part II: 11.30-13.00 (Chair: Paola Cappanera)

- **F. Frosini** e **E. Ciagli**, LaSTh, Azienda Ospedaliera Universitaria Careggi (FI). *Analisi ed ottimizzazione di percorsi clinici per pazienti oncologici*
- **J. Guercini**, AOU IRCCS San Martino. *Progettazione dei flussi del nuovo polo emato-oncologico*

Conference Program

Plenary Sessions

PL1

INFORMS, analytics, research and challenges

Nicholas Hall

Sept. 10th
16.00-17.00
Archimede Hall

Abstract This talk will cover four topics at a nontechnical level.

- The first part of the talk should be of interest to the leaders and future leaders of the Italian OR Society. It describes INFORMS? organization, strategic goals, current situation and activities. A particular focus is INFORMS? first ever national Policy Summit to be held on Capitol Hill in Washington, May 21st.
- The second part of the talk should be of interest to researchers and practitioners. The speaker will provide his perspectives on Analytics, what it means and does not mean, where it is leading the field, and some unintended consequences.
- The third part of the talk should be of interest to younger scholars and graduate students. The speaker will discuss the currently active directions and research potential of three topics: the sharing economy, precision healthcare, and project management. - The last part of the talk provides a brief discussion of the challenges faced by the operations research and analytics profession currently and over the next 10 years.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

Nicholas Hall
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PL2

On the limits of computation in non-convex optimization

Panos Pardalos

Sept. 11th
10.30-11.30
Archimede Hall

Abstract Large scale problems in engineering, in the design of networks and energy systems, the biomedical fields, and finance are modeled as optimization problems. Humans and nature are constantly optimizing to minimize costs or maximize profits, to maximize the flow in a network, or to minimize the probability of a blackout in a smart grid.

Due to new algorithmic developments and the computational power of machines (digital, analog, biochemical, quantum computers etc), optimization algorithms have been used to "solve" problems in a wide spectrum of applications in science and engineering.

But what do we mean by "solving" an optimization problem? What are the limits of what machines (and humans) can compute?

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

Panos Pardalos
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PL3

Operations Research in transportation and supply chain management

M. Grazia Speranza

Abstract The developments in digital technologies are creating new challenges and opportunities to Operations Research. In this paper, research trends in transportation and supply chain management will be discussed and some examples briefly presented.

Sept. 12th
10.30-11.30
Archimede Hall

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

M. Grazia Speranza
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Variational Analysis, Games and Intertwined Optimization Programs (invited session)

Chair: G. Bigi

VAGOP1	*Financial contagion: a variational approach*
	S. Giuffrè, G. Cappello, P. Daniele and A. Maugeri
VAGOP2	*Coalitional games in evolutionary supply chain networks*
	L. Scrimali
VAGOP3	*A financial optimization model with short selling and transfer of securities*
	G. Colajanni and P. Daniele
VAGOP4	*Fixed-point and extragradient methods for quasi-equilibria*
	G. Bigi and M. Passacantando
VAGOP5	*Random traffic equilibrium problem via stochastic weighted variational inequalities*
	A. Barbagallo and G. Scilla

VAGOP1

Financial contagion: a variational approach

Sofia Giuffrè, Giorgia Cappello, Patrizia Daniele and Antonino Maugeri

Sept. 10^{th}
17.30-19.30
Bellini

Abstract The talk deals with a general equilibrium model of financial flows and prices evolving in time. The equilibrium conditions in a dynamic sense are provided and their formulation in terms of an evolutionary variational inequality is given. Thanks to the variational inequality theory an existence result for the equilibrium solution is proved and, considering the Lagrange dual formulation of the financial model, the Lagrange variables, called deficit and surplus variables, are introduced. By means of these variables, we may study the possible insolvencies related to the financial instruments and their propagation to the entire system, producing a "financial contagion". The model takes also into account the non-performing loans of the banks.

Keywords: Financial networks, Dual Lagrange formulation, Financial contagion.

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VAGOP2

Coalitional games in evolutionary supply chain networks

Laura Scrimali

Abstract We focus on the coalition formation in a supply chain network that consists of three layers of decision-makers, namely, suppliers, manufacturers, and retailers, with prices and shipments that evolve over time. We suppose that some partners in the chain vertically merge each other and act as one player to confront the other players that make their choices independently. In this model, the retailer is the dominant player and is a profit-maximizer. We present a non-cooperative approach to the coalitional game and provide the equilibrium conditions governing the model as well as an equivalent evolutionary variational inequality formulation.

Sept. 10th
17.30-19.30
Bellini

Keywords: Evolutionary variational inequality; supply chain; coalitions; Nash equilibrium.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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VAGOP3

A Financial Optimization Model with Short Selling and transfer of securities

Gabriella Colajanni and Patrizia Daniele

Sept. 10th
17.30-19.30
Bellini

Abstract In this paper we present a financial mathematical model, based on networks, aiming at maximizing the profits while simultaneously minimizing the risk. In addition, our model is characterized by short selling, which consists in the sale of non-owned financial instruments with subsequent repurchase, and transfer of securities. We propose an Integer Nonlinear Programming (INLP) Problem, whose solution provides us with the optimal distribution of securities to be purchased and sold.

Keywords: Financial problems, Risk management, multicriteria decision-making, multi-period portfolio selection problems, Short Selling, transfer of securities.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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VAGOP4

Fixed-point and extragradient methods for quasi-equilibria

Giancarlo Bigi and Mauro Passacantando

Sept. 10th
17.30-19.30
Bellini

Abstract The quasi-equilibrium problem (QEP) is a quite natural generalization of the so-called abstract equilibrium problem (EP) where the constraints are given through a set-valued map describing how the feasible region changes together with the considered point. QEPs are modeled upon quasi-variational inequalities (QVIs) and generalized Nash equilibrium problems (GNEPs). As EP subsumes optimization, multiobjective optimization, variational inequalities, fixed point and complementarity problems, Nash equilibria in noncooperative games and inverse optimization in a unique mathematical model, further quasi type models could be analysed through the QEP format beyond QVIs and GNEPs.
Unlikely QVI and GNEP, algorithms for the QEP format did not receive much attention. The goal of the talk is to discuss possible extensions of two classical algorithmic approaches for optimization and VIs to QEPs, i.e., fixed point and extragradient methods. The main difficulties arise from the moving feasible region: the iterates belong to different sets and any solution of QEP has to be a fixed point of the constraining set-valued map. Therefore, a range of convexity, monotonicity and Lipschitz assumptions both on the equilibrium bifunction and the constraining set-valued map must be met in suitable combinations to achieve convergence.

Keywords: Generalized Nash games, quasi-variational inequalities, fixed-point techniques.

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VAGOP5

Random traffic equilibrium problem via stochastic weighted variational inequalities

Annamaria Barbagallo and Giovanni Scilla

Abstract The aim of the talk is to study a new weighted transportation model with uncertainty, the so-called random weighted traffic equilibrium problem. More precisely, the equilibrium principle is introduced as a generalization of Wardrop principle. Then, the equilibrium condition is characterized by a stochastic weighted variational inequality in a non-pivot Hilbert space. Thanks the variational formulation, some theoretical results, as existence and stochastic continuity results for equilibrium distributions, are obtained using vari-ational methods. Finally, a numerical example is provided.

Sept. 10$^{\text{th}}$
17.30-19.30
Bellini

Keywords: Traffic problem, Stochastic weighted variational inequalities, Non-pivot Hilbert spaces.

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2. Barbagallo, A., Scilla, G.:*Stochastic weighted variational inequalities in non-pivot Hilbert spaces with applications to a transportation mode*l. Journal of Mathematical Analysis and Applications, 457, 1118 1134, (2018).

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Heuristic and Metaheuristic 1

Chair: R. Mansini

HEUR1.1	*Set covering formulation for the antenna covering problem*
	A. Napoletano, M. Monaci, M. Pozzi and D. Vigo
HEUR1.2	*A new hyper-heuristics for multi-objective optimization*
	D. Anghinolfi and M. Paolucci
HEUR1.3	*Using cryptography techniques as a safety mechanism applied to components in autonomous driving*
	A. Troia and A. Modello
HEUR1.4	*The Mahalanobis distance for feature selection using genetic algorithms: an application to BCI*
	M.E. Bruni, P. Beraldi, D. Nguyen Duy and A. Violi
HEUR1.5	*Hybridizing kernel search*
	R. Mansini and R. Zanotti

HEUR1.1

Set covering formulation for the antenna covering problem

Antonio Napoletano, Michele Monaci, Matteo Pozzi and Daniele Vigo

Sept. 10th
17.30-19.30
Empedocle

Abstract The *Antenna Covering Problem* (ACP) is an optimization problem arising in the telecommunication context. In the ACP, a geographic area has to be served by a given set of antennas. The area is discretized into a set $M = \{1, \dots, m\}$ of *squares*. Each square i is characterized by a service-demand d_i. Antennas can be installed on a given set of specific *sites*, and are configurable according to a set of parameters (e.g., orientation, tilting, power, ...). The parameter-setting influences the antenna behaviour in terms of emitted power, and determines the cost of the configuration and the subset of squares that it can potentially cover. Given a budget b, the ACP asks to install a number of antennas and determine their configurations in such a way that (i) the total cost of the selected antennas is not larger than the budget b; and (ii) the number of uncovered squares is a minimum. We propose a heuristic algorithm for the solution of real-world ACP instances within the collaboration of an important international player in the field. The algorithm is based on a set covering formulation in which columns are associated to possible configurations of the antennas, and rows are associated with squares. The algorithm operates in two main phases. In the first one, a large number of possible configurations for antennas are evaluated using a greedy adaptive constructive approach. Each configuration j refers to a specific tuning of the parameters for a certain antenna, and is associated with a nonnegative cost c_j and with a set $M_j \subseteq M$ of squares that the antenna can cover in the given configuration. In the second phase, we consider a variant of the set covering problem with side constraints, including the budget requirement. For this problem, we present a mathematical model based on an Integer Linear Programming formulation, and a heuristic algorithm based on a lagrangean relaxation

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of the formulation.Finally, we report some preliminary computational experiments on real-world instances

HEUR1.2

A new hyper-heuristics for multi-objective optimization

Davide Anghinolfi and Massimo Paolucci

Sept. 10^{th}
17.30-19.30
Empedocle

Abstract Multi-objective optimization (MOP) refers to problems where several objective functions have to be simultaneously optimized. MOP problems arise in many fields, such as engineering, economics, and logistics, when decisions need to be taken in the presence of trade-offs between two or more conflicting objectives. Solving MOP problems consists in identifying the set of the Pareto optimal solutions (Pareto front). Since the cardinality of the Pareto front is typically exponential in size, MOP are usually NP-hard problems. Therefore, metaheuristic approaches have been proposed in literature, which extend for example simulated annealing (SA), genetic algorithm (GA) or ant colony optimization to MOP. This paper proposes a new multi-objective hyper-heuristic approach that combines two metaheuristics, in particular, GA and SA, operating at two hierarchical levels. Since, in general, the behavior of a metaheuristics is affected by a number of parameters and design choices, on the upper level GA searches the space of the "configurations" of the SA parameters, whereas, at the lower level, a configured SA explores the solution space of the original MOP problem in order to identify a good estimate of the Pareto front. In particular, GA operates on a population of P SA configurations, which are run in parallel and whose results are evaluated in order to assign a fitness to such configurations; genetic operators and selection rules based on fitness are then used to evolve the SA configurations in generations. In addition, appropriate mechanisms are devised to manage both the local Pareto fronts of each individual SA and the global Pareto front maintained by GA, as well as to evaluate the solution explored by the single SA. An experimental analysis performed on the proposed approach, called as multi-objective Genetic Simulated Annealing (MO-GSA) is reported.

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Keywords: Multi-objective optimization, Metaheuristics, Hyper-heuristics.

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HEUR1.3

Using cryptography techniques as a safety mechanism applied to components in Autonomous Driving

Alberto Troia and Antonino Mondello

Abstract Many applications are being developed that adopt a new emerging technology inspired by biological structures in nature to solve real-life problems; this approach involves implementations based on artificial neural networks (ANNs), deep learning, and other forms of artificial intelligence(AI). Autonomous driving is one area where these AI implementations can be applied; however, with it brings several uncertainties, including the safety and security of the implementation. The intent of this paper is to provide a new perspective in using cryptography as a methodology to implement safety in the hardware that incorporates AI technology in automotive while addressing at the same time classical problems due to physical and software failures.

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Empedocle

Keywords: Artificial intelligence; Machine Learning; Deep Learning; Neural Network; Genetic Algorithm; Neuron; Gene; HASH; HMAC; SHA256; Digest; Weight Matrix; Secure Storage; Memory; Automotive; autonomous driving.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEUR1.4

The Mahalanobis distance for feature selection using genetic algorithms: an application to BCI

Maria Elena Bruni, Patrizia Beraldi, Du Nguyen Duy and Antonio Violi

Sept. 10th
17.30-19.30
Empedocle

Abstract High dimensionality is a big problem that has been receiving a lot of interest from data scientists. Classification algorithms usually have trouble handling high dimensional data, and Support Vector Machine is not an exception. Trying to reduce the dimensionality of data selecting a subset of the original features is a solution to this problem. Many proposals have been applied and obtained positive results, including the use of Genetic Algorithms that has been proven to be an effective strategy. In this paper, a new method using Mahalanobis distance as a fitness function is introduced. The performance of the proposed method is investigated and compared with the state-of-the-art methods.

Keywords: Mahalanobis Distance; Genetic Algorithm; Feature Selection.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEUR1.5

Hybridizing kernel search

Renata Mansini and Roberto Zanotti

Sept. 10th
17.30-19.30
Empedocle

Abstract Kernel Search (KS) is a general purpose heuristic framework initially proposed for the solution of 0-1 Mixed Integer Linear Programming (MILP) problems and successfully applied to the multi-dimensional knapsack problem (Angelelli et al. (2010)), and to a portfolio selection problem (Angelelli et al. (2012)). The method is based on the construction and solution of a sequence of restricted problems by means of a MILP solver. The method starts by identifying a kernel set of variables, i.e. a set of promising variables that are presumably non-zero in an optimal solution, dividing the remaining ones into groups (buckets) according to a sorting criterion (based on the reduced costs of the LP optimal solution). Then a sequence of small MILP subproblems are constructed and sequentially solved. Each subproblem takes into account the kernel set (possibly updated) plus a selected set of additional variables (the current bucket). KS ends when all (or a predefined number of) buckets are considered. At each iteration, the kernel set is updated by including the variables that have been selected when solving the current MILP sub-problem. The algorithm may scroll the sequence of buckets more than once, use disjoint buckets or allow for their partial overlapping, consider equal size buckets or variable size buckets. All these features are controlled by parameters. KS has some strong potentialities (e.g. it is an effective technique for decomposing a general MILP into small-size subproblems), and some evident drawbacks (e.g. the difficulty to identify promising variables when reduced costs do not provide a clear signal). In this paper, we investigate possible changes to KS with the aim of enhancing its behavior. Starting from its best features, we will innovate both the way subproblems are constructed and promising variables identified by embedding ideas and techniques from other domains such as Artificial Intelligence. Promising computational results on different benchmark problems suggest that many opportunities have still to be tested for the KS, and there are several research lines on which it will be possible to elaborate.

Keywords: Kernel Search, Artificial Intelligence, Hybrid methods.

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Nonlinear Optimization 1 (invited session)

Chair: M. Roma

NLOPT1.1	*On the convergence of steepest descent methods for multiobjective optimization* **G. Cocchi**, G. Liuzzi, S. Lucidi and M. Sciandrone
NLOPT1.2	*New clustering methods for large scale global optimization* **L. Tigli**, F. Bagattini and F. Schoen
NLOPT1.3	*Optimization models for active power distribution networks* **M.T. Vespucci**, D. Moneta, P. Pisciella and G. Viganò
NLOPT1.4	*A Derivative-free method for complex optimal design problems* **S. Lucidi**, A. Credo, G. Liuzzi, F. Rinaldi and M. Villani
NLOPT1.5	*Numerical experiences with preconditioned Newton-Krylov methods in large scale unconstrained optimization* **M. Roma**, M. Al-Baali, A. Caliciotti and G. Fasano

NLOPT1.1

On the convergence of steepest descent methods for multiobjective optimization

Guido Cocchi, Giampaolo Liuzzi, Stefano Lucidi and Marco Sciandrone

Sept. 10th
17.30-19.30
Majorana

Abstract In this work, we propose an algorithm based on steepest descent methods for multiobjective optimization. All the objective functions are assumed to be continuously differentiable. The proposed method, which does not scalarize the objective functions, builds an approximation of the Pareto front. The algorithm iteratively improves a temporary list of non dominated solutions. At every iterations, a point of the current list is considered for the computation of a set of suitable search directions.
Properties of global convergence to Pareto stationary points are stated. Moreover, in order to measure the performance of the proposed algorithm, we compare it with state of art multiobjective optimization algorithms on a set of test problems.

Keywords: Multiobjective optimization, steepest descent methods.

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NLOPT1.2

New clustering methods for large scale global optimization

Luca Tigli, Francesco Bagattini and Fabio Schoen

Sept. 10th
17.30-19.30
Majorana

Abstract Clustering methods have been among the most popular global optimization (GO) strategies in the 90's; they have been abandoned for several reasons, one of which being the difficulties in applying them to large scale GO problems. In this talk I will show how we can apply those method to difficult large scale problems thanks to the idea, drawn from machine learning, of mapping solution to a suitable feature space. In particular, I will show how the method can be applied to large Lennard-Jones or Morse atomic cluster optimization as well as to sphere packing problems in a cube. These problems are notoriously hard, in particular when their dimension increase. We successfully applied the idea of clustering, which consists in starting a local descent from randomly generated initial configurations, clustering in the feature space and then applying a full descent procedure only to a few representative elements in each cluster. The method enabled us to find the putative global optima for all hard instances (e.g., all Morse clusters with $\rho = 14$ up to 200 atoms and all sphere packing problems up to 70 spheres) saving, in each instance, at least 50% of the local searches with respect to a method in which early local descent stopping is not applied. A discussion on the two most important ingredients of a clustering methods, i.e. a good and effective local search procedure and a mapping into a significative low-dimensional feature space, will be presented.

Keywords: Global optimization, Clustering methods.

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NLOPT1.3

Optimization models for active power distribution networks

Maria Teresa Vespucci, Diana Moneta, Paolo Pisciella and Giacomo Viganò

Sept. 10th
17.30-19.30
Majorana

Abstract One aim of the European Union is to increase the share of renewable generation, also produced by small size generators (<10 MW) connected to Medium Voltage (MV) and Low Voltage (LV) distribution networks, i.e. Distributed Renewable Energy Sources (DRES). Power system stability will be affected by the stochastic and non-programmable nature of many renewable resources, as well as by the decrease of the share of conventional generation, which may be used to operate and regulate the power system. As RES based generation is replacing conventional generators on the physical market, DRES as well as loads will be allowed to participate to the operation of the power system However, MV networks are designed neither for high penetration of distributed generators nor for the par-ticipation of distributed generators to the management of the transmission network. In particular, voltage and current congestions in MV networks could limit the power exchange of distributed resources. Moreover, the complex behavior of distribution networks makes it difficult to determine the capabilities of the resources (i.e. the active and reactive limits of the power exchange), which guarantee the expected operation of the network. In this scenario the DSOs need to implement advanced control schemes in order to foster the participation of distributed resources to the management of the transmission network.

Keywords: Distributed power generation, Reactive power control, Smart grids.

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NLOPT1.4

A Derivative-free method for complex optimal design problems

Stefano Lucidi, Andrea Credo, Giampaolo Liuzzi, Francesco Rinaldi and Marco Villani

Sept. 10th
17.30-19.30
Majorana

Abstract The interest in efficiently solving optimal design problems has grown rapidly during the past few decades. This is motivated by their importance from both an industrial and a scientific perspective. Usually these problems must be tackled by using a black box approach since they need simulation codes for computing the values of their objective functions and constraints. Therefore no first order information are available. In this talk, we propose a derivative free algorithm for a particular class of difficult black box optimization problems arising in the optimal design field. The distinguishing features of this class of problems are:

- the presence of discrete variables due to technological limits;
- the different variable effects on the physics of the design;
- the need that variables of the problems satisfy many additional linear relations

After having described the algorithm and its theoretical properties, we report the numerical results obtained when tackling some optimal design problems of electric motors.

Keywords: Derivative-Free Methods, Nonlinear Optimization Methods.

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NLOPT1.5

Numerical experiences with preconditioned Newton-Krylov methods in large scale unconstrained optimization

Massimo Roma, Mehiddin Al-Baali, Andrea Caliciotti and Giovanni Fasano

Sept. 10$^{\text{th}}$
17.30-19.30
Majorana

Abstract In this work, we deal with a class of approximate inverse preconditioners, based on Krylov-subspace methods, for the solution of large indefinite linear systems, or a sequence of such systems. The main interest is the application to truncated Newton methods for the solution of large scale (nonconvex) unconstrained optimization problems, where a sequence of possibly indefinite linear systems (the Newton equations) is required to solve. The preconditioners are iteratively constructed by gaining information as by-product of the Krylov method adopted. In particular, we propose the use of the SYMMBK method, which is specifically suited for large indefinite linear systems. The SYMMBK method is based on the Lanczos algorithm and represents an alternative solver with respect to the usual Conjugate Gradient method, when tackling indefinite problems. This led to a significant improvement of the resulting method both in terms of efficiency and in terms of robustness, as showed by the results of an extensive numerical experience reported.

Keywords: Large scale optimization, Newton-Krylov method, Preconditioning.

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Airport Routing and Scheduling (invited session)

Chair: R. Pesenti

AIROPT1

Air Traffic Optimization and Route Development: The case of Catania Airport

Daniele Casale, F. D'Amico and D. Baglieri

Sept. 10th
17.30-19.30
Pirandello

Abstract Aviation industry plays a vital role in the economic and social development worldwide and traveller demand will keep rising in the next years. As a consequence, airports are increasingly involved in managing route development as a means of attracting and growing air services. Recent studies highlight that market growth has a significant positive on airport performance (Halpern and Graham, 2016). However, little is known about the different levels of route development activity at airports, or the extent to which route development activity affects strategic decision-making. Based on the Catania Airport, this study offers some managerial implications and provides insights for research on air traffic management.
With a turnover of more than 84M Euros in 2017 and a traffic equal to 9.1M passengers, Catania airport is one of the largest companies in Sicily and the most crowded airport in Southern Italy. In addition, it shows one of the highest Compound Annual Growth Rate (CAGR) of the Italian airports system in terms of passengers (Assaeroporti, 2017). In fact, comparing 2012 and 2016 the percentage of passengers on-board of international flights increased, passing from 22% to31%, and the overall number of international passengers has nearly doubled, reaching nearly 2.5 million of international passengers during 2016. Despite this positive performance, the catchment area of Catania airport provides more tourism opportunities, which might be exploited economically. Accordingly, identifying and assessing new routes is prominent to shape strategic growth of Catania airport and to strengthen its role on the local economic development. To support this activity, Catania airport has recently adopted a software tool, "B Route Development" which allows assessing markets and potential new routes and traveling patterns and creating business cases for new or improved routes as well. Findings are exploratory in nature and will improve the understanding of the key factors driving air traffic optimization of regional airports and help to guide policy makers considering regional passenger aviation issues.

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Keywords: air traffic management, airport marketing, route development.

AIROPT2

Effects of aircraft separation on air traffic flow management models

Luigi De Giovanni, Giovanni Andreatta, Lorenzo Capanna, Guglielmo Lulli and Luca Righi

Sept. 10th
17.30-19.30
Pirandello

Abstract The Air Traffic Flow Management (ATFM) problem aims at optimizing flight trajectories taking into account the capacity of the air traffic network resources. To this end, mathematical models for ATFM (e.g. Bertsimas and Stock-Patterson 1998) include capacity constraints at airports and en-route sectors, to limit the number of aircraft that simultaneously use the same resource: for example, in Europe, a feasible plan ensures that the overall number of aircraft entering a sector in one hour is below a given threshold.

Capacities are determined at a strategic phase such that many requirements, including available control facilities and aircraft separation, can be matched. However, the trajectories corresponding to actually filed flight plans in the European Airspace (Eurocontrol, 2017) show that declared capacities are often conservative and a larger number or aircraft is allowed.

Starting from Djeumou Fomeni et al. (2017), we propose a new Integer Programming model for ATFM aiming at better exploiting the available observed capacity. The model considers further flow management actions related to changes in the flight level and includes constraints to guarantee horizontal and vertical aircraft separation. It has been tested on European ATFM instances, and an analysis of the possible improvements that can be obtained in terms of airport throughput, flight delays and costs is presented.

Keywords: Air Traffic Flow Management, Aircraft Separation, Integer Programming.

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AIROPT3

Coordination of scheduling decisions in the management of airport airspace and taxiway operations

Andrea D'Ariano, Francesco Corman, Dario Pacciarelli and Marcella Samà

Sept. 10th
17.30-19.30
Pirandello

Abstract This paper addresses the real-time problem of coordinating aircraft ground and air operations in an airport area. At a congested airport, airborne decisions are related to take-off and landing operations, while ground (taxiway) decisions consist of scheduling aircraft movements between the gates and the runways. Since the runways are the initial/terminal points of both decisions, coordinated actions have a great potential to improve the overall performance. However, in the traffic control practice the different decisions are taken by different controllers, at least in large airports. Weak coordination may result in long queues at the runways, with increasing aircraft delays and energy consumption. This paper investigates models, methods and policies for improving the coordination between taxiway scheduling and airborne scheduling. The performance of a solution is measured in terms of delay and travel time, the latter being related to the energy consumption of an aircraft. A microscopic mathematical formulation [**?**] is adopted to achieve reliable solutions. Exact and heuristic methods [**?**][**?**] have been analyzed in combination with the different policies, based on practical-size instances from Amsterdam Schiphol airport, in the Netherlands. Computational experience shows that good quality solutions can be found within limited time, compatible with real-time operations.

Keywords: Air Traffic Control, Scheduling Policies, Ground Operations, Intelligent Decision Support, Schedule Optimization, Alternative Graph.

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AIROPT4

The path & cycle formulation for the hotspot problem in air traffic management

Giorgio Sartor, Carlo Mannino and Patrick Schittekat

Sept. 10th
17.30-19.30
Pirandello

Abstract Air traffic management involves the coordination of flights in a particular region of the world with the objective of guaranteeing their safety while possibly reducing delays [1]. Each region is subdivided in smaller sectors and the number of airplanes that will occupy each sector in a given time can be forecast taking into account the timetable and the planned route of the airplanes. For safety reasons, a certain capacity is assigned to each sector and a hotspot is defined as a sector in which the predicted number of airplanes is greater than its maximum capacity in at least one point in time. The hotspot problem consists of finding a hotspot-free schedule for the airplanes that minimize delays. In particular, given the route and timetable of a set of flights we assume that the airplanes will fly at constant speed and we focus on choosing their departure times in order prevent hotspots while minimizing the total sum of delays. We present a novel, non-compact formulation for this problem that is alternative to the more conventional big-M. In particular we extend the methodology first developed in [2] that exploits Benders' decomposition to obtain a (master) problem only in the binary variables - plus a few continuous variables to represent the objective function. The decomposition allows us to get rid of infamous big-M coefficients (at the cost of an increased number of linear constraints). Moreover, the constraints of the reformulated master correspond to basic graph structures, such as paths, cycles and trees. The new formulation is obtained by strengthening and lifting the constraints of a classical Benders' reformulation. Preliminary computational results on random but realistic instances show that the new approach favorably compares against the big-M formulation.

Keywords: Mixed Integer Programming, job/shop scheduling, Air Traffic Management

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AIROPT5

Airport slot allocation and uncertainty

Raffaele Pesenti, Tatjana Bolić, Lorenzo Castelli and Paola Pellegrini

Abstract The current airport slot allocation process follows a multiple-step heuristic procedure that aims, on the one side, at respecting the airports' capacities and, on the other side, at minimizing as much as possible the schedule displacement, i.e., the difference between the requested and assigned slot times (see, e.g., Pyrgiotis and Odoni, 2014). As pointed out by Zografos et al. (2012), this procedure is highly inefficient. Recently, Pellegrini et al. (2017) proposed SOSTA, a MILP model for optimization of the slot allocation process at the European scale. In this work, we extend this model to take into consideration the uncertainty that may afflict flight schedules. In particular, the extended model incorporates information on expected delays. This research is motivated by the fact that peak hour slots are very valuable for airlines and subject to secondary market negotiations. The grandfather right rule favors their assignment to incumbent airlines subject only to the use it or loose it condition. However, the practical application of the same rule does not prevent that, eg, in a worst-case scenario, some flights may be constantly late but have assigned high value slots that in fact are not used on the expected times, preventing competing airlines form exploiting these scarce resources.

Sept. 10th
17.30-19.30
Pirandello

Keywords: Slot allocation, Uncertainty, Optimization

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Routing 1

Chair: G. Righini

ROUT1	*A network function virtualization problem with simple path routing* **G. Carello**, B. Addis and M. Gao
ROUT2	*Specification and aggregate calibration of a quantum route choice model from traffic counts* **M. Di Gangi** and A. Vitetta
ROUT3	*Dissimilar arc routing applied to the money collection* **L. Santiago Pinto**, M. Constantino and M.C. Mourão
ROUT4	*Dynamic programming for the electric vehicle orienteering problem with multiple technologies* **G. Righini** and D. Bezzi

ROUT1.1

A Network Function Virtualization problem with simple path routing

Giuliana Carello, Bernardetta Addis and Meihui Gao

Abstract The diffusion of applications, both on computers and mobile devices has yielded to an increasing demand for network services. So far, the network services were provided by expensive hardware appliances, which could not keep up with the ever increasing demand nor allow new services to be embedded at a reasonable cost. Thus, Network Functions Virtualization, according to which hardware appliances are replaced with Virtual Network Functions (VNF) running on generic servers, has been recently proposed to overcome such drawback and allow to flexibly, dynamically and cost-effectively operate network services.
A key problem to implement the Network Functions Virtualization paradigm is the so called VNF chaining problem: VNFs location must be selected among the network nodes and the routing of the demands must be decided, so as to guarantee that each demand can pass through the functions it requires.
In this work we consider a particular case of VNF chaining problem where each demand requires a single service and must be routed on a simple path. Link and service capacity are considered. The goal is to minimize the number of VNF instances installed. We investigate the problem properties and we compare two formulations inspired by the two main modelling strategies proposed in the literature.

Sept. 11th
8.30-10.00
Bellini

Keywords: Virtual Network Functions, location & routing, telecommunication network.

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ROUT1.2

Specification and aggregate calibration of a quantum route choice model from traffic counts

Massimo Di Gangi and Antonino Vitetta

Abstract This paper analyses certain aspects related to the route choice model in transport systems. The effects of an interference term have been taken into consideration in addition to the effect of a traditional covariance term. Both the specification and calibration of an interference term in a quantum route choice model are shown in the context of an assignment model. An application to a real system is reported where the calibration of QUMs (Quantum Utility Models) was performed using traffic counts. Results are compared with traditional and consolidated models belonging to the Logit family. Based on the theoretical and numeric results, it is highlighted how the interference term and quantum model can consider other aspects (such as information) with respect to traditional RUMs (Random Utility Models).

Keywords: Assignment, path choice, quantum.

Sept. 11th
8.30-10.00
Bellini

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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ROUT1.3

Dissimilar arc routing applied to the money collection

L. Santiago Pinto, Miguel Constantino and M. Cândida Mourão

Sept. 11th
8.30-10.00
Bellini

Abstract The Portuguese company in charge of the street parking in Lisboa faces two kinds of problems regarding robberies: the safes in the streets as well as the collecting vehicles. Looking at the safety of the vehicles, routes should be as unpredictable as possible. As safes are spread over the streets, an Arc Routing is a natural approach. Although some studies for node routing problem exist, references on arc routing regarding the safety issue are scarce. We first call this as the Dissimilar Arc Routing Problem (DARP). DARP is defined on a mixed graph. Edges represent narrow two way streets that may be served by only one traversal. Arcs are large two way streets that need to be served each direction, or one way streets. The nodes are street crossings, dead-end streets and a depot, where every tour must start and end. The links that represent streets with safes to be collected are named as tasks. Services should be performed on a daily basis and a planning time horizon of five working days is on focus. The problem aims at finding a set of dissimilar tours, one tour for each day, which minimizes the total time.
To impose dissimilarity, tours are divided into periods, and it is avoided that a same task is scheduled for the same period in different tours. We present a branch and price methodology to tackle this problem. Computational experiments are reported and analyzed.

Keywords: Dissimilar Arc Routing, Mixed Integer Programming Formulation, Branch and Price.

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ROUT1.4

Dynamic programming for the electric vehicle orienteering Problem with multiple technologies

Giovanni Righini and Dario Bezzi

Sept. 11th
8.30-10.00
Bellini

Abstract The Electric Vehicle Routing Problem (EVRP) is a variant of the classical VRP in which vehicles must recharge their battery by visiting recharge stations while traveling along their routes. When the EVRP is solved via column generation, the pricing problem is a variation of the Orienteering Problem or Elementary Shortest Path with Resource Constraints, with a special resource (energy) that can be restored. If several recharge technologies are available and partial recharges are allowed, each route can be travelled with diferent trafe-offs between time and cost, assuming faster recharge technologies to be also more expensive. In terms of dynamic programming states, this means that each label corresponding to a path from the depot to a generic node does not correspond to a single state but rather to as many states as the points in a polyhedron. Such a polyhedron, being defined by minimum and maximum amouts of energy that can be recharged with each technology, has a special structure. We exploit these observations to devise a specialized dynamic programming algorithm suitable for bi-directional extension.

Keywords: Combinatorial optimization, Vehicle routing problem, Dynamic programming.

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Optimization under Uncertainty (invited session)

Chair: F. Maggioni

OPTU1 *Trust your data or not - standard remains standard (QP); implications for robust clustering in social networks*
I. Bomze, M. Kahr and M. Leitner

OPTU2 *A two-stage stochastic model for distribution logistics with transshipment and backordering: stochastic vs deterministic solutions*
R. Cavagnini, L. Bertazzi and F. Maggioni

OPTU3 *A cubic spline interpolation approach for nested CVaR portfolio optimization*
A. Staino and E. Russo

OPTU4 *Bounds for probabilistic constrained problems*
F. Maggioni, A. Lisser and S. Peng

OPTU1

Trust your data or not - standard remains standard (QP); implications for robust clustering in social networks

Immanuel Bomze, Michael Kahr and Markus Leitner

Sept. 11th
8.30-10.00
Empedocle

Abstract In a Standard Quadratic Optimization Problem (StQP), a possibly indefinite quadratic form (the simplest nonlinear function) is extremized over the standard simplex, the simplest polytope. Despite of its simplicity, this nonconvex continuous optimization model is quite versatile and can even serve to solve discrete problems like the Maximum-Clique-Problem. Here we will focus on Clustering in Social Networks applications in a Machine Learning context. A fundamental problem arising in social network analysis regards the identification of communities (e.g., work groups, interest groups), which can be modeled naturally with the framework of StQP. However the problem data are uncertain as the strength of social ties can only be roughly estimated based on observations. Therefore the robust counterpart for these problems refers to uncertainty only in the objective, not in the constraints. It turns out that for the StQP, most of the usual uncertainty sets do not add complexity to the robust counterpart. On the other hand, it is well known that most probably within this problem class, a generic StQP instance is not too hard to solve as the worst cases are hidden in relatively thin manifolds of the class. These hard instances allow for remarkably rich patterns of coexisting local solutions, which are closely related to practical difficulties in solving StQPs globally.

Keywords: Robust optimization, Quadratic optimization, Graph clustering.

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OPTU2

A two-stage stochastic model for distribution logistics with transshipment and backordering: stochastic vs deterministic solutions

Rossana Cavagnini, Luca Bertazzi and Francesca Maggioni

Sept. 11th
8.30-10.00
Empedocle

Abstract We present a two-stage stochastic program for a distribution logistic system with transshipment and backordering under stochastic demand and we first argue that it is NP-hard. Then, we perform a computational analysis based on a distribution network. In the case with two retailers, we show that modeling uncertainty with a stochastic program leads to better solutions with respect to the ones provided by the deterministic program, especially if limited recourse actions are admitted. Although there are special cases in which the deterministic and the stochastic solutions select the same retailers towards which sending items, in general, the deterministic solution cannot be upgraded in order to find the optimal solution of the stochastic program. Finally, in the case with four retailers, transshipment can provide more flexibility and better results.

Keywords: Optimization under Uncertainty, Transshipment, Backordering, Stochastic solution analysis.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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OPTU3

A cubic spline interpolation approach for nested CVaR portfolio optimization

Alessandro Staino and Emilio Russo

Sept. 11th
8.30-10.00
Empedocle

Abstract We propose a time-consistent dynamic portfolio selection model based on the *nested Conditional Value-at-Risk (CVaR) model*. To the authors' knowledge, there are applications of the nested CVaR model only when asset log returns are stagewise independent. For instance, Kozmík & Morton (2015) apply a stochastic dual dynamic programming algorithm to solve the nested CVaR model and propose an approach based on importance sampling to find an upper bound estimator for the optimal objective value. Keeping fixed the assumption of stagewise independence, Dupačová & Kozmík (2015) use a contamination technique to find lower and upper bounds that can be used to test the solution stability. Our contribution moves in the direction of providing a first attempt to apply the nested CVaR model when asset log returns are stagewise dependent and the market is frictionless. Specifically, at a given decisional epoch, the objective function is a composite risk function obtained by a recursive definition of a conditional risk measure, being the latter a convex combination of expected loss and CVaR. The nested CVaR model is presented as a multistage stochastic programming problem in which the underneath uncertainty is described by a scenario tree. Asset log returns are stagewise dependent and the market index volatility is the unique variable affecting the intertemporal dependence. Then, a backward induction scheme is implemented to solve the nested CVaR model and, at each stage, a cubic spline interpolation is applied to manage the computational complexity of the problem.

Keywords: Stochastic programming, Portfolio optimization, Cubic spline interpolation.

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OPTU4

Bounds for probabilistic constrained problems

Francesca Maggioni, Abdel Lisser and Shen Peng

Sept. 11th
8.30-10.00
Empedocle

Abstract Change constrained optimization problems is an important class of optimization problems under uncertainty which involve constraints that are required to hold with specified probabilities. The main difficulty of this class of problems is that its feasible set may happen to be nonconvex, making the optimization highly problematic. For this reason, computationally tractable approximations provided by bounding approaches could be very useful in practice. in this talk we develop bounds for probabilistic constrained problems with single change constraints, joint chance constraits with indipendent matrix vector rows and joint chance constraints with dependent matrix vector rows. The deterministic approximations of probability inequalities are based on the one-side Chebyshev inequality, the Berstein's inequality, Chernoff inequality and Hoeffding inequality and allow to reformulate the chance costrained problem considered in a convex and efficiently solvable way under specific conditions. Approximations based on piecewise linear and tangent approximations are also provided allowing to reduce further the complexity of the problem. Finally, numerical re-sults on randomly generated data are provided allowing to identify the tighter deterministic approximations.

Keywords: Stochastic Programming, Chance Constrained Problems, Bounds.

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Operation and Planning Problems for Energy and Environment (invited session)

Chair: G. Oggioni

OPPEE1	*Stochastic power system expansion planning with emission constraints* **L. Boffino**, A. J. Conejo, R. Sioshansi and G. Oggioni
OPPEE2	*Scheduling energy and reserves under contingencies in isolated power systems with high presence of electric vehicles* **R. Domínguez** and M. Carrion
OPPEE3	*Energy optimization of a speed-scalable and multi-states single machine scheduling problem* **M. Aghelinejad**, Y. Ouazene and A. Yalaoui
OPPEE4	*Expansion planning of a small size electric energy system* **G. Oggioni**, L. Baringo and L. Boffino

OPPEE1

Stochastic power system expansion planning with emission constraints

Luigi Boffino, Antonio J. Conejo, Ramteen Sioshansi and Giorgia Oggioni

Sept. 11th
8.30-10.00
Majorana

Abstract In 2015, 195 countries signed the "Paris Climate Agreement" with the aim of reducing CO_2 emissions worldwide. In order to achieve the reduction targets the Electric Energy Sector needs to be transformed. In this work, we consider a two-stage stochastic programming model for generation and transmission expansion planning that includes both high voltage AC and DC lines and combines renewable and conventional sources together with storage facilities. Short-term and long-term uncertainties are modeled through operating condition and scenarios, respectively. We select 2050 as the final year of our analysis. We explicitly model carbon emissions, studying the effect of CO_2 reduction on investments decisions that transforms a thermal-dominated electric energy system into a renewable-dominated one. Five different case studies are analyzed in order to draw conclusions on both environmental policy and competitive technologies.

Keywords: Generation and transmission expansion planning, CO_2 reduction, stochastic programming.

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OPPEE2

Scheduling energy and reserves under contingencies in isolated power systems with high presence of electric vehicles

Ruth Domínguez and Miguel Carrion

Sept. 11th
8.30-10.00
Majorana

Abstract The use of electric vehicles in isolated power systems represents a beneficial option because of two reasons: first, their participation in the power system operation may allow a less use of fossil-fuel power plants and a better integration of renewable energies; and second, the comparatively shorter distances in small-isolated systems are in accordance with the battery autonomy. Thus, in this work we present a stochastic unit commitment problem to schedule energy and reserve capacity in the day-ahead market considering: i) the uncertainty related to the intermittent renewable production and the demand, ii) the provision of the primary frequency response under a N-1 reliability criterion, iii) different usage patterns of electric vehicles and their participation to provide reserve services to the power system. The model is formulated as a two-stage stochastic programming problem with binary variables. A solution procedure is proposed to solve instances of the problem with a large set of scenarios. Finally, the scheduling model is tested in a real isolated power system comprising 8 nodes and 38 generating units.

Keywords: Electric vehicles, Retailer, Stochastic programming.

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OPPEE3

Energy optimization of a speed-scalable and multi-states single machine scheduling problem

MohammadMohsen Aghelinejad, Yassine Ouazene and Alice Yalaoui

Sept. 11th
8.30-10.00
Majorana

Abstract This study deals with the single-machine scheduling problem to minimize the total energy consumption costs. The considered machine has three main states (OFF, ON, Idle), and the transitions between states OFF and ON are also considered (Turn-on and Turn-off). Each of these states as well as the processing jobs consume different amount of energy. Moreover, a speed scalable machine is addressed in this paper. So, when the machine performs a job faster, it consumes more units of energy than with a slower speed. In this study, two new mathematical formulations are proposed to model this problem, and their efficiency are investigated based on several numerical experiments.

Keywords: Energy efficiency; Single machine scheduling; Time-dependent energy cost; Speed-scalable multi-states system.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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OPPEE4

Expansion Planning of a Small Size Electric Energy System

Giorgia Oggioni, Luis Baringo and Luigi Boffino

Sept. 11$^{\text{th}}$
8.30-10.00
Majorana

Abstract We propose a stochastic adaptive robust optimization approach for the expansion of a small size electricity system problem. This involves the construction of candidate renewable generating units, storage units and charging stations for electric vehicles (EVs). The problem is formulated under the perspective of the Distribution System Operator, which aims at determining the expansion plan that minimizes both investments and operation costs, including the power bought from the main grid. Long-term uncertainties in the future peak demands, in the cost of purchasing power from the main grid, and in number of EVs are modeled using confidence bounds, while short-term uncertainties in the demand variability, in the production of stochastic units, and in the electricity prices are modeled through a number of operating conditions. The effectiveness of the proposed approach is confirmed by the results of an illustrative example.

Keywords: Electric vehicles, expansion planning, robust optimization.

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Operations Research in Health Care: Challenges and New Opportunities 1 (invited session)

Chair: R. Aringhieri

HEAC1.1 *Modelling and solving elective patient admission problems*
V. Solina, R. Guido, G. Mirabelli and D. Conforti

HEAC1.2 *Offline patient admission, room and surgery scheduling problem*s
R. Guido, V. Solina, G. Mirabelli and D. Conforti

HEAC1.3 *Reducing overcrowding at the emergency department through a different physician hand nurse shift organisation: a case study*
G. Bonetta, R. Aringhieri and D. Duma

HEAC1.4 *Integrating mental health into a primary care system: a hybrid simulation model*
R. Aringhieri, D. Duma and F. Polacchi

HEAC1.1

Modelling and solving elective patient admission problems

Vittorio Solina, Rosita Guido, Giovanni Mirabelli and Domenico Conforti

Abstract Recently, interest in hospital bed assignment has increased. Patient admission scheduling problems are very challenging. Main decisions are about the period of hospitalization of the patients and their assignment to hospital rooms in a well-defined planning horizon. For each patient, the earliest admission date, the latest admission date and the length of stay are known. Some patients have an overstay risk, then they could extend the hospital stay. Each room has a defined capacity, a gender policy, a level of expertise in treating each specialty, a set of available equipment, that could be mandatory or preferred for patients. In the literature, this problem was solved in an online manner. The aim of this work is to model and solve the offline problem by an efficient matheuristic. The proposed optimization model is presented in a sparse version and tested on a set of 150 benchmark instances, characterized by real-world features. Our results are very close to the computed lower bound values. This confirms the validity of the solution approach that allows to obtain optimal/sub-optimal solutions in a short computational time.

Sept. 11th
8.30-10.00
Pirandello

Keywords: Combinatorial Optimization, Patient Admission, Scheduling

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HEAC1.2

Offline patient admission, room and surgery scheduling problems

Rosita Guido, Vittorio Solina, Giovanni Mirabelli and Domenico Conforti

Sept. 11th
8.30-10.00
Pirandello

Abstract Patient admission and surgery scheduling is a complex combinatorial optimization problem. It consists on defining patient admission dates, assigning them to suitable rooms, and schedule surgeries accordingly to an existing master surgical schedule. This problem belongs to the class of NP-hard problems. In this paper, we firstly formulate an integer programming model for offline patient admissions, room assignments, and surgery scheduling; then apply a matheuristic that combines exact methods with rescheduling approaches. The matheuristic is evaluated using benchmark datasets. The experimental results improve those reported in the literature and show that the proposed method outperforms existing techniques of the state-of-the-arts.

Keywords: Combinatorial optimization, Patient admission scheduling, Surgery scheduling, Matheuristic.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEAC1.3

Reducing overcrowding at the emergency department through a different physician and nurse shift organisation: a case study

Giovanni Bonetta, Roberto Aringhieri and Davide Duma

Abstract Overcrowding is a widespread problem affecting the performance of an Emergency Department (ED). In this paper we deal with the overcrowding problem at the ED sited at *Ospedale Sant'Antonio Abate di Cantù*, Italy. Exploiting the huge amounts of data collected by the ED, we propose a new agent-based simulation model to analyse the real impact on the ED overcrowding of a different physicians and nurses shift organisations. The proposed simulation model demonstrates its capability of analysing the ED performance from a patient-centred perspective.

Sept. 11th
8.30-10.00
Pirandello

Keywords: emergency department, overcrowding, agent based simulation.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEAC1.4

Integrating mental health into a primary care system: a hybrid simulation model

Roberto Aringhieri, Davide Duma and Francesco Polacchi

Sept. 11th
8.30-10.00
Pirandello

Abstract Depression and anxiety appear to be the most frequently encountered psychiatric problems in primary care patients. It has been also reported that primary care physicians under-diagnose psychiatric illness in their patients. Although collaborative care has been shown to be a cost-effective strategy for treating mental disorders, to the best of our knowledge few attempts of modelling collaborative care interventions in primary care are known in literature. The main purpose of this paper is to propose a hybrid simulation approach to model the integration of the collaborative care for mental health into the primary care pathway in order to allow an accurate cost-effectiveness analysis. Quantitative analysis are reported exploiting different and independent input data sources in order to overcome the problem of the data appropriateness. The analysis demonstrates the capability of the collaborative care to reduce the usual general practitioner overcrowding and to be cost-effective when the psychological treatments have a success rate around the 50%.

Keywords: mental health, collaborative care pathway, cost effectiveness, discrete event, agent based, hybrid simulation.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Mini Workshop, Session I - Sportello Matematico: Experiences, Perspectives and Success Stories of Technology Transfer and Operational Research

Chair: A Sgalambro

SM1 *Sportello Matematico, a project for industrial transfer of mathematical technologies: an introduction*
M. Ceseri

SM2 *The role of technology translator: the journey from the first contact to the research contract*
S. Vermicelli

SM3 *A success story of Operational Research on the dairy industry*
F. Maggioni and **A. Melchiori**

SM4 *Open discussion: lessons learned and forward look*
A. Sgalambro

Paths

Chair: P. Festa

PATH1

Mathematical formulations for the optimal design of Resilient Shortest Paths

Marco Casazza, Alberto Ceselli and Andrea Taverna

Abstract We study a Resilient Shortest Path Problem (RSPP) arising in the literature for the design of communication networks with reliability guarantees. A graph is given, in which every edge has a cost and a probability of availability, and in which two vertices are marked as source and destination. The aim of our RSPP is to find a subgraph of minimum cost, containing a set of paths from the source to the destination vertices, such that the probability that at least one path is available is higher than a given threshold. We explore its theoretical properties and show that, despite a few interesting special cases can be solved in polynomial time, it is in general NP-hard. Computing the probability of availability of a given subgraph is already NP-hard; we therefore introduce an integer relaxation that simplifies the computation of such probability, and we design a corresponding exact algorithm. We present computational results, finding that our algorithm can handle graphs with up to 20 vertices within minutes of computing time.

Sept. 11th
11.30-13.00
Empedocle

Keywords: Branch and price, column generation, network reliability, shortest path problem.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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PATH2

Reoptimizing shortest paths: recent advances

Serena Fugaro, Paola Festa and Francesca Guerriero

Sept. 11th
11.30-13.00
Empedocle

Abstract A wide variety of applications in logistics and transportation often requires to solve a sequence of shortest path problems (SPPs), in which two subsequent instances solely differ by a slight change in the graph structure. Examples of such changes can be related to the variation of the cost of a subset of arcs, the change of the source node of the shortest path, or a combination of both. In contrast to solution approaches that solve each SPP *ex-novo*, the goal of reoptimization consists in the reduction of the computational effort required, solving the k^{th} SPP reusing valuable information gathered in the solution of the $(k-1)^{th}$-instance of the sequence. In scientific literature, in-depth investigations have been published concerning changes of source node or in cost of a single arc (e.g. [2], [3]). In this work, we focus on more general cases, in which multiple cost changes for any subset of arcs are allowed. We propose an efficient implementation of the algorithmic strategy described by Pallottino and Scutell [1], in which the reoptimization paradigm is carried over with a two-phase dual-primal approach.

Keywords: Shortest path, reoptimization, dual approach.

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PATH3

Complexity analysis and optimization of the constrained shortest path tour problem

Paola Festa, Luigi Di Puglia Pugliese, Daniele Ferone and Francesca Guerriero

Sept. 11th
11.30-13.00
Empedocle

Abstract Given a directed graph with non-negative arc lengths, the Constrained Shortest Path Tour Problem (CSPTP) is aimed at finding a shortest path from a single-origin to a single-destination, such that a sequence of disjoint and possibly different-sized node subsets are crossed in a given fixed order. Moreover, the optimal path must not include repeated arcs. In this talk, theoretical properties of the problem will be discussed, proving that it belongs to the complexity class NP-complete. To exactly solve small sized instances, a Branch & Bound method will be described. To find near-optimal solutions for medium to large scale instances, a Greedy Randomized Adaptive Search Procedure will be proposed. To empirically evaluate the performance of the proposed approaches, we will analyze the results of computational experiments carried out on a significant set of test problems.

Keywords: Shortest path problems, Network flow problems, Combinatorial optimization, Branch & Bound, GRASP.

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References

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Optimization Models for Social and Financial Sustainability (invited session)

Chair: R. Riccardi

OPTFS1

Contract design in electricity markets in presence of stochasticity and risk aversion: a two stages approach

Arega Getaneh Abate, Rossana Riccardi and Carlos Ruiz Mora

Abstract In the last three decades,an increasing number of countries worldwide have liberalized their electricity power sectors. Electricity prices are now determined by an equilibrium of supply and demand, which introduces a substantial price risk with volatilities much higher than those of equity prices. A big share of the total electricity in liberalized power markets is traded over the counter through bilateral agreements: it has been completed for some years in Scandinavia and the United Kingdom, is well under way in the United States and being embraced in most continental Western Europe,[1] Germany and the Netherlands are quite deregulated, followed by Spain. Italy is establishing power trading in a competitive environment. This represents a multi-billion spot market that is developing very quickly. And the same pattern of evolution as in the financial markets is being observed, with the growth of a variety of derivative instruments such as forward and futures contracts, swaps, plain-vanilla and exotic options ((i.e. non-standard) options like spark spread options, swing options and swap options). In liberalized electricity markets, business risks can be effectively managed through contracts. Generators, retail suppliers and consumers can agree on prices, volumes, times and other conditions that create the desired certainty within the framework of the contract. In fact, liquid and effective markets for financial contracts improve competition by enabling sophisticated risk management. This, in turn, eases market access for new and smaller market players and contributes to ensuring that market power is not exercised. Most

Sept. 11th
11.30-13.00
Majorana

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[1] European reform was pursued at two parallel levels. First, under EU Electricity Market Directives, member countries were required to take at least a minimum set of steps by certain key dates toward the liberalization of their national markets. Second, the European Commission promoted efforts to improve the interfaces between national markets by improving cross-border trading rules, and to expand cross-border transmission links.

markets provide a framework for a liquid market in the day-ahead and real-time segments through market rules and design. As electricity markets mature throughout the world, futures markets become more and more liquid and relevant for electricity trading. Futures markets allow trading products (mainly forward contracts and options) spanning a large time horizon, e.g., one month, while spot markets are typically cleared on an hourly basis throughout the time periods spanned by the futures market products. Thus, futures and spot markets interact and such interaction results in multi-market equilibria (Ruiz et al., 2013). Ruiz et al. in Ruiz et al. (2013) provide an electricity equilibrium model involving a futures market and a collection of successive spot markets within the time span of the considered future derivatives. They conclude that the analytical results obtained are applied to a market involving different competition levels: monopoly, cartel, conjectural variation, Cournot and perfect competition. However, the aforementioned research did not include uncertainty (both production cost uncertainty and demand uncertainty) and different contracts in their model. Therefore, using Ruiz et al. (2013) as a departure, in this work, we develop a single spot market and a single futures market equilibrium models under uncertainty. Moreover, we add contract design (particularly, contracts for differences and two part tariffs contracts) between oligopolistic electricity producers in the presence of stochasticity with a two stages approach. We assume a single futures market that is cleared prior to the spot market. Thus, the quantities sold in the futures market are to be delivered at the time when the single spot market takes place. Therefore, the novelty in our work is that we develop a simplified single spot market and introduce the two contracts in the presence of stochasticity, that mainly focuses on cost uncertainty and demand uncertainty, knowing that price and quantity are decided in advance. Contracts for differences and two part tariffs are assessed as a coordination mechanism for risk hedging and investment, which is also inspired by Oliveira et al. (2013). Finally, since operators are usually risk averse, a coherent risk measure is introduced to deal with both risk neutral and risk averse operators. To that end, this work has thrived to come across with the objective of developing simple and realistic models for the volatile and recently deregulated electricity market that can be recast as a mixed linear complementarity problem. Equilibrium conditions at each spot market are described as a function of the futures market decision variables, which in turn allows describing the equilibrium in the futures market implicitly enforcing equilibrium in each spot market.

Keywords: Spot and future electricity markets, Stochastic programming, Risk aversion.

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OPTFS2

The effect of additional resources for disadvantaged students: evidence from a conditional efficiency model

Giovanna D'Inverno, Kristof De Witte and Mike Smet

Sept. 11th
11.30-13.00
Majorana

Abstract Inequalities in educational and lifelong learning opportunities prevent individuals from reaching their full potential and their personal satisfaction. To reduce the impact of disadvantaged backgrounds on educational achievement, many policies have been promoted. Among them, the Flemish Community of Belgium offers an interesting setting given the inequality level experienced by its educational system. Specifically, the Flemish Ministry of Education enacted a program to provide additional funding to schools with a significant proportion of disadvantaged students. These additional resources are allocated according to an exogenous cut-off. We exploit this information toevaluate the effect of additional fundingfor disadvantaged students on educational outcomes by using a conditional efficiency analysis. Particular attention is devoted to the impact of socio-economic background variables.Our analysis relies on administrative data on students in secondary education in Flanders.

Keywords: Conditional efficienc, Education, School resources, Educational outcomes, Disadvantaged students.

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OPTFS3

A Genetic Algorithm Framework for the Orienteering Problem with TimeWindows

Francesco Santoro, Claudio Ciancio, Annarita De Maio, Demetrio Laganà and Antonio Violi

Sept. 11th
11.30-13.00
Majorana

Abstract The Orienteering Problem (OP) is a routing problem which has many applications in logistics, tourism and defense. Given a set of nodes, where each node represents a Point of Interest (POI), the orienteering problem aims to design a tour leaving from a starting POI, visiting a subset of POIs and finally arriving at the ending POI. The objective of the problem is to maximize the total score of the visited POIs while the total travel time and the total cost of the route do not exceed two predefined thresholds. Each POI is characterized by a score, a position, a visit time, and a time window in which the POI can be visited. This problem is often investigated to develop tourism trip planning mobile applications. Usually these apps must be able to generate good solutions in few seconds. Therefore, the use of efficient heuristic approaches to find good quality solutions is needed. In this paper we present a genetic algorithm framework combined with some local search operators to deal with the analyzed problem.

Keywords: Orienteering Problem, Tourist Trip Design Problem, Local Search, Genetic Algorithm.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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OPTFS4

Efficiency valuation of green stocks and portfolio construction: a two stage approach

Rossana Riccardi, Elisabetta Allevi, Antonella Basso and Giorgia Oggioni

Sept. 11th
11.30-13.00
Majorana

Abstract Nowadays, beside classical financial aspects, new relevant social requirements are perceived as important and need to be included in the construction of an investment portfolio. In particular, the environment is rapidly becoming a factor as relevant in an investment decision as more traditional financial elements such as liquidity or competition, since investors' mandates involve contributing to public policy goals, and one of the most important among these is climate mitigation. Many initiatives are born around the climate change mitigation of investors' portfolios and this is one of the main theme identified by the sustainable finance literature. In this paper, we evaluate and manage a "green" investment portfolio that integrates classical financial tasks with some environmental issues. We first propose two synthetic indicators of environmental sustainability which effectively inform financial agents on the "greenity" of their investments. These alternative indicators could serve as an overall measure of environmental sustainability; they will also overcome the drawback that limits the evaluation of green investments to the measurement of CO_2 emissions. Then, we propose alternative integrated methods for portfolio optimization that involves decisions on stock screening, stock selection, and capital allocation. A two steps approach is adopted: in the first step a wide set of relevant stocks are screened in order to find a group of potential investment targets that are simultaneously profitable and green. For this selection procedure we use a suitable data envelopment analysis (DEA) model with different selection methods. In the second step we apply an ad-hoc Mean-Variance portfolio optimization model to determine the allocation of capital to each stock in the final portfolio. The analysis is carried out on a sample period of five years (taking as benchmarks the STOXX All Europe 100 and EURONEXT indices), using a moving window approach to con-

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struct a green portfolio and evaluate its performance with periodic rebalance of the portfolio.

Keywords: Green investments, DEA, Markowitz portfolio selection.

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Operations Research in Health Care: Challenges and New Opportunities 2 (invited session)

Chair: P. Cappanera

HEAC2.1	*Resource allocation in an Emergency Department: an integrated process mining and online optimisation approach* **D. Duma** and R. Aringhieri
HEAC2.2	*Cooperative policies for drug replenishment at intensive care units* **R. Rossi**, P. Cappanera, M. Nonato and F. Visintin
HEAC2.3	*Quantifying externalities in decision making: a case study in healthcare access measurement* **M. Gentili** and M. Mohammadi
HEAC2.4	*The generalized Skill VRP: time windows, precedence constraints and device uncertainty* **P. Cappanera**, C. Requejo and M.G. Scutellà

HEAC2.1

Resource allocation in an Emergency Department: an integrated process mining and online optimisation approach

Davide Duma and Roberto Aringhieri

Sept. 11th
11.30-13.00
Pirandello

Abstract The Emergency Department (ED) management presents a really high complexity due to the admissions of patients with a wide variety of diseases and different urgency, which require the timely execution of different activities involving human and medical resources. Furthermore, unpredictability and high variability of the patient arrivals make the resource allocation a very challenging problem.
We propose a two-phase approach. In the first phase, we develop an ad hoc process mining algorithm to to deal with the unstructured ED process. Such an algorithm allows us to obtain a process model capable (i) to replicate properly the patient paths, and (ii) to predict the next activities to be performed. In the second phase, we propose a simulation model to represent the ED process, in which several online optimisation policies are embedded to deal with the resource allocation. Such policies exploit the prediction mined from the ED dataset in the first phase of our approach. A quantitative analysis is provided to compare the online optimisation methods with the real case policy, focusing on performance indices that take into account the patient-centred perspective.

Keywords: Emergency Department, Process Mining, Online optimisation

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HEAC2.2

Cooperative policies for drug replenishment at Intensive Care Units

Roberta Rossi, Paola Cappanera, Maddalena Nonato and Filippo Visintin

Sept. 11th
11.30-13.00
Pirandello

Abstract This paper addresses the effects of lateral transshipment within a drug Day hour Room inventory policy in a real case-study involving two Intensive Care Units. An extension of a previous developed integer linear programming model is proposed, which decides when, what and how much to order, ensuring orders regularity. Preliminary results on realistic instances suggest the potential advantage in terms of reduction of order occurrences while using excess stock efficiently and profitably. This analysis is a first step towards the introduction of the cooperative model within an optimization-simulation tool deployed in a rolling-horizon framework.

Keywords: Cooperation, lateral transshipment, point-of-use drugs inventory, hospital logistics.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEAC2.3

Quantifying externalities in decision making: a case study in healthcare access measurement

Monica Gentili and Mohsen Mohammadi

Sept. 11th
11.30-13.00
Pirandello

Abstract We introduce a novel approach to quantify externalities of an optimized solution taken under uncertainty. Specically, we address the outcome interval problem which constists of determining the best and worst values of a given linear function (namely, the outcome function) of the optimal solutions of an interval linear optimization problem. We present some theoretical properties of the problem and solve it heuristically and exactly. We apply the proposed approach using a specific application in healthcare access measurement. Our experimental results show that the proposed approach is a useful tool for reliable decision making.

Keywords: Interval linear programming, Optimization under uncertainty, Healthcare access management.

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HEAC2.4

The generalized Skill VRP: time windows, precedence constraints and device uncertainty

Paola Cappanera, Cristina Requejo and Maria Grazia Scutellà

Sept. 11th
11.30-13.00
Pirandello

Abstract The Skill VRP has been addressed in [1] and [2]. Here we study a generalization that incorporates very realistic temporal constraints, the management of special devices, and uncertainty aspects, making the problem particularly significant in application contexts such as Field Service and Home Care.
We are given a directed network where nodes correspond to clients, a set of (partially ordered) operations required by each client, a set of available technicians, and a set of operations each technician is skilled to perform. An operation may also require the use of a special device. Given technician dependent travelling costs, we study the problem of defining the tours for the technicians and for the special device, while respecting skill compatibility constraints among clients and technicians, the partial ordering relation associated with operations at each client, time window constraints at the clients, maximum workday duration of the technicians and synchronization. The objective function, to be minimized, is the overall travelling cost. Then, uncertainty on availability of the special device is addressed. We propose a mathematical model for the generalized Skill VRP, and a robust model for its uncertain counterpart, by reporting the results of preliminary computational experiments.
Keywords: Skill VRP, temporal constraints, robustness.

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References

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Mini Workshop, Session II - Practice of OR - Having Impact on the Outside World: Spin-off and Start-up Experiences in Italy 1

Chair: L. Palagi

PROR1.1	*The Euro Working Group on Practice of OR: opportunities and challenges*
	M. Pozzi, co-founder of the EURO Working Group on Pactice of OR
PROR1.2	*OR in the railway industry: OptRail's story*
	L. Lamorgese, OPTRAIL srl
PROR1.3	*Applications of OR and ML techniques to the retail business*
	P. Riva, ORS Group
PROR1.4	*OAKS: machine learning and optimization for utilities, supply chain and marketing*
	I. Giordani, OAKS srl

PROR1.1

The Euro Working Group on Practice of OR: opportunities and challenges

Matteo Pozzi

Abstract A new EURO working group on Practice of OR was created in late 2017 to aggregate practitioners from all industries, that apply OR in real life business processes.
The group has managed to attract a significant group of players, ranging from OR-based consultancies to industrial players with significant OR teams, who gathered in February 2018 in Paris Saclay in the first conference focused on "Measuring Impacts of OR projects".
Following the recent EURO conference, where the group promoted a number of initiatives within the "Making an Impact" stream, the ever-growing community is now targeting the next conference, to be held in Bologna in March 2019.
This session will introduce the Working Group's objectives and structure, highlighting key opportunities and challenges that the industry is facing, in order to promote awareness and contribution from all interested parties.

Keywords: Euro Working Group, Practitioner.

Sept. 11th
14.30-16.00
Bellini

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PROR1.4

OAKS: machine learning and optimization for utilities, supply chain and marketing

Ilaria Giordani

Sept. 11th
14.30-16.00
Bellini

Abstract OAKS (Optimization, Analytics, Knowledge and Simulation) is an innovative startup founded at the end of 2017 by a group of Researchers with Operation Research and Computer Science background with experience in deploying innovative Data Management & Analytics solutions for supporting key industrial needs. ?Indeed, starting from specific industrial and business needs, OAKS offers effective data management and data analytics solutions with the possibility to design and develop specific tailored solutions, which integrate Machine Learning & Optimization services. Specific products have been already developed in different sectors, such as critical infrastructures (e.g. water utilities), supply chain (e.g. inventory management for perishable and pharmaceutical products), finance (e.g. fast streaming data acquisition and real time analysis), media, marketing & sales (e.g. social and multimedia data analysis to support marketing strategies).?Recently, OAKS has enriched its team with people with managerial expertize in the industrial and marketing sectors to improve its commercial strength and market uptake opportunities.

Keywords: Machine Learning & Optimization, Streaming and network analytics, Natural Language Processing..

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Heuristic and Metaheuristic 2

Chair: A. Ceselli

HEUR2.1	*Modelling local search in a knowledge base system*
	S. Pham. P. De Causmaecker and J. Devriendt
HEUR2.2	*Local search techniques for nurse roste ring*
	S. Ceschia, R. Guido and A. Schaerf
HEUR2.3	*Data driven local search algorithms for improving MIP decompositions*
	A. Ceselli and S. Basso

HEUR2.1

Modelling local search in a Knowledge Base System

San Tu Pham, Patrick De Causmaecker and Jo Devriendt

Abstract In this paper we present how the basic building blocks of local search approaches problem constraints, neighbourhood moves, objective function, move evaluations can be modelled declaratively using $FO(\cdot)$, an extension of first order logic. We extend the Knowledge Base System IDP with three built-in local search heuristics, namely first improvement, best improvement and tabu search, which take those building block specifications as input and execute local search accordingly. To demonstrate the framework, three neighbourhood moves for three different problems are modelled and tested.

Sept. 11th
14.30-16.00
Empedocle

Keywords: Local search; Metaheuristics; Knowledge base system.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEUR2.2

Local search techniques for nurse rostering

Sara Ceschia, Andrea Schaerf and Rosita Guido

Sept. 11th
14.30-16.00
Empedocle

Abstract The management of a healthcare institution is a complex task. Among all the planning and scheduling problems arising in a hospital, the nurse rostering problem has particularly attracted the attention of the research community, thanks also to the two International Nurse Rostering Competitions (INRC-I and INRC-II).
The problem proposed for INRC-II (Ceschia et al., 2018) considers several customary constraints, such as staff requirements, nurses with different skills, limits on the number of consecutive assignments and days-off, preferences, and week-end duties. However, differently from most of the problem formulations presented in the literature, it assumes that staff requirements and nurse preferences become available dynamically and it requires to be solved in multiple stages, one for each week of the planning horizon.
This work addresses the *static version* of the INRC-II problem, which is based on the assumption that information is completely available from the beginning. We devise a local search algorithm, driven by a Simulated Annealing metaheuristic, that works on a search space that includes also infeasible solutions. It uses a combination of large neighborhoods that either change nurse assignments (working shift or day-off) or swaps the assignments of two compatible nurses, for multiple consecutive days. In case of multi-day changes, the selection of the next shift depends also on the previous assignment, so as to handle consecutiveness constraints. The algorithm also relies on a greedy selection of the skill assignment for multi-skill nurses.
The study and experiments are ongoing, however the first results on the competition benchmarks, which will be presented at the conference, are encouraging with respect to the state-of-the-art ones on this problem (Wickert et al. 2016, Legrain et al. 2017).

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Keywords: Nurse Rostering, Large Neighborhoods, Simulated Annealing.

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HEUR2.3

Data driven local search algorithms for improving MIP decompositions

Alberto Ceselli and Saverio Basso

Sept. 11th
14.30-16.00
Empedocle

Abstract Motivated by the perspective of building general purpose solvers for Mixed Integer Programs (MIP), which are able to automatically exploit decomposition techniques, we tackle the problem of identifying good decomposition patterns. In particular, our research targets the design of *detectors*, that is algorithmic components taking as input a generic MIP instance, and producing as output a suitable decomposition pattern for it. When input MIP instances have no previously known inner structure, such a task is complicated by many features, the most critical one being the following: decomposition patterns are typically scored according to the computational performance they yield (namely dual bound quality at the root node of a branching tree, and computing effort needed to obtain it), which is know only after running simulations. Algorithmic detectors, instead, are assumed to work in a preprocessing phase, when only static algebraic properties of MIP instances can be observed. In this talk we review our recent attempts exploiting a data driven approach: we build models with supervised learning techniques, exploiting a large training set of simulations on random decompositions. Then we propose novel techniques which explore the option of (a) using regression techniques for mapping static properties of MIP instances and decomposition patterns to computational performance features (b) using these regression models to score decompositions while exploring suitable neighborhoods in a local search algorithm. We report computational results on instances drawn from the MIPLIB.

Keywords: Dantzig-Wolfe decomposition, Machine Learning, Local Search.

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Applications of Stochastic Optimization (invited session)

Chair: P. Beraldi

STOCH1

A deterministic approximation for the long-term capacitated supplier selection problem with total quantity discount and activation costs under uncertainty

Daniele Manerba, Guido Perboli and Roberto Tadei

Sept. 11th
14.30-16.00
Majorana

Abstract Capacitated Supplier Selection problem withTotal Quantity Discount and Activation Costs (CTQD-AC) is a multi-supplier multi-product procurement problem includingsupplier selection, total quantity discount policies, restricted availabilities of the products at the suppliers, and business activation costs. To model realistic procurement settings in the long-term period, the CTQD-AC has been studied in its stochastic counterpart by explicitly considering different sources of uncertainty, such as product demand and prices (Manerba et al., 2018). However, due to the computational burden of solving stochastic models, only relatively small instances can be efficiently addressed. For this reason, following Tadei et al. (2012, 2017), we propose a deterministic approximation of the stochastic CTQD-AC problem that works under a mild assumption on the probability distribution of the random variables. The quality of our approximation is tested against the classicaltwo-stage Stochastic Programming approaches existing in the literature.

Keywords: Procurement logistics, Total Quantity Discount, Deterministic approximation.

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STOCH2

Comparative Statics via Stochastic Orderings in a Two-Echelon Market with Upstream Demand Uncertainty

Stefanos Leonardos, Constandina Koki and Costis Melolidakis

Sept. 11th
14.30-16.00
Majorana

Abstract We revisit the classic Cournot model and extend it to a two-echelon supply chain with an upstream supplier who operates under demand uncertainty and multiple downstream retailers who compete over quantity. The suppliers belief about retail demand is modeled via a continuous probability distribution function F. If F has the *decreasing generalized mean residual life (DGMRL)* property, then the suppliers optimal pricing policy exists and is the unique fixed point of the *mean residual life (MRL)* function. This closed form representation of the suppliers equilibrium strategy facilitates a transparent comparative statics and sensitivity analysis. We utilize the theory of stochastic orderings to study the response of the equilibrium fundamentals wholesale price, retail price and quantity to varying demand distribution parameters. We examine supply chain performance, in terms of the distribution of profits, supply chain efficiency, in terms of the *Price of Anarchy*, and complement our findings with numerical results.

Keywords: Continuous Distributions, Demand Uncertainty, Generalized Mean Residual Life, Comparative Statics, Sensitivity Analysis, Stochastic Orders.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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STOCH3

Impulse and singular stochastic control approaches for management of fish-eating bird population

Yuta Yaegashi, Hidekazu Yoshioka, Koichi Unami and Masayuki Fujihara

Abstract Stochastic optimization serves as a central tool for effective population management. We present an impulse control model and a related singular control model for finding the cost-effective and sustainable population management policies of fish-eating birds, a predator of fishery resources. The impulse control model considers the cost proportional to the amount of the killed bird and the fixed cost, while singular counterpart considers only the proportional cost. Their optimal controls from both qualitative and quantitative viewpoints are discussed.

Sept. 11th
14.30-16.00
Majorana

Keywords: Stochastic optimization, impulse control, singular control, threshold-type population management.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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STOCH4

The optimal tariff definition problem for a prosumers' aggregation

Patrizia Beraldi, Maria Elena Bruni, Gianluca Carrozzino, Massimiliano Ferrara and Antonio Violi

Sept. 11th
14.30-16.00
Majorana

Abstract This paper deals with the problem faced by an aggregator in defining the optimal tariff structure for a group of prosumers aggregated within a coalition. The random nature of the main parameters involved in the decision process is explicitly accounted for by adopting the stochastic programming framework and, in particular, the paradigm of integrated chance constraints. Numerical experiments carried out on a realistic test case shows the efficacy of the proposed approach in providing more profitable rates for both consumers and producers with respect to the standard market alternatives.

Keywords: Microgrid; Tariff definition; Chance constraints.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Railway Optimization (invited session)

Chair: V. Cacchiani

ROPT1	*Model-based and data-driven approaches for railway traffic management and energy efficient operations* **F. Corman**, X. Luan and V. De Martinis
ROPT2	*Construction of discrete time graphs from real valued railway line data* **S. Harrod**
ROPT3	*Maintenance of railway rolling stock and timetable integration* **L. Bach** and D. Palhazi Cuervo
ROPT4	*Line planning and train timetabling using passenger demand data* **V. Cacchiani**, D. Huisman, G.-J. Polinder and M. Schmidt

ROPT1

Model-based and data-driven approaches for railway traffic management and energy efficient operations

Francesco Corman, Xiaojie Luan and Valerio De Martinis

Sept. 11th
14.30-16.00
Pirandello

Abstract Railway systems must increase their performance and economic competitiveness to remain an effective and efficient transport mode. In realtime traffic management dispatching aims at adjusting the impacted schedule and reducing negative consequences during disruption, focusing on reducing delays, and increasing punctuality. Energy efficient operations are also increasingly important, as they relate to operational cost and keeping the environmental advantage with regard to other modes. Typical models existing in academia focus on either of those two problems, as the interaction of real-time traffic management (retiming, reordering, rerouting) and train control (changing speed profile) is particularly difficult to include in linear, or mixed integer linear models. We discuss in this talk multiple innovative integrated optimization approaches for real-time traffic management that inherently include train control, and deliver both a train dispatching solution (including train routes, orders, departure and arrival times at passing stations) and a train control solution (i.e., train speed trajectories). Different ways to solve the non linearities of those formulations are proposed, showing to which extent correct, model-based approach can reach in describing non linear complex dynamics related to speed and acceleration. On the otehr hand, from a practical point of view, pure model-based approaches are shown to depend heavily on assumptions on parameters and dynamic and kinematic equations. In a real-time perspective, those might be hard to estimate, compute and disseminate with the required precision. An opportunity to go beyond this assumption-heavy approach is to embrace data driven methodologies. We discuss the weak and strong points of model-based versus data driven approaches, referring to a practical test case based on real on-board monitoring of electric trains. A

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roadmap on the interplay of model-based and data-driven approaches for improving energy efficiency of railway systems is also proposed.

Keywords: Railway Traffic, Energy Efficiency, Data-Driven.

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ROPT2

Construction of Discrete Time Graphs from Real Valued Railway Line Data

Steven Harrod

Abstract Railway timetables are frequently modeled as discrete time expanded graphs. The selection of the magnitude of the discrete time unit can significantly alter the structure of the graph and change the solutions generated. This paper presents a method for generating improved mappings of real railway track segments to discrete arc graphs given a chosen discrete time unit. The results show that the dimensions of the generated graph are not monotonic and a range of values should be evaluated.

Keywords: Railway Timetable, Discrete Optimization, Railway Operations.

Sept. 11$^{\text{th}}$
14.30-16.00
Pirandello

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ROPT3

Maintenance of railway rolling stock and timetable integration

Lukas Bach and Daniel Palhazi Cuervo

Sept. 11th
14.30-16.00
Pirandello

Abstract When planning the maintenance of a large fleet of railway rolling stock. Each of the rolling stock units should be serviced following their maintenance program: a specification of the (maintenance) tasks the rolling stock should be subject to. Overall, a maintenance program defines the following information about each task: The requirements in terms of personnel, equipment and spare parts. The task's cycle or, in other words, how often the task should be carried out. This might depend on the number of kilometers traversed by the vehicle, the number of days the vehicle is in active operations, and/or a maximum period of time that is allowed between two consecutive executions of the task.
Currently, in the case we study, all the maintenance tasks are carried out as close to their expected deadline as possible. The main problem with this approach, however, is the strong seasonality that emerges in the workload of the maintenance depots. The depots have capacity to cope with the workload peaks, which leads to unutilized resources in time periods that are less busy. Considering the rotation of the rolling stock in combination with the maintenance appointments is no trivial task. When turning to the literature, there is a clear trend to integrate multiple problems and solve them one single approach when possible. In Giacco et al. (2014) a rolling stock rostering problem is designed to consider that the rolling stock is supposed to visit maintenance depots. A similar problem is addressed by Andres et al. (2015).
We present a model, that for each maintenance task, determine the time and the depot in which it should be carried out. Such that: the deadlines of the tasks in the maintenance programs of each rolling stock is respected. The capacity of the depots is not exceeded. The maintenance tasks to be carried out in a single day (in a maintenance depot) can be arranged into work packages that are feasible for the crew to execute. The plan is feasible with respect to schedule of the rolling stock.

Keywords: Railway, Maintenance, Scheduling.

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Line planning and train timetabling using passenger demand data

Valentina Cacchiani, Dennis Huisman, Gert-Jaap Polinder and Marie Schmidt

Abstract Line planning and train timetabling are typically solved in sequence. Line planning determines the optimal train lines, with the corresponding stopping pattern and frequency, by taking into account passenger demand data. Train timetabling starts from the given line plan and determines the optimal train timetables, while satisfying railway infrastructure constraints. This sequential approach can lead to timetables that are not satisfactory from the passengers point of view. In this work, we propose an iterative framework to determine timetables that are good from a passenger perspective. We iteratively combine two modules: the first one consists of a PESP-based timetabling model that minimizes the weighted sum of waiting time at the departure station and travel time of all passengers, but neglects railway infrastructure constraints. The second module is a Lagrangian-based heuristic algorithm that aims at modifying as little as possible the timetables obtained by the first module, while guaranteeing railway infrastructure constraint satisfaction. Computational results are reported on real-world instances.

Keywords: Timetabling, Passenger demand.

Sept. 11th
14.30-16.00
Pirandello

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Game Theory

Chair: M. Sanguineti

GATH1

When the other matters. The battle of the sexes revisited

M. Ángeles Caraballo, Asunción Zapata, Amparo M. Marmol and Luisa Monroy

Abstract In this paper we address bimatrix games when the players take into account not only their own payoff, but they also show some concerns about the payoff of the other player. We propose a weighted Rawlsian representation of players preferences which can accommodate the behaviours of different types of players, which are identified with different values of the parametres. The Battle of the Sexes game is analyzed in this extended setting where certain social interactions between the players determine their strategic behaviours. The best response correspondences are described depending on the relative importance that each player assigns to her own payoff and to the payoff of the other. This permits the identification of the corresponding sets of equilibria and the study of the changes produced with the variation of the parameters.

Keywords: battle of the sexes, equilibria, bi-matrix games, rawlsian function.

Sept. 11th
16.30-18.30
Archimede Hall

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GATH2

Production control in a competitive environment with incomplete information

Konstantin Kogan and Fouad El Ouardighi

Sept. 11th
16.30-18.30
Archimede Hall

Abstract We consider an industry consisting of a large number of firms producing substitutable products and engaged in a dynamic Cournot-type competition. The firms are able to reduce their marginal production costs by accumulating their own experience as well as the experience spillovers from other firms. In particular, firms accumulate production experience through proprietary learning, which, however, depreciates over time. We determine steady-state Nash equilibrium policies that are based on the assumption that the firms do not have precise information about each competitor and therefore are unable to respond to a specific firms dynamics. The firms, however, do react to overall industry trends. We show that in such a case, though the information used for production control is incomplete, in the long run the firms tend to the output they would converge to under complete information. We also find that industry growth due to more firms entering the market results in decreasing long-run equilibrium output of each firm when the depreciation of experience is higher than the rate of spillovers. Otherwise, the opposite result can emerge, i.e., the steady-state output will grow.

Keywords: Production, Control, Differential games, Quantity competition.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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GATH3

Tree-wise single peaked domains

Stefano Vannucci

Abstract The present note provides two conditions which are jointly sufficient for a finite family of uniquely topped total preorders on a finite set to be tree-wise single peaked - even when it is not line-wise single peaked. One of the two conditions is also a necessary one.

Sept. 11th
16.30-18.30
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Keywords: Tree, Betweenness, Single peakedness, Majority rule, Strategy-proofness.

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GATH4

Noncooperative model predictive control

Michael Heinrich Baumann and Marleen Stieler

Abstract Nash strategies are a natural solution concept for noncooperative dynamic games because of their 'stable' nature. For optimal control problems on very long or even infinite horizons, Model Predictive Control (MPC) appears to be a well suited numerical method to approximate optimal solutions. The idea of MPC is to repeatedly solve an optimization problem on a (shorter) finite horizon with current state as initial value and to apply only the first piece of the optimal strategy to the system. The idea to perform and analyze MPC based on Nash strategies instead of (Pareto-) optimal control sequences is appealing because it allows for solving dynamic games that are analytically intractable (on an infinite horizon). However, existence and structure of Nash strategies heavily depend on the specific game under consideration. This is in contrast to solution concepts such as usual optimality and Pareto optimality, in which one can state very general existence results. Moreover, the calculation of Nash strategies is, in general, a difficult task. In this talk we present a class of games, namely affine-quadratic games, for which sufficient conditions for trajectory convergence of the MPC solution can be derived. We furthermore investigate the relation between the closed- and open-loop Nash strategies on the infinite horizon in terms of the trajectories.

Keywords: Noncooperative Games, Nash Equilibria, Model Predictive Control.

Sept. 11th
16.30-18.30
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GATH5

Transferable Utility Games for the Assessment of Public Transportation Transfers

Marcello Sanguineti, Yuval Hadas and Giorgio Gnecco

Sept. 11th
16.30-18.30
Archimede Hall

Abstract The study of connectivity plays a major role in the design and analysis of transportation networks. The assessment of such networks can relate to their components, such as nodes and arcs, in terms of the respective contributions to the overall connectivity. In public transportation, transfer points are nodes that connect between different routes and enable network connectivity. A very natural question arising in the investigation of connectivity concerns how important each node is with respect to the others. To address this issue, we introduce a game-theoretic approach based on cooperative games with transferable utility (TU games). Given a public transportation system, a TU game is defined which considers the public transportation network, the transfer points, the travel times, the stochastic properties of transfers, and the demand. The nodes of the network represent the players in such a game, and the Shapley values of the nodes are used to identify the centrality of the nodes. A Monte Carlo approximation of the Shapley value is introduced, which is both fast and capable of integrating the stochastic properties of the network. Based on such a game, the relative importance of each transfer point can be identified. Transfers induce reliability issues, related to the stochastic nature of the system. As a result, a transfer could be missed due to delays, causing longer travel times and frustration. Hence, the suggested TU game integrates these stochastics properties, and provides the means to assess transfer points' reliability effect on the network performance. The effectiveness of the approach is demonstrated with a simple network.

Keywords: Public transportation, Transfers analysis, Cooperative game theory.

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Mini Workshop, Session II - Practice of OR - Having Impact on the Outside World: Spin-off and Start-up Experiences in Italy 2

Chair: L. Palagi

PROR2.2

Intuendi s.r.l: smart solutions for demand planning and inventory optimization

Guido Cocchi

Abstract Intuendi s.r.l is an innovative startup born in Florence in the first quarter of 2016. The five cofounders are mathematicians and information engineers graduated at the University of Florence.
The Intuendi vision is to allow companies taking better decisions about market strategies and inventory replenishment. What Intuendi offers is a user-friendly inventory optimization and demand forecasting software, available with the Software as a Service (SaaS) licence paradigm. Intuendi addresses all companies which produce and/or sell finished goods (manufacturing or e-commerce).
A user can access its personal data from anywhere, manage its products, launch new forecasts, check the inventory status, download the purchase orders list optimized with respect to the available budget and exploit other important features.

Keywords: Inventory optimization, Demand forecasting, Software As A Service.

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Bellini

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PROR2.3

ACTOR, i successi e gli insuccessi di uno spinoff accademico

Gianni Di Pillo

Abstract ACTOR (Analytics, Control Technologies Operations Research) is an academic spinoff participated by Sapienza University of Rome, some professors of the same University, and ACT-OpertionsResearch, a private company active in the fields that determine the acronym. Established in 2011, ACTOR is carrying out a number of projects in the public and private sectors. In this talk we point out on some critical issues that may affect the development of an academic spinoff, to the extent that a success may result in a failure.

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Keywords: Academic Spinoff.

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PROR2.4

Operations Research and beyond, surfing the Digital Wave

Matteo Pozzi

Sept. 11th
16.30-18.30
Bellini

Abstract Optit is a spin-off of the OR Group of the Alma Mater Università di Bologna established in 2007. The aim of this talk is to update the general information regarding the company and focus on the business trends that are driving its recent growth.
Thank to increasing digitalization of industrial processes and an unprecedented availability of data, a new awareness is emerging regarding the need for decision support systems. Advanced analytics, data science, machine learning and artificial intelligence have become relatively common buzz word at board level, creating new opportunities for OR specialists, that the same time face the challenge of new competitors and the urge to expand and go beyond the "classic" domain of OR.
Optit's experience will be shared to present our way to surf this "Digital Wave", leveraging on consolidated experiences and looking at the next challenges offered by this increasingly dynamic market.
Keywords: Data Science, Machine Learning, Decision Support Systems.

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Heuristic and Metaheuristic 3

Chair: P. Brandimarte

HEUR3.1	*A hybrid metaheuristic for the optimal design of photovoltaic installations* **M. Salani**, G. Corani and G. Corbellini
HEUR3.2	*Fair collaboration schemes for firms operating dial-a-ride services in a city network* **V. Morandi**, E. Angelelli and M.G. Speranza
HEUR3.3	*A fast metaheuristic for the general single truck and trailer routing problem* **L. Accorsi** and D. Vigo
HEUR3.4	*A hybrid-metaheuristic for named entity recognition* **D. Ferone**, E. Fersini and E. Messina
HEUR3.5	*Inventory management in a fashion retail network: a matheuristic approach* **P. Brandimarte**, A. Biolatti, G. Craparotta and E. Marocco

HEUR3.1

A hybrid metaheuristic for the optimal design of photovoltaic installations

Matteo Salani, Giorgio Corani and Gianluca Corbellini

Abstract We consider the Photovoltaic Installation Design Problem (PIDP) were photovoltaic modules must be organized in strings and wired to a set of electronic devices. The aim is to minimize installation costs and maximize power production considering 'mismatch losses" caused by non-uniform irradiation (shading) and directly related to design decisions. We relate the problem to the known class of location routing problems and thanks to the existing knowledge on the problem, we design a route-first cluster-second heuristic. We propose an efficient machine learning approach to evaluate PV string performances accounting for mismatch losses. We prove that our approach is effective on real-world instances provided by our industrial partner.

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Keywords: Metaheuristic, Machine Learning, Photovoltaic Installation Design.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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HEUR3.2

Fair collaboration schemes for firms operating dial-a-ride services in a city network

Valentina Morandi, Enrico Angelelli and M.Grazia Speranza

Sept. 11th
16.30-18.30
Empedocle

Abstract Standard DARP problem, as stated in Cordeau et Al.(2003), consists in finding minimum-cost routing in a complete graph guaranteeing that all requests are satisfied. Several variants of DARP have been proposed in the literature on heterogeneity, routing properties, multiple depots, multiple loads, multiple periods, transfers between different vehicles, soft time windows, single and multi-objective DARP (cost related and users related objectives) and with stochastic and dynamic information(see Molenbruch et Al.(2017) for a recent survey listing all these DARP variants and used solution methods). In literature, no works on collaboration between different firms operating in dial-a-ride transport service have been proposed. Since customers are spread on the city network, some of them could turn out to be not so convenient for the firm, either in terms of distance or time windows required. On the other hand, other firms can have a higher convenience in servicing that customer. Thus, the basic idea of this work is that each firm would share customers with other firms that have more convenience in doing the services. The main issue related to sharing customers is that each firm requires being advantaged by joining the cooperative, and hence, particular attention has to be given to maintain the fairness among firms. We assume that each firm collects the revenues deriving from all its customers. When a different firm serves one of its customers, it can be rewarded receiving an amount of money proportional to the customer revenue (revenues sharing scheme) or exchanging service time (time exchanging scheme). In the time exchanging scheme a firm can accumulate credits or debts in terms of time spent in servicing other firms requests. Credits are gained in servicing other firms requests and debts are charged to each firm for each request serviced by other firms. In this talk, MILP models solving the revenues sharing and the time exchanging scheme and maintaining fairness among different firms will be presented along with a metaheuristic algorithm able to return a solution in a short time.
Keywords: Collaboration, Darp, Metaheuristic

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HEUR3.3

A Fast Metaheuristic for the General Single Truck and Trailer Routing Problem

Luca Accorsi and Daniele Vigo

Sept. 11th
16.30-18.30
Empedocle

Abstract The Single Truck and Trailer Routing Problem (STTRP) consists in serving a set of customers with known demand using a single vehicle, made up by a capacitated truck and an uncapacitated trailer. The vehicle is based at a main depot. Due to accessibility constraints some customers cannot be visited by the complete vehicle thus, it is necessary to detach the trailer in appropriate parking locations before visiting them. Some slightly different STTRP variants were studied in the literature. Therefore, we propose a generalization which includes all the vertex types considered in the variants, namely: *truck customers*, *vehicle customers* both with and without parking facility, and *satellite depots*, that are pure parking locations that do not have to be mandatorily visited. Truck customers can be visited by the truck only, i.e., without the trailer, while the other vertices can be visited either by the truck or by the whole vehicle. The vehicle is thus allowed to detach its trailer both at satellite depots and at vehicle customers, provided that they have a parking facility. The solution of the problem consists in a first-level route that traverses vehicle customers and, if necessary, satellite depots, together with a set of second-level routes, originating from parking locations traversed by the first-level route. The objective is to serve all the customers, while minimizing the total traveling cost. We devised a simple three-phase heuristic algorithm based on a GRASP assignment of the customers to the satellites and a VND improvement phase, performed on a sparsified graph. The proposed method is able to improve several best known solutions for the studied variants of the general problem. We also present new instances for the general version of the problem along with some computational results.

Keywords: vehicle routing, single truck and trailer, metaheuristic algorithms.

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HEUR3.4

A hybrid-metaheuristic for named entity recognition

Daniele Ferone, Elisabetta Fersini and Enza Messina

Abstract Information Extraction (IE) is a process focused on automatic extraction of structured information from unstructured text sources. One open research field of IE relates to Named Entity Recognition (NER), aimed at identifying and associating atomic elements in a given text to a predefined category such as names of persons, organizations, locations and so on. In this work we exploited Conditional Random Fields (CRFs) to learn the dependencies between hidden variables (semantic labels) and observed variables (textual cues). The inference problem can be formalized as the assignment of a finite sequence of semantic labels to a set of interdependent variables associated with textual cues, In order to improve the performances of the inference procedure we extend the CRF model by introducing logic rules, representing domain knowledge, in the decision process. Such rules can be either extracted from data or defined by domain experts. The label assignment problem to be solved during the inference phase, is then modeled as a Soft-Constrained Maximum Path Problem. A Hybrid-Metaheuristic is proposed to solve it, and extensive computational experiments are carried out to study the performances of the algorithm.

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Keywords: Name entity recognition, Maximum path problem.

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HEUR3.5

Inventory Management in a Fashion Retail Network: A Matheuristic Approach

Paolo Brandimarte, Amedeo Biolatti, Giuseppe Craparotta and Elena Marocco

Sept. 11th
16.30-18.30
Empedocle

Abstract We consider a network consisting of a central warehouse, owned by a fashion firm, and a large number of retail stores. Some stores are owned by the firm itself, whereas others are owned by franchisees. An initial inventory allocation decision is made at the beginning of the selling season and it is periodically updated. Inventory reallocation consists of both direct shipments from the warehouse and lateral shipments among the retail stores. A suitable inventory allocation and shipping policy must take into account current inventory levels, the probability of selling each unit, shipping costs and constraints, as well as other preferences, which impact the expected utility of shipping an item from a node to another node of the network. Unlike standard models for inventory management, we consider operational constraints and a range of user preferences, which result in a pure binary LP model with a matching flavor. Given the number of nodes and involved SKUs, the resulting optimization model may include about 2 million binary variables, and even solving the LP relaxation takes hours using state-of-the-art software. We consider a simple greedy heuristic and a matheuristic, based on solving a sequence of maximum-weight matching problems. The aim of the latter is to limit the number of open arcs for lateral shipments, which results in a reduced optimization problem that may be solved by commercial software. We present preliminary results obtained on a set of real-life problem instances.

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Keywords: matheuristics, weighted matching, fashion retail network.

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Nonlinear Optimization 2 (invited session)

Chair: M. Gaudioso

NLOPT2.1 *Applying a multiple instance learning technique to image classification*
A. Fuduli, A. Astorino, M. Gaudioso, W. Khalaf and E. Vocaturo

NLOPT2.2 *A Levenberg-Marquardt method for large nonlinear least-squares problems with dynamic accuracy in functions and gradients*
S. Bellavia, S. Gratton and E. Riccietti

NLOPT2.3 *Membrane system design optimization*
M. Bozorg, B. Addis, C. Castel, E. Favre, A.-A. Ramirez-Santos and V. Piccialli

NLOPT2.4 *Deterministic convergence proof for genetic algorithms: a generalized scheme for bound constrained optimization*
F. Romito

NLOPT2.5 *On some optimization problems related to revolution cones*
M. Gaudioso and A. Astorino

NLOPT2.1

Applying a Multiple Instance Learning technique to image classification

Antonio Fuduli, Annabella Astorino, Manlio Gaudioso, Walaa Khalaf and Eugenio Vocaturo

Sept. 11$^{\text{th}}$
16.30-18.30
Majorana

Abstract In binary Multiple Instance Learning (MIL) the objective is to discriminate between positive and negative sets of points. In the MIL terminology each set is called bag and the points inside each bag are called instances. In the case of two classes of instances (positive and negative), a bag is positive when it contains at least a positive instance and it is negative if it contains only negative instances. For such kind of problems there exist in literature two different approaches (see Amores 2013 and Carbonneau et al. 2018): the bag-level approach and the instance level approach. While in the former the total entity of each bag is considered, in the latter a classifier is obtained on the basis of the characteristics of the instances, without looking at the whole entity of each bag.
We have applied to image classification an instance-level technique based on the Lagrangian relaxation of a Support Vector Machine (SVM) type model and we report some numerical results. In particular, given a set of images, for each of them we have performed a segmentation in the following way. Starting from a bitmap

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image, we have obtained an indexed image, where each element corresponds to a pixel and contains a triplet representing the RGB (red, green, blue) scale. Once the indexed image has been generated, the successive step has consisted in converting each indexed image (and the corresponding colormap) into a RGB image. After that, we have proceeded by grouping the pixels in square subregions of appropriate dimension: each image subregion forms the so called blob. In the MIL framework the images constitute the bags and the blobs correspond to the instances.

Keywords: Multiple Instance Learning, Image classification, Lagrangian relaxation.

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NLOPT2.2

A Levenberg-Marquardt method for large nonlinear least-squares problems with dynamic accuracy in functions and gradients

Stefania Bellavia, Serge Gratton and Elisa Riccietti

Sept. 11$^{\text{th}}$
16.30-18.30
Majorana

Abstract We consider large scale nonlinear least-squares problems for which function and gradient are evaluated with dynamic accuracy. More precisely, we consider the case in which the exact function to optimize is not available or its evaluation is computationally demanding, but approximations of it are available at any prescribed accuracy level. Typical problems that fit in this framework are data-fitting problems like those arising in machine learning [1] and data assimilation [2], in which a huge amount of data is available, so that evaluating objective function and gradients is usually very expensive. This motivates the derivation of methods that approximate the function and/or the gradient and even the Hessian through a subsampling. This topic has been widely studied recently, see for example [1,2,3].
Other problems in which inaccurate function values occur, and do not necessarily arise from a sampling procedure, are those where the objective function evaluation is the result of a computation whose accuracy can vary and must be specified in advance.
In this talk we describe a Levenberg-Marquardt method for solving such problems that relies on a control of the accuracy level of function and gradients approximations, and imposes an improvement of the approximations quality when the accuracy is detected to be too low to proceed with the optimization process. Moreover, having in mind large scale problems, the linear algebra operations is handled by an iterative Krylov solver and inexact solutions of the subproblems will be sought for. Our intention is to rely on less accurate (and hopefully cheaper quantities) whenever possible in earlier stages of the algorithm, increasing only gradually the demanded accuracy, so as to obtain a reduced computational time for the overall solution pro-

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cess.
We also show numerical results obtained on two test problems arising in data assimilation and in machine learning. Numerical results enlight that when the exact function is available, but it is expensive to optimize, the use of our accuracy control strategy allows to obtain large computational savings.

Keywords: Levenberg-Marquardt method, Dynamic accuracy, Nonlinear least-squares.

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NLOPT2.3

Membrane System Design Optimization

Marjan Bozorg, Bernardetta Addis, Christophe Castel, Eric Favre, Alvaro-Andres Ramirez-Santos and Veronica Piccialli

Sept. 11th
16.30-18.30
Majorana

Abstract Membrane gas separation by means of synthetic polymeric membranes is a well-established technology for several industrial applications ([3]). Due to the increasing attention on CO2 emissions, one highly relevant application of membrane gas separation is the CO2 capture from power plants and industrial emissions ([2]). Because of the inherent limitations of the solution-diffusion separation mechanism in polymeric membranes, several separation stages are often necessary when applications demand high levels of recovery and purity of one or several components, and/or when the feed is poor in the component(s) to be recovered.
Optimizing the design translates into an hard non convex MINLP problem, that remains non convex even when considering a fixed design. We model the problem treating some of the design choices by means of continuous optimization, obtaining a non-convex NLP. To tackle this problem we adapted a Monotonic Basin Hopping (MBH) strategy to the problem. We apply smart enumeration for the remaining purely combinatorial choices. We validate our method on a well-known state of the art case study ([1]) and apply it on a real world case study obtaining very good results.

Keywords: global optimization, MINLP, industrial design.

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NLOPT2.4

Deterministic convergence proof for genetic algorithms: a generalized scheme for bound constrained optimization

Francesco Romito

Abstract This work overcomes the lack of literature about deterministic convergence for a class of derivative-free global optimization algorithms which are widely used in real world problems. There are studies, examples and tons of applications of Genetic Algorithms (GA) but only the probability convergence proofs have been provided. Here we present a generalized scheme for Genetic Algorithms for which is possible to prove convergence to local optima. Ordinarily, the simplest way to attain this property is including a globally convergent local search into the algorithmic scheme. We show how to achieve convergence properties without the hybridization with any globally convergent local search. For this purpose, we have introduced discretization techniques. Furthermore, by these techniques we can reduce the impact of the probabilistic components of the algorithm and affect positively the exploration geometry, making a broader and orderly search in the feasible domain. The resulting algorithm scheme has been compared with a version of the GABRLS algorithm, presented as the winner of the Generalization-based Contest in Global Optimization (GENOPT 2017).

Sept. 11th
16.30-18.30
Majorana

Keywords: Derivative-free Optimization, Globally convergent algorithm, Genetic algorithm.

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NLOPT2.5

On some optimization problems related to revolution cones

Manlio Gaudioso and Annabella Astorino

Abstract A revolution cone is a subset of a finite dimension space defined on the basis of an orientation axis and an aperture angle. The apex of the cone may be located at the origin or, more in general, constrained to stay inside a given set, e.g. polyhedral. Possible applications of revolution cones are both the coverage of any given set or the separation of two sets. Consequently they can be considered as potential tools for set-approximation as well as for binary classification. In these areas several problems arise, such as finding the revolution cone of minimal aperture angle which covers a discrete point set or calculating the minimal (maximal) aperture angle cone which separates, even approximately, two discrete point sets. Solving such problems requires calculation of minima of appropriate objective functions which are, typically, nonsmooth. The objective of the talk is to survey several problems that have been solved in such framework and to indicate directions for future research and applications.

Sept. 11$^{\text{th}}$
16.30-18.30
Majorana

Keywords: Revolution cones, Nonsmooth optimization.

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New Trends in Public Transport (invited session)

Chair: A. D'Ariano

TPT1

Vehicle scheduling: spatial conflicts representation, detection and resolution

Carlo Mannino, Oddvar Kloster, Atle Riise and Patrick Schittekat

Sept. 11th
16.30-18.30
Pirandello

Abstract When scheduling the movements of vehicles on a transportation network, one must avoid that two vehicles get too close to each other (*conflict*). Most scheduling algorithms rely on a standard decomposition of vehicle's trajectory into the occupation of a sequence of segments. Segments may correspond to atomic volumes (for airplanes), non-shareable road or track sections (for road vehicles and trains), canal sections (for ships) etc, see, for instance, [1] for airplanes, [2] for ships, [3] for trains.. In the standard approach, later referred to as *resource based*, a conflict occurs when two vehicles are scheduled on the same segment in overlapping time intervals. However, this approach falls short when complex spatial conflicts occur, because both segments and vehicles can have complicated shapes - giving raise to conflicts in non-shared resources. To cope with these complex situations we introduce a novel representation, called *conflict diagrams*, and demonstrate how this concept is a powerful mechanism for presenting spatial conflicts between two objects moving on a spatial graph. We discuss the conflict diagram's properties and show how they can be constructed and extended following simple rules. We then discuss how the conflict diagram relates to timing variables associated with each vehicle, and how conflict diagrams can be used to construct feasible schedules. Indeed, similarly to the resource based case, conflict diagrams can be exploited to build suitable disjunctive programs and compute optimal conflict-free schedules. This work is motivated by an application in air traffic management, namely that of finding a conflict free trajectory solution for taxiing aircraft at an airport. It is funded by an EU project within the framework of SESAR joint undertaking.

Keywords: Air traffic management, Vehicle scheduling, Conflict diagrams.

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Optimization models and algorithms for supporting the shift to electromobility of public transport in a metropolitan area

Dario Pacciarelli, Valentina Conti, Andrea Gemma and Maria Pia Valentini

Sept. 11th
16.30-18.30
Pirandello

Abstract The trend towards what is called "shift to electromobility" is witnessing a strong acceleration, in political decisions as well as in the scientific literature. The White Paper "Roadmap to a single European transport area" [1] suggests the European phasing out from traditional fuel vehicles by 2050. Different kinds of reports, often the result of international research projects, have been published in the last years in Europe [2][3][4][5], USA, China and Japan. More recently, the mass media have reported important decisions by large companies or nations in this regard. For example, in July 2017, the car company Volvo announced that research activities aimed at developing combustion engines will cease from 2019, while Emmanuel Macron announced in the same days the intention of France to prohibit the sale of petrol or diesel vehicles by 2040. Norway foresees the elimination of all fossil fuel cars by 2025 . The Bloomberg report "Electric Vehicle Outlook 2017" has revised upward the previous estimates of growth in the electricity market, bringing the forecast for the sale of electric vehicles in 2040 to 54% of the market, against the previous forecast of 35%. This acceleration is caused not only by the environmental drive towards a reduction in emissions but mainly by the expected decline of the price of lithium batteries (-70% by 2030). In fact, the fall in battery prices opens up new scenarios for public transport, making the investments in electric vehicles more convenient compared to diesel or petrol technologies. This work reports on the preliminary results of an ongoing Italian project aiming to develop a tool to support the operational decisions of public administrations interested in converting part of their existing public transport from current diesel engines to new electrical technologies. Given a budget for the investment in electro-mobility, the aim is to define the most convenient set of electrifications in the existing transport network in order to maximize the reduction of operating costs. The tool being developed will be able to select, among the existing technologies, the most profitable for each line. In fact, the market of Electric vehicles offers numerous solutions, involving very different

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investment and operating costs, such as: (A) battery recharge at the depot, (B) battery recharge at the terminus, (C) battery recharge along the route. The first year of research focused on architectures A and B, with the aim of defining optimization models and solution algorithms able to solve problems of realistic dimensions (average Italian city) in a short time. A comprehensive MILP model has been developed to this aim. A relaxation of the model enables the fast computation of lower and upper bounds. Preliminary results, carried out for the bus network of Florence, are very promising. Nearly optimal solutions are computed in very short computation time.

Keywords: Public transport, Electromobility, MILP, Heuristics.

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TPT3

Models and algorithms for the real-time train scheduling and routing problem

Marcella Samà, Andrea DAriano, Dario Pacciarelli and Marco Pranzo

Sept. 11th
16.30-18.30
Pirandello

Abstract This talk deals with the real-time train scheduling and routing problem in complex railway networks [3]. The problem is NP-hard and finding a good quality solution in a short computation time for practical size instances is a very difficult task [1]. In this work we model the problem via an alternative graph formulation [2] and solve it by using a new methodology based on the relaxation of train routing constraints. We assign a nominal routing to each train, formed by common and alternative operations. We call a common operation the traversing of a block section by the train which takes place independently from the actual path chosen. An alternative operation is the shortest path between two common operations and represents alternative portions of a path in the network traversable by the train. Using a so built alternative graph allows to specify implication rules enabling to speed up the computation and to quickly compute good quality lower bounds. This is achieved by solving the corresponding train scheduling problem. Such a lower bound is then used as a first step toward the development of a branch-and-bound algorithm for the overall problem. The decisions taken during the branch-and-bound algorithm refer to selecting the routing of trains and solving the train sequencing and timing decisions generated by these selections. Computational experiments are performed on several railway infrastructures and disturbed traffic situations.

Keywords: Real-time railway traffic optimization, Disjunctive programming.

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TPT4

Comparing different solvers for the real-time railway traffic management problem

Pierre Hosteins, Paola Pellegrini and Joaquin Rodriguez

Abstract We propose to study the problem of real-time traffic management in railways, which tries to minimise the trains delays after a perturbation disturbs the regular railway operations. In practice, we seek for the best routing and scheduling decisions for the trains within a given time horizon, in case of a given perturbation. In order to model the problem, we use a MILP formulation previously detailed in Pellegrini et al (2015). The model studies the routing and scheduling of trains at a microscopic scale representing the infrastructure at a very high level of detail. We will provide a thorough study of the performances of the model with several commercial and non-commercial Mixed Integer Linear solvers such as CPLEX, Gurobi, GLPK and the Google linear solver within the CBC branch and cut framework. We will also study the performances of a heuristic generic solver named LocalSolver (see Benoist et al (2011)) and try to explore possibilities for integrating the different solvers in order to improve the global results and performances. A diversified benchmark with several french railway infrastructures will be used to generate the benchmark results.

Sept. 11th
16.30-18.30
Pirandello

Keywords: Real-time railway traffic management, Mixed-integer linear programming, Solver comparison.

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Optimization model and algorithm for integrating train timetabling and track maintenance scheduling

Bisheng He, Andrea D'Ariano, Lu Gongyuan, Peng Qiyuan and Zhang Yongxiang

Sept. 11th
16.30-18.30
Pirandello

Abstract This paper addresses the problem of improving the integration between passenger timetabling and track maintenance scheduling. We propose a microscopic optimization model and an iterative heuristic for solving this problem efficiently. We consider the block section as the atomic resource to be managed, meaning that if one link is occupied then all other links in the same block section will be occupied as well. A mixed-integer linear programming formulation is proposed for the integrated optimization problem in which train timing, sequencing and routing are the timetabling variables, while timing and sequencing of maintenance tasks are the track maintenance variables. The constraints and objective function proposed in this work address the specifications of the INFORMS RAS 2016 Problem Solving Competition [1]. In this context, the main decision variables are the entry and exit times of the trains on each block section plus the start and end times of each maintenance task. Since the integrated optimization problem is strongly NP-hard, an iterative heuristic is proposed to compute near-optimal solutions in a short computation time. The heuristic is based on a decomposition of the overall problem into a train scheduling and routing subproblem and a track maintenance scheduling subproblem. The connecting information between the two subproblems concerns the train routes, the start and end times of the maintenance tasks, the first and second trains that are scheduled after each maintenance task. Computational experiments are performed on a set of realistic railway instances, which were introduced during the INFORMS RAS 2016 Problem Solving Competition [1]. The iterative algorithm outperforms a commercial solver and the winning papers of this competition [2] in terms of both solution quality and time to compute the best known solutions.

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Keywords: Train Scheduling and Routing, Infrastructure Maintenance Scheduling, Mixed-Integer Linear Programming, Heuristics.

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Equilibrium Models and Variational Inequalities (invited session)

Chair: M. Pappalardo

EQVI1	*Cutting surface methods for equilibria*
	M. Passacantando, G. Bigi and G. Mastroeni
EQVI2	*A network equilibrium model for electric power markets with uncertain demand*
	F. Raciti, M. Pappalardo and M. Passacantando
EQVI3	*Equilibria on networks with uncertain data*
	J. Gwinner and F.S. Winkler
EQVI4	*Quasi-variational equilibrium models for network flow problems*
	M. Pappalardo and G. Mastroeni

EQVI1

Cutting surface methods for equilibria

Mauro Passacantando, Giancarlo Bigi and Giandomenico Mastroeni

Abstract The abstract equilibrium problem (EP) provides a rather general setting which includes several mathematical models such as optimization, variational inequalities, fixed point and complementarity problems, Nash equilibria in noncooperative games. It is well known that a pseudomonotone EP is equivalent to minimize the so-called Minty gap function. Though it is a convex function, it can be difficult to evaluate since this requires to solve nonconvex optimization problems. The aim of this talk is to present cutting type methods for solving EP via the Minty gap function, relying on lower convex approximations which are easier to compute. These methods actually amount to solving a sequence of convex optimization problems, whose feasible region is refined by nonlinear convex cuts at each iteration. Convergence is proved under suitable monotonicity or concavity assumptions. The results of preliminary numerical tests on linear EPs and nonsmooth variational inequalities are also reported.

Keywords: Equilibrium problem, Minty gap function, Cutting surface.

Sept. 12th
8.30-10.00
Archimede Hall

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EQVI2

A network equilibrium model for electric power markets with uncertain demand

Fabio Raciti, Massimo Pappalardo and Mauro Passacantando

Sept. 12th
8.30-10.00
Archimede Hall

Abstract We use the theory of stochastic variational inequalities to develop a network equilibrium model of the whole supply chain of electricity markets. In particular, we take into account the case where the markets demand functions are not exactly known but are affected by some kind of uncertainty. Monotonicity properties of the operator are investigated and the affine case is analyzed in detail. Finally, some numerical experiments providing the approximated mean values and standard deviations of the solutions are showed.

Keywords: Variational Inequalities, Uncertain Demand, Electricity Market.

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EQVI3

Equilibria on networks with uncertain data

Joachim Gwinner and Friedemann Sebastian Winkler

Abstract This contribution is concerned with Wardrop traffic equilibria. As is well known these equilibria can be formulated as variational inequalities over a convex constraint set. Here we consider uncertain data that can be modeled as probabilistic. We survey different solution approaches to this class of problems, namely the expected value formulation, the expected residual minimization formulation, and the approach via random variational inequalities. To compare these solution approaches we provide and discuss numerical results for a 12 node network as a test example.

Keywords: Wardrop traffic equilibrium, uncertain data, probabilistic approaches, unfairness measure.

Sept. 12th
8.30-10.00
Archimede Hall

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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EQVI4

Quasi-variational equilibrium models for network flow problems

Massimo Pappalardo and Giandomenico Mastroeni

Sept. 12th
8.30-10.00
Archimede Hall

Abstract We consider a formulation of a network equilibrium problem given by a suitable quasi-variational inequality where the feasible flows are supposed to be dependent on the equilibrium solution of the model. The Karush-Kuhn-Tucker optimality conditions for this quasi-variational inequality allow us to consider dual variables, associated with the constraints of the feasible set, which may receive interesting interpretations in terms of the network, extending the classic ones existing in the literature.

Keywords: Equilibrium models, Quasi-variational inequalities, Karush-Kuhn-Tucker multipliers.

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Routing 2

Chair: C. Sterle

ROUT2.1 *An exact method for the multi-trip VRP with time windows*
R. Paradiso, W.E.H. Dullaert, D. Laganà and R. Roberti

ROUT2.2 *Cover inequalities for a vehicle routing problem with time windows and shifts*
D. Said, S. Ropke and T. van Woensel

ROUT2.3 *An Integer linear programming formulation for routing problem of university bus service*
S. Hulagu and H.B. Celikoglu

ROUT2.4 *Inventory routing with pickups and deliveries: formulation, inequalities and branch-and-cut algorithm*
C. Sterle, C. Archetti, M. Boccia, A. Sforza and M.G. Speranza

ROUT2.1

An exact method for the multi-trip VRP with time windows

Rosario Paradiso, Wout E.H. Dullaert, Demetrio Laganà and Roberto Roberti

Sept. 12th
8.30-10.00
Bellini

Abstract The Multi-Trip Vehicle Routing Problem with Time Windows, Limited Duration and Loading Times (MTVRPTWLD) is a variant of the VRPTW, where vehicles can perform multiple trips in the planning horizon. A trip is defined as a sequence of visited customers and a departure time from the depot. Each trip cannot exceed a given maximum time duration. In this work, a new two-phase exact method is proposed to solve the problem. The proposed algorithm is based on a formulation where each variable corresponds to a structure, where a structure is a trip without an associated departure time from the depot. In the first phase, a lower bound is computed by using column generation and all structures having a reduced cost w.r.t. the computed dual solution not greater than the gap between an input upper bound and the achieved lower bound are generated. In the second phase, a branch and cut algorithm based on the set of structures generated in Phase 1 is used to find an optimal solution of the problem. One of the features that differentiates our approach from the others in the literature, is that all our formulations are ”structures” based, instead of considering trip or routes (a route is a set of consecutive trips performed by the same vehicle). The computational results achieved by the proposed solution method clearly show its effectiveness. All instances proposed in the literature with up to 40 customers can be solved within 30 minutes. The proposed solution method clearly outperforms the exact solution methods proposed in the literature that are not even able to solve all the proposed instances.

Keywords: Vehicle-routing, Column generation, Exact method.

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ROUT2.2

Cover inequalities for a vehicle routing problem with time windows and shifts

Said Dabia , Stefan Ropke and Tom van Woensel

Abstract This paper introduces the Vehicle Routing Problem with Time Windows and Shifts (VRPTWS). At the depot, several shifts with non–overlapping operating periods are available to load the planned trucks. Each shift has a limited loading capacity. We solve the VRPTWS exactly by a branch–and–cut–and–price algorithm. The master problem is a set partitioning with an additional constraint for every shift. Each constraint requires the total quantity loaded in a shift to be less than its loading capacity. For every shift, a pricing sub-problem is solved by a label setting algorithm. Shift capacity constraints define knapsack inequalities, hence we use valid inequalities inspired from knapsack inequalities to strengthen the LP-relaxation of the master problem when solved by column generation. In particular, we use a family of tailored robust cover inequalities and a family of new non-robust cover inequalities. Numerical results show that non-robust cover inequalities significantly improve the algorithm.

Sept. 12th
8.30-10.00
Bellini

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ROUT2.3

An Integer Linear Programming Formulation for Routing Problem of University Bus Service

Selin Hulagu and Hilmi Berk Celikoglu

Abstract The initial phase of our work, concentrating on the formulation of a staff service bus routing problem (SSBRP), is motivated by a real life problem of a university at a multi-centric metropolitan city. In order to improve the overall cost efficiency of the existing staff service bus operation system of the Technical University of Istanbul (ITU) we ultimately aim to find a set of staff service bus routes that provides transportation to and from four campuses for its eligible academics and administrative staff currently using service buses. An integer linear programming formulation for the SSBRP for the single campus case is presented.

Sept. 12th
8.30-10.00
Bellini

Keywords: Optimization, School Bus Routing Problem, Traffic and Transportation.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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ROUT2.4

Inventory routing with pickups and deliveries: formulation, inequalities and branch-and-cut algorithm

Claudio Sterle, Claudia Archetti, Maurizio Boccia, Antonio Sforza and M. Grazia Speranza

Sept. 12th
8.30-10.00
Bellini

Abstract The Inventory Routing Problem (IRP) consists in the distribution of one or more products from a supplier to a set of customers over a discrete planning horizon (Bertazzi and Speranza, 2013). IRP and its variants have been widely tackled in the last 30 years by the operations research community, mainly motivated by real applications arising in different contexts and in particular in supply chain management (Coelho et al., 2013). In this work we address the Inventory Routing Problem with Pickups and deliveries (IRP-PD) where a single commodity has to be picked up from pickup customers and delivered to delivery customers over a given planning horizon and on the basis of the customers' production/consumption rates (Archetti et al., 2017). A fleet of homogeneous vehicles is available to visit customers. Vehicles start and end their routes at the supplier's depot, where a given amount of commodity is available to be distributed and any exceeding amount of commodity collected by the vehicles can be transported to. The objective is to determine a distribution and collection plan minimizing the sum of routing cost and inventory cost at the customers. We propose a flow formulation together with sets of valid inequalities either original or adapted from IRP and lot-sizing literature (Avella et al., 2017). A branch-and-cut algorithm is proposed to solve the problem and it is experienced on a wide set of benchmark instances. Computational results show that the algorithm outperforms state-of-the-art algorithms both in terms of quality of the solution and computation time.

Keywords: Inventory-routing, Lot-sizing reformulation, Branch-and-cut.

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Teaching OR, Mathematics and Computer Science (invited session)

Chair: A. Sforza

TEACH1

High-school students in a problem-solving environment

Eugenia Taranto, Daniela Ferrarello and Maria Flavia Mammana

Abstract To reduce the gap between student's education provided by the school system and the demand for competencies in the workplace, the Italian Government issued a new law, the 107 of 2015 (La Buona Scuola). "Students are guaranteed a richer educational offer that looks to tradition [...], but also to the future (more languages, digital skills, Economics)" - authors translation (https:labuonascuola.gov.it). Students can learn also by means of non formal education thanks to the connection between School and the outside environment. In fact, one of the most significant innovations of law 107 is the Alternanza Scuola-Lavoro (ASL), an innovative teaching method, compulsory for students of the last three years of high-school, which through practical experience outside the school (compa-nies, universities, etc) helps to consolidate the knowledge acquired at school and test on the field the students' attitudes, to enrich their training and to orientate their studies and their future job. In this stream, at the Department of Mathematics and Computer Science of the University of Catania, an activity consisting of 7 meetings (for a total of 40 hours) was organized for hosting students from 4 high-schools. The first part of the activity, 4 of the 7 meetings, was dedicated to theoretical lessons on Operations Research theory. The second part, instead, consisted in presenting simple but realistic decision problems to the students in a problem-solving environment. These problems were similar to the ones required outside the school (such as at home, in a local organization, in some jobs). To solve the problems students were asked to use their knowledges and connect them with each other (Gentile, 2011). Students had to show what they know and how they use it: in other words, they put in place their competencies. The students were divided into groups formed by students from different schools, and they interactively discussed the problems modeling. Using the input

Sept. 12th
8.30-10.00
Empedocle

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data, the students get and discuss numerical solution through the use of common software tools (i.e. Excel spreadsheets and solver add-ins). In this talk, we share this experience that has brought the world of the school closer to that of the university. It has allowed introducing students to the main aims of the Operations Research, useful to form their computational thinking through the use of technologies, as fostered by the Italian curriculum (Indicazioni Nazionali: https://goo.gl/mQ5YHi) and European standards.

Keywords: Competencies, Problem solving, Alternanza Scuola-Lavoro.

The research of the authors was supported by the research project "Modelli Matematici nell'Insegnamento-Apprendimento della Matematica" DMI, University of Catania.

TEACH2

"Ottimizziamo!": feedback and perspectives

Giovanni Righini and Alberto Ceselli

Abstract Science Technology Engineering and Mathematics (STEM) education has been recognized as a critical weak point in the Italian educational system since 2004, when the Government took a special initiative called "Progetto Lauree Scientifiche (PLS)", offering incentives to students who enroll in STEM curricula. Recently, another emergency arose in the agenda of the Italian Government, that is the mismatch between education provided by the school system and demand for skills and competencies in our economy: two years ago our Government reacted with another initiative, called "Alternanza Scuola-Lavoro (ASL)", which now compels all high school students to spend a prescribed yearly amount of hours in companies and other institutions rather than at school. In this talk we share our feelings and feedback on the project "Ottimizziamo!", an initiative that we have been offering to high school students since more than ten years ago in the frameworks of PLS and ASL. It consists on tailored laboratory sessions, in which we present to the students simple (but realistic) hard decision problems, we interactively discuss their modeling, we share some input data and we propose to obtain and discuss numerical solution through the use of common software tools (i.e. spreadsheets and solver add-ins). The project fits perfectly in the hot trend of "computational thinking". It allowed us to reach hundreds of students every year, presenting them the main aims and scopes of our discipline.

Sept. 12th
8.30-10.00
Empedocle

Keywords: Teaching of Operations Research, High School Students.

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TEACH3

Optimization in videogames: using optimization algorithms for increasing performance, user interaction and experience

Flora Amato

Abstract Nowadays, there is a rising need for optimization and artificial intelligence techniques in videogame development, in order to improve gameplay and visual experience. Video Game Optimization entails a series of processes for increasing performances for better gameplay and visual experience. Designers and developers have to manage optimization throughout the entire video game creation process, but this enormously complicates many components development like graphic and sound. Optimization is an ongoing process that has to consider dynamicity in games. Hence, Videogames are now one of the main testing grounds for Artificial Intelligence research.
This presentation aims to cover the main issues in application of optimization strategy in videogames and to provide a discussion on the state of the art in this field.

Sept. 12th
8.30-10.00
Empedocle

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TEACH4

Problem solving and optimization as a teaching strategy for mathematics. The institutional experience in the Campania Region

Antonio Sforza and Adriano Masone

Sept. 12th
8.30-10.00
Empedocle

Abstract In the last 10 years, several institutions in the Campania Region have carried out a series of initiatives aimed at preparing students in the region to take part in the OCSE-PISA mathematics test [1], based on the concept of problem solving, which is beginning to be addressed in mathematics teaching. In this context, the Education Department of the Campania Region promoted two courses, Logimat and Logimat2 [2] on logical-mathematical learning from 2008 - 2010. The scope was to train mathematics teachers in secondary schools, as part of an agreement between the Ministry of Education and the Campania Region, which establishes initiatives aimed at supporting the education of mathematics, science and technology in schools and promoting didactic innovation. School teachers who successfully attended the course made a final presentation on a theme related to logical-mathematical learning and received an attendance certificate from the Campania Region. After this experience, the Campania Office of the Ministry of Education implemented another initiative devoted to developing the problem solving approach in the teaching of mathematics in secondary schools. The Project - OCSE PISA 2015 - Objective 500, aimed to increase proficiency of fifteen year old students in Campania, to achieve the score of 500 in the OCSE PISA test. The project was biennial and 80 schools participated in the initiative. After this, Citt della Scienza, the Naples Science Centre, promoted the National Project LogicaMente [3], created to support the improvement of scientific, logical and mathematical skills of students, and to promote and support the collaboration between education, science and society. In the last three years, the University Federico II of Naples set up the F2S group (Federico II in Schools) to build a link between school and university, with the aim of preparing students for the university experience.

Keywords: Mathematics, Teaching, Problem Solving.

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Travelling Salesman Problem

Chair: M. Dell'Amico

TSP1 *An iterated local search algorithm for the pollution traveling salesman problem*
C. Contreras-Bolton, V. Cacchiani, J. Escobar. L.M. Escobar-Falcon, R. Linfati and P. Toth

TSP2 *Dynamic traveling salesman problem with stochastic release dates*
C. Archetti, D. Feillet, A. Mor and M.G. Speranza

TSP3 *Speeding-up the exploration of the 3-OPT neighborhood for the TSP*
G. Lancia and M. Dalpasso

TSP4 *A new formulation for the flying sidekick traveling salesman problem*
M. Dell'Amico and S. Novellani

An Iterated Local Search Algorithm for the Pollution Traveling Salesman Problem

Carlos Contreras-Bolton, Valentina Cacchiani, John Escobar, Luis Miguel Escobar-Falcon, Rodrigo Linfati and Paolo Toth

Sept. 12th
8.30-10.00
Majorana

Abstract Motivated by recent works on the Pollution Routing Problem (PRP), introduced in [1], we study the Pollution Traveling Salesman Problem (PTSP). It is a generalization of the well-known Traveling Salesman Problem, which aims at finding a Hamiltonian tour that minimizes a function of fuel consumption (dependent on distance travelled, vehicle speed and load) and driver costs. We present a Mixed Integer Linear Programming (MILP) model for the PTSP, enhanced with sub-tour elimination constraints, and propose an Iterated Local Search (ILS) algorithm. It first builds a feasible tour, based on the solution of the Linear Programming (LP) relaxation of the MILP model, and then loops between three phases: perturbation, local search and acceptance criterion. The results obtained by the ILS on instances with up to 50 customers are compared with those found by a Cut-and-Branch algorithm based on the enhanced MILP model. The results show the effectiveness of

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the ILS algorithm, which can find the best solution for about 99% of the instances within short computing times.

Keywords: Pollution Traveling Salesman Problem, Iterated Local Search, MILP model.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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TSP2

Dynamic traveling salesman problem with stochastic release dates

Claudia Archetti, Andrea Mor, M. Grazia Speranza and Dominique Feillet

Sept. 12th
8.30-10.00
Majorana

Abstract The dynamic traveling salesman problem with uncertain release dates Day hour Room (DTSP-urd) is the problem in which a dispatcher receives goods from its suppliers as the distribution takes place. The arrival time of the goods at the depot is called the release date of a parcel. In the DTSP-urd, release dates are stochastic and dynamically updated as the distribution takes place. The objective of the problem is to minimize the total time needed to serve all customers, given by the sum of the traveling time and the waiting time at the depot. The waiting time is due to the fact that the vehicle has to wait at the depot for all the parcels of the customers it is going to serve in the next route. A reoptimization technique is proposed to tackle the dynamic aspect of the problem. To define the reoptimization epochs, three policies are introduced, with increasing reoptimization frequency. Two models are introduced for the solution of the problem at each decision epoch. The first one is an adaptive deterministic model where a point estimation of the release dates is used. The second is a stochastic model exploiting the entire probabilistic information available for the release dates. An instance generation procedure is proposed to simulate the evolution of the information about the release dates and computational tests are performed to assess which of the models and policies is most beneficial.

Keywords: Traveling salesman problem with release dates, dynamism, stochasticity.

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TSP3

Speeding-up the exploration of the 3-OPT neighborhood for the TSP

Giuseppe Lancia and Marcello Dalpasso

Abstract We consider the $3-$OPT local search neighborhood for the Traveling Salesman Problem. Given a tour, a move in this neighborhood consists in removing any three edges of the tour and replacing them with three new ones. There is a standard, obvious, polynomial algorithm (complete enumeration) of complexity $O(n^3)$ to choose the best possible move and it was recently shown that this complexity is unavoidable in the worst case. Notice that for complete enumeration worst- and average-case coincide.
TSP instances of interest can have thousands of nodes, which makes the cubic algorithm practically useless. In this paper we describe an alternative algorithm whose average complexity is quadratic rather than cubic. The algorithm is based on a rule for quickly choosing 2 out of 3 edges in a good way, and then completing the choice in time $O(n)$. To this end, the algorithm uses max-heaps as a suitable data structure.

Sept. 12th
8.30-10.00
Majorana

Keywords: Branch and price, column generation, network reliability, shortest path problem.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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TSP4

A new formulation for the flying sidekick traveling salesman problem

Mauro Dell'Amico and Stefano Novellani

Abstract In the last decades e-commerce has boomed and home deliveries have followed the same trend. One of the proposed methods to deliver parcels to customer in a faster way is the use of unmanned areal vehicles, also called drones (see, e.g., Wang et al.). In this work we consider a particular problem called Flying Sidekick Traveling Salesman Problem introduced by Murray and Chu, where a truck and a drone are coupled and cooperate to deliver parcels to customers. The drone can leave and return to the truck to perform a delivery within a certain battery endurance, in the meanwhile the truck can keep serving other customers. The synchronization of the two vehicles is thus crucial. The aim of the problem is to minimize the latest time of return to the depot of both vehicles.
With respect to the literature, we propose an improved formulation based on a branch- and-cut algorithm with the introduction of valid inequalities. We tested our method on benchmark instances and we show promising preliminary results.

Keywords: TSP, Drones, MILP.

Sept. 12th
8.30-10.00
Majorana

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Mathematical Programming 1

Chair: L. Liberti

MATHPRO1.1	*The non-linear generalized assignment problem*
	S. Martello, C. D'Ambrosio and M. Monaci
MATHPRO1.2	*Least cost influence propagation in (social) networks*
	M. Monaci, M. Fischetti, M. Kahr, M. Leitner and M. Ruthmair
MATHPRO1.3	*Gomory mixed-integer cuts are optimal*
	M. Di Summa, A. Basu and M. Conforti
MATHPRO1.4	*Perspective cuts for the ACOPF with generators*
	L. Liberti, C. Gentile and E. Salgado

MATHPRO1.1

The non-linear generalized assignment problem

Silvano Martello, Claudia D'Ambrosio and Michele Monaci

Sept. 12th
11.30-13.00
Archimede Hall

Abstract Given a set of n items, each with positive profit and weight, and a container (knapsack) with a given capacity, the Knapsack Problem (KP) requires to select a subset of items so that the total weight of the selected items does not exceed the capacity and the total profit of the selected items is a maximum.One of the most studied generalizations of the KP is the Generalized Assignment Problem (GAP). In this problem, there are m heterogeneous knapsacks available for packing the items, and the profit and weight associated with the packing of a certain item j into a certain knapsack i depend on both i and j. While the KP is weakly NP-hard and can be solved efficiently in practice, the GAP is strongly NP-hard and turns out to be extremely challenging from a computational viewpoint. We consider a version of the GAP in which the items can be fractionated among knapsacks, and profits and weights are described by general non-linear functions. The resulting Non-Linear Generalized Assignment Problem (NLGAP) is a continuous optimization problem in which nonlinearities appear both in the objective function and in (some of) the constraints. We present a mathematical formulation of the problem and use it to derive possible relaxations, thus producing upper bounds on the optimal solution value. We also introduce approximate algorithms and local search procedures that are used to compute high-quality heuristic solutions. We report on preliminary computational experiments on a large set of randomly generated instances to compare the proposed algorithms with state-of-the-art solvers for nonlinear programming.

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MATHPRO1.2

Least cost influence propagation in (social) metworks

Michele Monaci, Matteo Fischetti, Michael Kahr, Markus Leitner and Mario Ruthmair

Sept. 12th
11.30-13.00
Archimede Hall

Abstract Influence maximization problems aim to identify key players in (social) networks and are typically motivated from viral marketing. An increased interest in studying and solving optimization problems related to the propagation of influence in social networks can be observed recently; see, e.g, Chen, Lakshmanan and Castillo (2013), and Kempe, Kleinberg and Tardos (2015). In this work, we introduce and study the Generalized Least Cost Influence Problem (GLCIP) that generalizes many previously considered problem variants. This allows to overcome some of the limitations of the previously proposed models that might prohibit their application in real world. A formulation that is based on the concept of activation functions is proposed and valid inequalities are introduced to strengthen the formulation. Exact and heuristic solution methods are developed and compared for the new problem on a large benchmark of instances. Our computational results show that the proposed approach is a viable way to solve the GLCIP and that it outperforms the state-of-the-art approaches for the previously considered relevant special cases of the GLCIP.

Keywords: Influence maximization, Mixed-integer programming, Social network analysis.

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MATHPRO1.3

Gomory mixed-integer cuts are optimal

Marco Di Summa, Amitabh Basu and Michele Conforti

Sept. 12th
11.30-13.00
Archimede Hall

Abstract Cutting planes are widely used to solve integer and mixed-integer linear programming problems. Among many families of cutting planes proposed in the literature, Gomory mixed-integer cuts seem to stand out for at least two reasons: (i) they can be derived via a simple closed formula from the optimal tableau of the continuous relaxation; (ii) in practice, they tend to perform better than other types of general-purpose cutting planes. However, a formal justification for this behavior has not been given up to now. We give a rigorous theoretical explanation for the empirical superiority of Gomory mixed-integer cuts by working in the context of the pure integer infinite group relaxation proposed by Gomory and Johnson, which is an infinite-dimensional model that encompasses all possible integer programming problems at the same time. We show that for this model, Gomory mixed-integer cuts are the valid inequalities that cut off the maximum volume from the nonnegative orthant, and therefore can be seen as the optimal cutting planes if the volume cut off is chosen as a criterion to measure the strength of a cutting plane.

Keywords: Cutting plane theory, Gomory mixed-integer cut, Infinite group relaxations.

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MATHPRO1.4

Perspective cuts for the ACOPF with generators

Leo Liberti, Claudio Gentile and Esteban Salgado

Sept. 12th
11.30-13.00
Archimede Hall

Abstract The alternating current optimal power flow problem is a fundamental problem in the management of smart grids. In this paper we consider a variant which includes activation/deactivation of generators at some of the grid sites. We formulate the problem as a mathematical program, prove its NP-hardness w.r.t. activation/deactivation, and derive two perspective reformulations.

Keywords: optimal power flow, alternating current, mathematical programming.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Scheduling

Chair: G. Nicosia

SCHED1

Data Throughput Optimization for Vehicle to Infrastructure Communications

Adriano Masone, Angela Sara Cacciapuoti, Marcello Caleffi, Antonio Sforza and Claudio Sterle

Sept. 12th
11.30-13.00
Bellini

Abstract The ultra-high bandwidth available at millimeter (mmWave) and Terahertz (THz) frequencies can effectively realize short-range wireless access links in small cells enabling potential uses such as driver-less cars, ultra-high-definition infotainment services and data backhauling. In this context, in alternative to fiber-based and legacy wireless-based backhauling, vehicles can be used as digital mules to increase the data throughput of a region served by a software defined network (SDN) transmitting data to the Software Defined Base Station (SD-BS), equipped with only one mmWave/Thz transceiver. In real applications, multiple vehicles may concurrently pass through the region and related data throughput depends on the relative distance with respect to the transceiver. For technological reasons, the SD-BS transceiver can be used by just one vehicle at each time instant (time-slot). Hence, an operational decision problem arises consisting in determining the assignment of the vehicles to the time-slots of the SD-BS maximizing the data throughput. The problem can be conceived as a variant of different combinatorial optimization problems like scheduling and assignment problems. An original mixed integer linear programming formulation of the problem is presented and tested on real-like instances generated from a case study.

Keywords: millimeter wave and TeraHertz communications, data throughput optimization, generalized assignment, scheduling.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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SCHED2

Improved approximation algorithms for the $P2||C_{\max}$ problem

Rosario Scatamacchia, Federico Della Croce and Vincent T'kindt

Abstract We consider problem $P2||C_{max}$ where the goal is to schedule n jobs on two identical parallel machines to minimize makespan. We first show that a slight variation of the Fully Polynomial Time Approximation Scheme (FPTAS) proposed by Sahni (1976) solves the problem with accuracy $(1+\varepsilon)$ and a reduced time complexity, from $O(\frac{n^2}{\varepsilon})$ to $O(n+\frac{1}{\varepsilon^3})$, for any $\varepsilon > 1/n$. Then, we exploit the famous Longest Processing Time (LPT) rule proposed by Graham (1969) that requires to sort jobs in non-ascending order of processing times and then to assign one job at a time to the machine whose load is smallest so far. We propose an algorithm that simply applies a single step of local search on the LPT schedule. The proposed algorithm runs with low polynomial complexity and shows up to favorably compare to the best performing heuristics for the problem. Moreover, we show that even a linear time version of the algorithm, which solves the subproblem with the largest 10 jobs only and then applies list scheduling to the remaining jobs, has a tight $\frac{13}{12}$-approximation ratio improving the ratio of $\frac{12}{11}$ proposed by He et al. in (2000). We use Integer Linear Programming (ILP) to analyze the approximation ratio of our approach. The proposed ILP reasoning could be considered a valid alternative to techniques based on analytical derivation.

Keywords: Two Identical Parallel Machines Scheduling, Approximation, Linear Programming .

Sept. 12th
11.30-13.00
Bellini

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A primal stabilization approach for column generation applied to vehicle scheduling problems

B. Pratelli, S. Carosi, A. Frangioni, L. Galli, L. Girardi and E. Tresoldi

Sept. 12th
11.30-13.00
Bellini

Abstract Since the 90's M.A.I.O.R. has been solving Vehicle Scheduling Problems (VSP) in the context of public transport. The more robust approach is to formulate them as large-scale Set Partitioning Problems, solved by Column Generation (CG) [2], since it is then possible to incorporate many admissibility rules on the schedules in the Pricing Problem (PP), which is customarily a Constrained Shortest Path (CSP) problem. While in some applications (e.g., Crew Scheduling Problems, Vehicle Routing Problems) the CSP has several constraints, which makes it costly to solve, most of VSP real instances have few feasibility rules, and therefore a comparatively easy PP. This, however, has a downside: since there are many feasible paths (columns) with roughly the same cost, it is difficult to select the proper set of columns to insert in the Master Problem (MP) at each iteration, which tends to significantly increase the number of CG iterations required to converge. M.A.I.O.R. already uses techniques to stabilize the MP, in particular bundle type algorithms [1], to reduce instability in CG; however, these work on the dual variables, and they are not completely effective in this case where the issue is the large degeneracy in the set of columns. We propose and computationally test a new approach where stabilization, rather than being limited to the MP, is also performed directly in the PP. The idea is to define the concept of Suggested Arc in the PP graph, based on the primal solution of the previous MP, and to restrict the PP to generate paths with a maximum number of not-suggested arcs; this can be done efficiently with a single extra label. The concept is related to, but different from, other techniques proposed

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to improve the quality of the columns [3]. The computational results show that this technique significantly improves the CG performances in real-world instances.

Keywords: Vehicle Scheduling, Column Generation, Stabilization.

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Constrained job rearrangements on a single machine

Gaia Nicosia, Arianna Alfieri, Andrea Pacifici, Ulrich Pferschy

Sept. 12th
11.30-13.00
Bellini

Abstract In several scheduling applications, one may be required to revise a predetermined plan in order to meet a certain objective. This may happen if changes in the scenario predicted beforehand occur (e.g., due to disruptions, breakdowns, data values different from the expected ones). In this case costly reorganization of the current solution impose a limit on the allowed number of modifications. In our work, we address a single-machine scheduling problem where we need to alter a given (original) solution, by re-sequencing jobs with constraints on the number and type of allowed job shifts. For different objectives and rearrangement types, we propose mathematical programming models and possible solution approaches.

Keywords: Scheduling, Integer Linear Programming, Re-sequencing, Dynamic programming.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Production Planning

Chair: V. Kumar

PRPL1 *Optimization of experimental studies on the example of activities of working in the economy of NKR*
I. Haroutyunyan, L. Avsharyan and K. Harutyunyan

PRPL2 *DDMRP vs MRP under specific stressed conditions*
A. Marin, P. Albertin D. Favaretto and R. Pesenti,

PRPL3 *Maximizing lifetime for a zone monitoring problem through reduction to target coverage*
A. Raiconi, F. Carrabs, R. Cerulli and C. D'Ambrosio

PRPL4 *A stochastic approach to reduce waiting time of steel melting shop vessels thereby increasing throughput*
V. Kumar, S. Mukherjee and R. Shanker Singh

PRPL1

Optimization of experimental studies on the example of activities of working in the economy of NKR.

Irena Haroutyunyan, Lilit Avsharyan and Karine Harutyunyan

Sept. 12th
11.30-13.00
Empedocle

Abstract To optimize the activities of the enterprise, you can use a model description. This is the manifestation of the fundamental role of models in the theory and practice of management of construction enterprises. A clear formalization and the creation of mathematical models undoubtedly represent new possibilities, connected mainly with the "objectification" of intuitive ideas, with the possibility of a critical analysis of clearly formulated hypotheses and with the "automaticity" of a mathematical apparatus that allows one to move from hypotheses to conclusions. Before dealing with the calculations it is necessary to clearly define what goals the company wants to achieve and which way it will choose for it. Here we consider one of the processes of business process management-planning. And the task of drawing up a financial plan (budget) is considered as an optimization task.

Keywords: Optimization, Mathematic modeling, Gross Domestic Product, Mathematic programming, Average monthly salary.

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PRPL2

DDMRP vs MRP under specific stressed conditions

Alessandro Marin, Paolo Albertin, Daniela Favaretto and Raffaele Pesenti

Sept. 12th
11.30-13.00
Empedocle

Abstract DDMRP is a formal multi-echelon planning and execution method that allows to manage the flow in manufacturing and distribution. This method could be defined as a hybrid approach because combines the pillars of the main theories present in the literature. DDMRP takes the best of each theory for example the pull and visibility promoted in Lean and Theory of constraint methodology or the identification and reduction of variability that are a feature of Six Sigma (Ptak and Smith, 2011, 2016). One of the main advantage of this approach on which we want to focus on, is the reduction of the bullwhip effect in relation with the supply portion (Ptak and Smith, 2017) In this paper, a case study will be investigated in order to measure and assess the impact of DDMRP for inventory replenishment, rather than a traditional MRP approach, in an Italian SME under stressed condition. The attitude of nine different clusters of purchased components created by the intersection of their lead time (short, medium, long) and demand variability (low, medium, high) will be monitored. The variability of the lead time is another important source of variation that could help to go deeper in the DDMRP behavior analysis. Each of these clusters will be composed by products with similar characteristics. After a minimum period of 6 months of analysis, answers to these two main questions will be possible: How DDMRP works in conditions where the components lead time is longer than 90 days and the variability is high rather than a MRP approach? How could be the impact of using a DDMRP approach in terms of costs?

Keywords: DDMRP, MRP, Lead time.

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PRPL3

Maximizing lifetime for a zone monitoring problem through reduction to target coverage

Andrea Raiconi, Francesco Carrabs, Raffaele Cerulli and Ciriaco D'Ambrosio

Sept. 12th
11.30-13.00
Empedocle

Abstract We consider a scenario in which it is necessary to monitor a geographical region of interest through a network of sensing devices. The region is divided into subregions of regular sizes (zones), such that if a sensor can even partially monitor the zone, the detected information can be considered representative of the entire subregion. The aim is to schedule the sensor active and idle states in order to maximize the lifetime of the network. We take into account two main types of scenarios. In the first one, the whole region is partitioned into zones. In the second one, a predefined number of possibly overlapping zones are randomly placed and oriented inside the region. We discuss how to transform any problem instance into a target coverage one, and solve the problem through a highly competitive column generation-based method.

Keywords: Wireless Sensor Networks, Maximum Lifetime Problem, Zone Monitoring, Area Coverage, Target Coverage.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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PRPL4

A stochastic approach to reduce waiting time of steel melting shop vessels thereby increasing throughput

Varun Kumar, Sandeepan Mukherjee and Rama Shanker Singh

Sept. 12th
11.30-13.00
Empedocle

Abstract In a Steel Industry, maximizing throughput in a Steel MeltingShop requires coherent and dynamic approach with appropriate equipment, facility design and the synchronization of production across units like iron making, steel making, furnaces and casting of the molten metal. There have been various approaches to identify and de-bottlenecks the system value chain.The logistics in terms of equipment and facilities have been very critical to move the materials inside and outside the plant and more often than not contains NVAs , bottleneck which are not clearly visible but felt by the management. Removal of these NVAs and bottlenecks require a combination of process redesign and investments in facilities and equipment in the production units supported by potential logistics redesign in terms routing and scheduling of equipment like cranes, ladle cars hot metal ladles and steel ladles used in the production shop. Using Discrete Event Simulation approach addresses the system-wide bottleneck removal problem such as congestions, interferences, delays, stoppages and idle times coupled with process and cycle time variations. This paper presents how DES was used to enhance the throughput of a meltshop by reducing the waiting time of vessels caused by interferenceof cranes. It helped in revealing how seemingly unnoticed bottlenecksare causing capacity loss, and further experimented with options to re-engineer the system by suggesting mechanisms for improvement with no additional equipment.

Keywords: Discrete Event Simulation, Steel Melting Shop, Waiting of Vessel.

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Conference
2. Greg Dressel, J. MacGregor Smith, *Uses of Simulation in Melt Shop Production Planning* , July 1997

Financial Optimization (invited session)

Chair: G. Consigli

FOPT1

Risk management for sovereign debt

Andrea Consiglio

Abstract Debt sustainability analysis hinges upon two conditions: declining debt stock and bounded gross financing needs (both measured as a ratio to the country's GDP). However, both debt stock and gross financing are stochastic processes due to the volatility of [1] GDP growth, [2] fiscal variables, [3] market rates at which a sovereign can finance its debt. We develop portfolio models for sovereign debt financing that jointly optimizing debt stock and gross financing flows for countries in distress. The models minimize or bound tail risk in both metrics of interest. There are trade-offs between the two metrics, and we discuss how the trade-offs can be quantified and each one restricted to remain below a threshold of sus-tainability. In case of either metric denoting unsustainable debt, the model identifies the hot spots and optimizes debt restructuring strategies. Illustrative results will be presented and discussed.

Sept. 12th
11.30-13.00
Majorana

Keywords: Sovereign Debt Management, Debt sustainability, Stochastic programming, Conditional VaR.

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FOPT2

Dealing with complex transaction costs in portfolio management

Antonio Violi, Patrizia Beraldi, Claudio Ciancio and Massimiliano Ferrara

Abstract In the last few years, very complex structures have been proposed for transaction costs, including flat rate costs above a given threshold or a minimum value for each operation. In this work, we propose a scenario-based model for the Portfolio Management of stocks under a complex function for transaction costs. Several operational constraints have been taken into account and an effective risk measure like the Conditional Value at Risk has been considered within a mean-risk objective function, in order to represent the risk-aversion attitude of the investor. The main contribution of the work is the effective modelling of the general function representing transaction costs by means of a set of ad-hoc variables and constraints. Preliminary computational results carried out for a specific transaction costs structure offered by a real-life trader show the effectiveness of the proposed model in the representation of such cost structures.

Keywords: Portfolio Management, Transaction Costs, Stochastic Programming, Risk Management.

Sept. 12th
11.30-13.00
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FOPT3

Multistage multivariate nested distance: an empirical analysis

Sebastiano Vitali, Milos Kopa and Vittorio Moriggia

Sept. 12th
11.30-13.00
Majorana

Abstract Multistage stochastic optimization requires the definition and the generation of a discrete stochastic tree that represents the evolution of the uncertain parameters through the time and the space. The dimension of the tree is the results of a trade-off between adaptability to the original probability distribution and computational tractability. Moreover, the discrete approximation of a continuous random variable is not unique. The concept of best discrete approximation has been widely explored and many enhancements have been proposed to adjust and fix a stochastic tree in order to represent as well as possible the real dis-tribution. Still, an optimal definition is practically not achievable. Therefore, the recent literature investigates the concept of distance between trees which are candidate to be adopted as stochastic framework for the multistage model optimization. The contribution of this paper is to compute the nested distance between a large set of multistage and multivariate trees and, for a sample of basics financial problem, to empirically show the positive relation between the tree distance and the distance between the corresponding optimal solutions and the optimal objective values. Moreover, we prove that the Lipschitz constant that bounds the optimal value distance is relatively weak.

Keywords: Multistage stochastic optimization, Nested distance, Portfolio models.

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FOPT4

Distributionally robust chance-constrained dynamic pension fund management

Giorgio Consigli, Daniel Kuhn, Davide Lauria and Francesca Maggioni

Sept. 12$^{\text{th}}$
11.30-13.00
Majorana

Abstract We consider a canonical asset-liability management (ALM) model for a defined benefit pension fund from the perspective of a PF manager seeking an optimal dynamic investment strategy under a set of asset and liability constraints and in particular a chance constraint on the pension fund solvency condition. This class of problems is well-known and it has been studied under several modelling approaches, and specifically within a discrete framework through multistage stochastic programming (MSP). A real-world case-study has been presented with a detailed problem formulation and MSP solution approach in Consigli et al. 2017: as in what follows, the complexity of such problem class comes from its long-term nature and the underlying risk sources, affecting asset returns and liability flows. In a MSP framework those uncertainties require a dedicated statistical model from which a scenario tree process is derived. When, as mostly the case, asset returns and liability costs are assumed to carry a continuous probability space, approximate solutions can be obtained by substituting those probability distributions with a discrete approximation and allowing strategy revisions only at discrete time points. In presence of realistic PF ALM problems' instances MSP approaches are able to accommodate a rich set of assumptions and market details but at the cost of a possible curse of dimensionality, the problem's in-sample instability and significant model risk: the first two represent a nontrivial trade-off, since in-sample stability calls for robust and stable solutions to different, sufficiently rich sampling methods. The latter may lead to inefficient decision processes due to unsuitable statistical assumptions. These drawbacks may all be overcome through a distributionally robust optimization (DRO) approach, that can be regarded as a natural generalization of stochastic programming and robust optimization approaches, accounting for both the decision maker's attitude to risk

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and ambiguity: the latter being referred to the uncertainty characterizing the probability measure to be associated with the decision problem's underlying stochastic factors.

Keywords: Defined benefit pension funds, Asset-liability management, Model ambiguity, Distributionally robust optimization, Stochastic optimization.

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Optimization in Transportation, Telecommunications and Supply Chain Networks (invited session)

Chair: F. Guerriero

OTSCN1

Network models for event impact analysis

Janusz Granat

Abstract Models in the form of time-evolving networks arises naturally application domains like communication networks. In particular, these models can be applied for analysis of impact of internal or external events on the network. The main concepts and formalisms for time-varying graphs has been presented in paper [1]. However, existing approaches less attention on including in the models directly information about event. This issue will be addressed in the presented paper. We will present the results of impact of events on changing structure of the network as well on network parameters. On the other hand, there by observation of changes of the network over time unknown events can be detected. The multi-ctriteria analysis will be applied for event impact analysis. Moreover, there is a growing demand for processing dynamic graph-structured big data in real time [2]. We will show how presented approach will work with a time-evolving network build and processed by Big data approaches.

Sept. 12th
14.30-16.30
Bellini

Keywords: Network models, Telecommunication, Event impact analysis.

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OTSCN2

Energy-and time-efficient dynamic drone path planning for post-disaster network servicing

Farouk Mezghani and Nathalie Mitton

Sept. 12th
14.30-16.30
Bellini

Abstract When a disaster strikes, the telecommunications infrastructure gets damaged making rescue operations more challenging. Connecting first responders through flying base stations (i.e. drone mounted LTE (Long-Term Evolution) femtocell base station) presents a promising alternative to support infrastructure failure during disasters [1]. The drone can travel the area and communicate with ground mobile devices, such as smartphones, and serves as flying data link to share information between survivors and rescuers.

Keywords: Drone data link, Path planning, Energy efficiency.

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OTSCN3

An application of profit management to vehicle routing problems

Giovanna Miglionico, Giovanni Giallombardo and Francesca Guerriero

Sept. 12th
14.30-16.30
Bellini

Abstract Profit management has been recently introduced to overcome the revenue management assumption of fixed operational costs with respect to the resource consumption. Indeed in a profit management setting both revenues and costs are fundamental in the selling decision since an accepted request produces both a revenue, obtained from selling the product, and a cost variation due to the increased consumption of all the resources in-volved in the product itself. We discuss the problem of a logistics service provider that, on a given planning horizon, receives requests of parcel collection from a set of customers located at the nodes of a dis-tribution network. The requests are to be fulfilled, in a future operational time-horizon, with the aim of maximizing the total future expected profit while the accept/reject decision must be made at the time each request is received. The profit increase at the booking time depends on the revenues associated to the requests accepted so far, on the random revenues associated to the requests accepted in the future and on the routing costs associated to the whole set of accepted requests. We formulate the problem as a dynamic and stochastic program and define some accept/reject policies in the profit management setting.

Keywords: Revenue Management, Profit Management, Vehicle Routing Problem (VRP).

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OTSCN4

Modeling and solving the packet routing problem in industrial IoT networks

Luigi Di Puglia Pugliese, Dimitrios Zorbas and Francesca Guerriero

Sept. 12th
14.30-16.30
Bellini

Abstract The IEEE802.15.4-TSCH (Time Slotted Channel Hopping) is a recent Medium Accesss Control (MAC) protocol designed for Industrial Internet of Things (IIoT) applications. The data transmissions in TSCH networks are performed according to a tight schedule computed by either a centralized entity or by the network nodes. The higher the schedule length, the higher the energy consumption of the network nodes and the end-to-end delay. In this paper, we address the problem of finding optimal routing topologies that minimize the schedule length. The problem can be viewed as a particular instance of the spanning tree problem with cost associated with each arc and a proper defined function that accounts for the schedule length. We propose a formulation for the problem along with optimal solution approaches. The computational results are carried out by considering realistic instances. The aim of the experimental phase is to evaluate the influence of the problem's characteristics on the optimal solution and to assess the behavior of the proposed solution approaches.

Keywords: routing problem, tree, mixed integer linear program, IoT.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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OTSCN5

The Green Vehicle Routing Problem with Occasional Drivers

Giusy Macrina and Francesca Guerriero

Abstract This paper introduces a new variant of the green vehicle routing problem with crowd-shipping. The company has an own mixed fleet composed of conventional combustion engine and electric vehicles. In addition, ordinary people named "occasional drivers" are available to deliver items to some customers on their route. The objective is to minimize the sum of routing costs of conventional and electric vehicles, by including fuel consumption cost and energy consumption cost, and occasional drivers' compensation. We describe an integer linear programming formulation for the problem and we also provide a comprehensive analysis on several indicators, such as routing costs and polluting emissions. The results show how the use of occasional drivers may lead not only to more convenient solutions, but also to highly interesting scenarios in a green perspective.

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14.30-16.30
Bellini

Keywords: Green Vehicle Routing Problem, CO_2 emissions, Electric vehicles, Crowd-shipping, Occasional Drivers.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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AIRO Young Session (invited session)

Chair: A. Santini

YOUNG1	*Bi-objective shortest path for touristic tours* **L. Amorosi** and P. Dell'Olmo
YOUNG2	*Machine Learning for predicting MILP resolution outcomes before timelimit* **M. Fischetti**, G. Zarpellon and A. Lodi
YOUNG3	*A branch and price algorithm to solve the quickest multicommodity k-splittable flow problem* **A. Melchiori** and A. Sgalambro
YOUNG4	*A tabu search algorithm for the min-max graph drawing problem* **T. Pastore**, P. Festa, A. Martinez-Gavara and R. Martì
YOUNG5	*Solving a class of longest subsequence problems via maximum cliques* **A. Santini** and C. Blum

Bi-objective shortest path for touristic tours

Lavinia Amorosi and Paolo Dell'Olmo

Abstract In this talk we consider the bi-objective shortest path (BSP) problem. This is a natural extension of the single objective problem and its applications arise in different fields. However, solving the bi-objective version of SP is more difficult than solving the single objective one because it is $\mathcal{NP}$-hard and intractable (Serafini 1987). Different solution techniques can be used to generate a complete set of efficient solutions (see Raith and Ehrgott, 2009). In this work, in order to find the Pareto frontier, we adopt a new two-phase method presented in (Amorosi, 2018) whose second phase strategy is based on the analysis of the reduced costs associated with the arcs of the underlying network. This procedure is a general one capable to find all feasible flows of an integer network flow problem. In this work we show its applicability, by means of an appropriate specialization, to the shortest path problem and its adaptation in the context of the second phase for generating a complete set of efficient solutions for the BSP problem. As experimental setting we choose a specific bi-criteria real problem: the planning of touristic tours taking into account travel time and the approval rating of the touristic sites, which has been dealt with in previous papers, yet not for generating the complete set of efficient solutions but only some non-dominated points (see Baffo, Carotenuto et al. 2016, Gavalas et al. 2014).

Sept. 12th
14.30-16.30
Empedocle

Keywords: Bi-criteria optimization, Touristic tours, Two-phase method.

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Machine Learning for predicting MILP resolution outcomes before timelimit

Martina Fischetti, Giulia Zarpellon and Andrea Lodi

Abstract Machine Learning and Mathematical Optimization are two closely related disciplines, and in the last years a lot of research has been devoted to their combined/integrated use. In particular, one thread of interest questions whether Machine Learning could help in the resolution of complex Mathematical Optimization problems by, for example, improving branch-and-bound decisions [1], or by estimating the optimal value for specific problems [2]. In our work, we investigate if Machine Learning could be used to predict whether a generic Mixed Integer Linear Programming problem will be solved to proven optimality within a given timelimit. The initial evolution of the problem's branch-and-bound tree is statistically summarized to be fed as input to a learning algorithm, which returns a binary prediction. This learned information could be useful to get an idea of the optimization trends after only a fraction of the specified timelimit has passed, ideally being able to tailor the use of the remaining resolution time in a more strategic and flexible way, using for example more aggressive heuristic strategies.

Keywords: Machine Learning, Branch and Bound, Mixed Integer Linear Programming.

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A branch and price algorithm to solve the quickest multicommodity k-splittable flow problem

Anna Melchiori and Antonino Sgalambro

Sept. 12th
14.30-16.30
Empedocle

Abstract In the network flow theory, a rich variety of contributions impose a thorough control on the paths to be used for flow transshipment, hence revealing a significant interest from a methodological but also application point of view. In this context, the k-Splittable Flow class limits to at most k the number of supporting paths for each commodity [1]. Recently [2], this modeling feature has been extended to the dynamic environment by introducing the strongly NP-hard Quickest Multicommodity k-splittable Flow Problem (QMCkFP) that asks for routing and scheduling each commodity through at most k different paths in a capacitated dynamic network with travel times on the arcs. In this work, we design the first exact approach for the optimal resolution of the QMCkSFP building on a path-based formulation of the problem. The algorithm falls within the Branch and Price paradigm and presents a tailored pricing problem and branching phase. The former is formulated for each commodity as a Shortest Path Problem with Forbidden Paths [3] in a time-expansion of the original dynamic digraph and it is solved through a dedicated dynamic programming algorithm that models forbidden paths as limited resourcesand accounts foradditional specific node-set resources to avoid the generation of loops over time.The branching rule forces and forbids the usage of subsets of paths over the time horizon whenever the k-splittable restriction is not satisfied. Extensive computational experiments are conducted to measure quality performances of the developed method on different sized instances of the problem.

Keywords: Quickest flow, k-Splittable flow, Branch and Price.

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A tabu search slgorithm for the min-max graph drawing problem

Tommaso Pastore, Paola Festa, Anna Martinez-Gavara and Rafael Martì

Sept. 12th
14.30-16.30
Empedocle

Abstract Graph drawing is a key issue in the field of data analysis, given the ever-growing amount of information available today that can be represented in terms of nodes and their connections. Graph Drawing Problems (GDP) are classical combinatorial problems whose applications have been widely relevant in fields as social network analysis and project management. While classically in GDPs the main aesthetic concern was related to the minimization of the total sum of crossing in the graph (min-sum), the focus of this talk will be a variant of the problem, the Min-Max GDP, whose objective consists in the minimization of the maximum crossing among all egdes. Recently proposed in scientific literature, the Min-Max GDP is a harder version of the original min-sum GDP that arises from the optimization of VLSI circuits and the design of interactive graph drawing tools. We propose a heuristic algorithm based on tabu search methodology to obtain high-quality solutions for instances of large size. Extensive experimentation on an established benchmark set shows that our method is able to obtain excellent quality solution in short computation time.

Keywords: Tabu Search, Graph Drawing.

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YOUNG5

Solving a class of longest subsequence problems via maximum cliques

Alberto Santini and Christian Blum

Sept. 12th
14.30-16.30
Empedocle

Abstract An important problem in bionformatics and, in particular, genetics, is that of finding a longest common subsequence (LCS) of a set of strings. A string is a sequence of symbols drawn from an alphabet; in the case of DNA strings, the alphabet is $\{A, C, G, T\}$. A subsequence of a string is obtained by deleting zero or more symbols from that string. For example, strings "ACCATGTTA" and "CGGATGCA" have "CATGA" as their longest common subsequence. Finding a common subsequence between two strings amounts to matching positions in the first to positions in the second string, such that the symbols at matched positions are the same and matchings do not cross. In the example above, the matches are: $(2,1),(4,4),(5,5),(6,6),(9,8)$. The LCS problem has polynomial complexity when the number of strings is fixed. There are, however, relevant generalisations which are NP-hard already for two strings. In this work we present a unified solution approach for several of these generalisations, such as (a) the longest *arc-preserving* common subsequence (LAPCS) problem, where an undirected graph is defined on each of the two strings (the positions are vertices) and arcs need to be preserved by the matching; or (b) the *c-diagonal* LAPCS problem, where the matches further need to preserve locality: matched indices cannot be further from each other than c positions; or (c) the *repetition-free* LCS problem, where each symbol can appear at most once in the common substring. No exact algorithm is currently available in the literature to solve large instances of these problems, and the state-of-the-art includes either heuristics or approximation schemes (these latter only for cases in which the arcs have particular structures). To solve these problems in a unified way, we build special conflict graphs and solve maximum-clique problems on them. The advantage of this approach is that many max-clique algorithms can be used as both

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exact or heuristic solvers (for example, by returning the largest clique found after a certain time limit). If the solver provides a proven maximal clique, however, we automatically have a proof of optimality for the subsequence problem, something that standard heuristics usually do not provide. We present preliminary results validating the feasibility of this approach, by comparing it with existing heuristic algorithms and with an integer model solved via a black-box solver.

Keywords: Bioinformatics, Genetics, Maximum-clique.

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Nonlinear Optimization 3 (invited session)

Chair: S. Lucidi

NLOPT3.1 *Steplength selection in gradient projection method for box-constrained quadratic programs*
S. Crisci, V. Ruggiero and L. Zanni

NLOPT3.2 *Using a factored dual in augmented Lagrangian methods for semidefinite programming*
M. De Santis, F. Rendl and A. Wiegele

NLOPT3.3 *How grossone can be helpful to iteratively compute negative curvature directions*
G. Fasano, R. De Leone, M. Roma and Y.D. Sergeyev

NLOPT3.4 *A derivative-free bundle method for convex nonsmooth optimization*
G. Giallombardo, M. Gaudioso and G. Miglionico

NLOPT3.5 *First order algorithms for constrained optimization problems in machine learning*
F. Rinaldi, A. Cristofari, M. De Santis and S. Lucidi

NLOPT3.1

Steplength selection in gradient projection method for box-constrained quadratic programs

Serena Crisci, Valeria Ruggiero and Luca Zanni

Sept. 12th
14.30-16.30
Majorana

Abstract Gradient methods are widely used for solving nonlinear optimization problems and their simplicity and low memory requirements make them the most convenient choice in many large scale applications. In the last years, very efficient gradient-based approaches have been designed, exploiting special strategies to accelerate their convergence rate (see [1,2,3] and references therein). In this talk, we focus on steplength selection techniques, providing a spectral analysis on quadratic optimization problems with box-constraints. Our analysis has been motivated by recent studies on the connection between the steplengths and the Hessian of the objective function [3,4] in the unconstrained case, which have confirmed how these rules are endowed with the property of capturing some second-order information in a low cost way. We propose modified versions of the well-known Barzilai-Borwein rules (and their extensions), obtaining improvements of the gradient projection methods. The practical effectiveness of the proposed strategies has been tested on random large scale box-constrained quadratic problems, on some well known non quadratic problems and on image deblurring applications.

Keywords: box-constraints, gradient projection methods, steplength selection.

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NLOPT3.2

Using a factored dual in augmented Lagrangian methods for semidefinite programming

Marianna De Santis, Franz Rendl and Angelika Wiegeleo

Abstract It is well known that SDP problems are solvable in polynomial time by interior point methods (IPMs). However, if the number of constraints m in an SDP is of order $O(n^2)$, when the unknown positive semidefinite matrix is $n \times n$, interior point methods become impractical both in terms of the time and the amount of memory required at each iteration. As a matter of fact, in order to compute the search direction, IPMs need to form the $m \times m$ positive definite Schur complement matrix M and find its Cholesky factorization. On the other hand, first-order methods typically require much less computation effort per iteration, as they do not form or factorize these large dense matrices. Furthermore, some first-order methods are able to take advantage of problem structure such as sparsity. Hence, they are often more suitable, and sometimes the only practical choice for solving large scale SDPs. Most existing first-order methods for SDP are based on the augmented Lagrangian method. Alternating direction augmented Lagrangian (ADAL) methods usually perform a projection onto the cone of semidefinite matrices at each iteration. With the aim of improving the convergence rate of ADAL methods, we propose to update the dual variables before the projection step. Numerical results are shown, giving some insights on the benefits of the approach.

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NLOPT3.3

How *grossone* can be helpful to iteratively compute negative curvature directions

Giovanni Fasano, Renato De Leone, Massimo Roma and Yaroslav D. Sergeyev

Sept. 12th
14.30-16.30
Majorana

Abstract We consider an iterative computation of negative curvature directions, in large scale optimization frameworks. We show that to the latter purpose, borrowing the ideas in [1-3], we can fruitfully pair the Conjugate Gradient (CG) method with a recently introduced numerical approach involving the use of grossone [3]. In particular, though in principle the CG method is well-posed only on positive definite linear systems, the use of grossone can enhance the performance of the CG, allowing the computation of negative curvature directions, in the indefinite case. The overall method in our proposal significantly generalizes the theory proposed for [1] and [2].

Keywords: Negative Curvature Directions, Grossone, Conjugate Gradient Method.

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NLOPT3.4

A derivative-free bundle method for convex nonsmooth optimization

Giovanni Giallombardo, Manlio Gaudioso and Giovanna Miglionico

Abstract We introduce a bundle method for the unconstrained minimization of a convex, possibly nonsmooth, function for which no subgradient information is available. The core of the approach is in the approximation mechanism of subgradients, that is based on the convexity of the objective function. In particular, we generate the approximation of a subgradient by exploiting the subgradient inequality for a convex function, namely, by enforcing each iterate-point stored in the bundle to fulfil the subgradient inequality at each other iterate-point. Two relative geometrical configurations of each point with respect to the remaining ones are analyzed, that gives rise to a pair of alternative auxiliary optimization problems, a linear program and a strongly convex quadratic program, whose solution allows to generate a subgradient approximation. The whole approximation mechanism is embedded into a bundle method for convex optimization, appropriately tailored to the derivative-free framework, for which we provide some convergence results along with a preliminary computational study on a set of academic test problems.

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Keywords: Derivative-free optimization, Nonsmooth optimization, Bundle method.

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NLOPT3.5

First order algorithms for constrained optimization problems in machine learning

Francesco Rinaldi, Andrea Cristofari, Marianna De Santis and Stefano Lucidi

Sept. 12th
14.30-16.30
Majorana

Abstract Thanks to the advent of the "Big Data era", simple iterative first-order optimization approaches for constrained optimization have re-gained popularity in the last few years. Examples of relevant applications where those methods are massively used include training of support vector machines, boosting (Adaboost), convex approximation in ℓ_p , mixture density estimation, lasso regression, finding maximum stable sets (maximum cliques) in graphs, portfolio optimization and population dynamics problems.
In the talk, we first review a few classic methods (i.e., conditional and projected gradient method) in the context of Big Data applications. Then, we discuss theoretical aspects of some new active-set variants for those classic methods. In particular, we introduce the definition of active-set gradient related direction and analyze convergence for a general algorithmic framework using this kind of direction. We further specify three different active-set gradient related directions that can be embedded in our algorithmic framework, prove convergence at a linear rate (under suitable assumptions), and also report some preliminary results showing the effectiveness of the strategy. Finally, we examine current challenges and future research perspectives.

Keywords: Active-set Strategies, First Order Methods.

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Decision Making

Chair: P. Hosein

DEMAK1	*Bargaining game model to determine a common set of weights in DEA* **I. Contreras**, M. Hinojosa and S. Lozano
DEMAK2	*A sequential decision process with stochastic action sets* **A. Narkiewicz**
DEMAK3	*Simplifying the minimax disparity model for determining OWA weights in large-scale problems* **H.T. Nguyen**
DEMAK4	*A hybrid method for cloud quality of service criteria weighting* **C.Z. Radulescu** and M. Radulescu
DEMAK5	*Cost minimization of library electronic subscriptions* **P. Hosein**, L. Bigram and J. Earle

DEMAK1

Bargaining game model to determine a common set of weights in DEA

Ignacio Contreras, Miguel Angel Hinojosa and Sebastián Lozano

Abstract Data Envelopment Analysis (DEA) is a mathematical method for evaluating the relative efficiency of a set of alternatives (decision making units (DMUs) in DEA terminology) which produce multiple outputs by consuming multiple inputs. Each DMU is evaluated on the basis of the weighted output over the weighted input ratio. One of the main features of DEA models is the free selection of weights, that is to say, each DMU selects the weighting scheme which optimizes its own evaluation. However, in some contexts this total flexibility might not be desirable; think for instance, of situations in which comparisons between alternatives or the construction of a ranking of DMUs must be carried out. In such cases, it seems more appropriate to consider a common vector of weights to compare or rank the alternatives. This justifies the existence in DEA-literature of diverse procedures to determine a common set of weights. In this paper a new proposal inspired on the principles of bargaining theory is developed to determine a common set of weights in DEA. In particular, the model is based on the Kalai-Smorodinsky solution.

Keywords: DEA, Bargaining, Common weights.

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DEMAK2

A sequential decision process with stochastic action sets

Adam Narkiewicz

Abstract The article proposes a normative model of dynamic choice in which an agent must sequentially choose actions in order to maximize her performance. Unlike in traditional models, the action sets are random. That is, for a given state history, instead of a known action set, there is a known probability distribution over action sets. For example, given the asset prices and portfolio history up to n-th period, the specific distributions of returns for the assets in the n+1-th period are known only after the n-th period. I prove that an optimal decision policy requires an agent to follow the maximum expected performance principle and that an optimal decision policy can be expressed as a function over state space, whose expected value the agent ought to maximize. I find necessary conditions for optimality in the general case, in a Markovian environment, and in a stationary environment. I also prove existence, uniqueness, and sufficient conditions for optimality under certain circumstances. I then apply these results to solve numerically three problems. The first is a portfolio allocation problem in which a future pensioner tries to maximize probability of having a certain portfolio value at the time of retirement or tries to obtain this value as quickly as possible. The second is an optimal-foraging problem. The third is a problem in which an artificial agent is trying to find the quickest route in a dynamically changing graph.

Keywords: Dynamic choice, Markov decision process, Random action sets, Portfolio selection.

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14.30-16.30
Pirandello

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DEMAK3

Simplifying the minimax disparity model for determining OWA weights in large-scale problems

Thuy Hong Nguyen

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14.30-16.30
Pirandello

Abstract In the context of multicriteria decision making, the ordered weighted averaging (OWA) functions play a crucial role in aggregating multiple criteria evaluations into an overall assessment supporting the decision makers choice. Determining OWA weights, therefore, is an essential part of this process. Available methods for determining OWA weights, however, often require heavy computational loads in real-life large-scale optimization problems. In this paper, we propose a new approach to simplify the well-known minimax disparity model for determining OWA weights. We use the binomial decomposition framework in which natural constraints can be imposed on the level of complexity of the weight distribution. The original problem of determining OWA weights is thereby transformed into a smaller scale optimization problem, formulated in terms of the coefficients in the binomial decomposition. Our preliminary results show that the minimax disparity model encoded with a small set of these coefficients can be solved in less computation time than the original model including the full-dimensional set of OWA weights.

Keywords: Ordered weighted averaging, OWA weights determination, binomial decomposition framework, k-additive level, large-scale optimization problems.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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DEMAK4

A hybrid method for cloud Quality of Service criteria weighting

Constanta Zoie Radulescu and Marius Radulescu

Abstract The Multi-Criteria Decision Making (MCDM) methods can be used for selection of a Cloud Services Provider (CSP). The most critical input of these methods is the assignment of criteria weights which can be based on subjective, objective, or a combination of weighting methods. In this paper a new hybrid method is proposed for Quality of Service (QoS) criteria analysis and weighting. The approach is based on a subjective weighting method and an objective weighting method. The hybrid method is applied in a case study. An analysis of causal relations and the degree of influence between QoS criteria based on DEMATEL method is presented.

Sept. 12th
14.30-16.30
Pirandello

Keywords: Subjective weighting, objective weighting, DEMATEL method, Quality of Service, Cloud Service Provider.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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DEMAK5

Cost Minimization of Library Electronic Subscriptions

Patrick Hosein, Laura Bigram and Jonathan Earle

Abstract Many libraries, particularly those at Universities in developing countries, are facing challenging financial times. This has led to the need for budget cuts and more efficient management of limited resources. One of the major costs of an academic library are the fees paid for subscriptions to electronic journals, databases, conference proceedings and for costs associated with downloads of individual papers if there is no subscription to the corresponding resource. Typically the decision as to whether or not a particular subscription is acquired is done based on faculty member requests, information about the resource (such as cost) and policies of the library. However, with the availability of a wide range of collected statistics, (number of downloads, impact factors, etc.) one can make better informed decisions. In this paper we provide a decision support system in which we define a metric for the value obtained per access to a resource and then determine the minimum budget required to achieve a given total value of this metric.

Keywords: Optimization, Data Analysis, Decision Support System.

Sept. 12th
14.30-16.30
Pirandello

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Mathematical Programming 2

Chair: M. Fischetti

MATHPRO2.1	*The stable set problem: clique and nodal inequalities revisited*
	F. Rossi, S. Smriglio and A.N. Letchford
MATHPRO2.2	*Perspective reformulations-based strengthening for the sequential convex MINLP technique*
	C. D'Ambrosio, A. Frangioni and C. Gentile
MATHPRO2.3	*Efficient codon optimization by integer programming*
	C. Arbib, M. Pinar, F. Rossi and A. Tessitore
MATHPRO2.4	*Integer optimization for deep learning*
	M. Fischetti

MATHPRO2.1

The stable set problem: clique and nodal inequalities revisited

Fabrizio Rossi, Stefano Smriglio and Adam N. Letchford

Sept. 13th
8.30-10.00
Bellini

Abstract The *stable set* problem, also known as the *independent set* or *node packing* problem, is a fundamental and much-studied combinatorial optimisation problem. It is also well-known to be equivalent to the *maximum clique* and *set packing* problems. These problems have a wide range of applications in operational research, computer science and elsewhere. Unfortunately, the stable set problem is $\mathcal{NP}$-hard in the strong sense and hard even to approximate. Moreover, it also tends to be very difficult in practice. Current leading exact algorithms may struggle with (unstructured) graphs with more than around 400 nodes. The stable set problem can be formulated in many different ways, and several different 0-1 linear programming formulations have been investigated in the literature. This problem is also rather unusual, in the sense that combinatorial algorithms are often more effective than mathematical programming algorithms.
In this talk, we examine an entire family of 0-1 LP formulations, based on various combinations of certain constraints known as *clique* and (lifted) *nodal* inequalities. Extensive computational experiments show that the choice of formulation can have a dramatic effect on the time taken to solve specific instances. Moreover, a careful analysis of the computational results enables us to derive guidelines for how to choose the right formulation for a given instance.

Keywords: Stable set problem, 0-1 linear programming.

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MATHPRO2.2

Perspective Reformulations-based Strengthening for the Sequential Convex MINLP Technique

Claudia D'Ambrosio, Antonio Frangioni and Claudio Gentile

Abstract The Sequential Convex MINLP (`SC-MINLP`) technique is a global optimization algorithm aimed at solving NonConvex Mixed-Integer NonLinear Problems with separable nonconvexities. At each iteration, it provides a lower and an upper bound by solving a Convex MINLP and a NonConvex NLP, respectively. The convex MINLPs are iteratively improved by adding breakpoints to the linearization of the concave parts of the problem. We propose to strengthen the convex MINLPs by exploiting its structure and modifying the convex terms using the Perspective Reformulation technique to strengthen the bounds. Experimental results on different classes of instances show a significant decrease of the solution time of the Convex MINLPs, i.e., the most time-consuming part of `SC-MINLP`, and has, therefore the potential to improving its overall effectiveness.

Sept. 13th
8.30-10.00
Bellini

Keywords: Global Optimization, Nonconvex Separable Functions, Perspective Reformulation.

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MATHPRO2.3

Efficient codon optimization by integer programming

Claudio Arbib, Mustafa Pinar, Fabrizio Rossi and Alessandra Tessitore

Sept. 13th
8.30-10.00
Bellini

Abstract When synthetic protein-coding genes are added to cloning vectors for expression within non-native host organism, the problem of choosing a proper codon sequence arises. On one hand, the chosen codons should have a high frequency in the host genome; on the other hand particular nucleotide basis sequences (called "motifs") should be avoided or, instead, are desired. Dynamic programming (DP) has successfully been used in literature to solve this problem. However, DP has a limit in terms of the problem size that one can solve, especially when long motifs are forbidden. We reformulate the problem as an integer linear program (ILP) using lazy constraint generation, and show that in this way one can easily solve problems with quadruplicated nucleotide bases and much longer forbidden motifs than with DP. Moreover, modelling the problem as ILP guarantees more flexibility than DP with respect to possible additional constraints and objectives.

Keywords: Codon optimization, Motif engineering, Integer programming.

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MATHPRO2.4

Integer Optimization for Deep Learning

Matteo Fischetti

Abstract A Deep Neural Network (DNN) is a Machine Learning architecture made by layers of internal units, each of which computes an affine combination of the output of the units in the previous layer, applies a nonlinear operator, and outputs the corresponding "activation" value. A commonly-used nonlinear operator is the so-called Rectified Linear Unit (ReLU), whose output is just the maximum between its input value and zero. In this talk we will investigate a 0-1 Mixed-Integer Linear Programming (0-1 MILP) model of a DNN with ReLU activations and fixed parameters, and propose an effective bound-tightening mechanism. We will also report computational results for a state-of-theart commercial MILP solver applied to the problem of constructing optimal adversarial examples for a known test case, namely, hand-written digit recognition. The results show that, for small DNNs, these instances can typically be solved to proven optimality in a matter of seconds/minutes on a standard PC.

Sept. 13th
8.30-10.00
Bellini

Keywords: Deep neural networks, Mixed-integer optimization, Deep learning, Mathematical optimization, Computational experiments.

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Prin SPORT 1 (invited session)

Chair: A. Sciomachen

SPORT1.1

A model for collaborative tactical planning in intermodal transportation

Claudia Caballini and Massimo Paolucci

Sept. 13th
8.30-10.00
Empedocle

Abstract In this paper, a tactical planning model for intermodal transportation in a Physical Internet context is introduced. The problem consists in delivering orders between pairs of locations in an intermodal transportation network at a European scale. Orders are originally assigned to a set of forwarders and are characterized by origin, destination, release and due dates, penalty for late delivery and service tariff paid by the customer. Forwarders serve the orders with a fleet of trucks, which depart from their different logistics bases, pick up an order (i.e., a container) and deliver it either to its final destination or to an intermediate destination depending on the transportation mode chosen. Possible modes are road (long distance transportation performed directly by the forwarder truck or medium distance relay), railway or ship. The transportation cost incurred by the forwarder depends on the selected mode and on the origin-destination distance, but it is also affected by the distance between the forwarder logistics base and the order origin. The whole distance and the forwarder transportation resource availability influence the ability of serving orders within their due-dates. It is assumed that forwarders may collaborate to both reduce costs and improve customer service levels. Thus, forwarders can exchange orders agreeing on the payment of a compensation cost. Two mixed integer programming models for tactical planning are proposed: a non-collaborative model (NCM), where forwarders serve their own orders individually, and a horizontal collaborative model (HCM) allowing the exchange of orders among forwarders while ensuring a sustainable collaboration (the profit of each forwarder with HCM is never lower of the one with NCM). The tests performed on a set of randomly generated instances up to 5000 orders and 50 forwarders show that cooperation enables to decrease the total distance and the related costs for serving orders, as well as to improve the respect of due-dates. Besides, a sensitivity analysis was conducted to determine how the

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social and environmental sustainability of transport can be influenced by incentives, as these issues are both key aspects of the Physical Internet paradigm.

Keywords: Intermodal transportation, Horizontal cooperation, Physical internet.

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SPORT1.2

On the worst optimal cost of the transportation interval problem

Raffaele Cerulli, Ciriaco D'Ambrosio and Monica Gentili

Sept. 13th
8.30-10.00
Empedocle

Abstract The Interval Transportation Problem (ITP) is a variant of the well known transportation problem where the coefficients of the problem range in an interval (i.e., are interval numbers). In this paper we focus on the special case of ITP when only right-hand-sides are interval numbers. We focus in determining the best and worst values of the optimal cost of the ITP among all the feasible realizations of the right-hand-side parameters. While finding the best optimum is an easy task [1], to the best of our knowledge, a formal proof of the computational complexity of finding the worst optimum is still missing. In this paper we prove some general properties of the best and worst optimum values, and we propose a new heuristic approach that outperforms the existing approaches on a set of benchmark instances.

Keywords: Transportation Problem, Uncertainty, Interval Optimization.

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SPORT1.3

A multi-commodity location-routing problem in a maritime urban area

Massimo Di Francesco, Teodor Gabriel Crainic, Enrico Gorgone and Paola Zuddas

Sept. 13th
8.30-10.00
Empedocle

Abstract Despite the very active research on location-routing problems, most of the studies investigated the single-commodity case [1]. Limited attention has been devoted to the multi- commodity variant, which plays an important role in the context of City Logistics, because the demand of goods is highly customized [2], [3]. This work aims to fill this gap and investigates a multi-commodity location-routing with vehicle selection problem defined in a City Logistics perspective in the case of a maritime urban area, where large-size vehicles enter in the center of the city from its port. We propose a heuristic algorithm, where the overall problem can be divided into three subproblems: a location-allocation problem, to select satellites and allocate each container to a satellite, while accounting for its capacity; an assignment problem, to select and assign vehicles to satellites; an open routing problem with splits to deliver pallets from each satellite determined. The subproblems are solved sequentially and included in an iterative procedure.

Keywords: Location, Routing, City-logistics.

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SPORT1.4

A decomposition-based heuristic for the truck scheduling problem in a cross-docking terminal

Marcello Sammarra, Manlio Gaudioso and M. Flavia Monaco

Abstract We consider the truck scheduling problem at a cross docking terminal with many inbound and outbound doors, under the assumption of constant handling time for all the trucks, the objective being to minimize the completion time of the whole process. We propose a mathematical model together with a Lagrangian Relaxation scheme. We discuss the structural properties of the relaxed problem and derive a Lagrangian heuristic able to compute, at the same time, good feasible solutions and increasing lower bounds. The numerical results show that the Lagrangian decomposition is a promising approach to the solution of such problems.

Keywords: Lagrangian relaxation; scheduling; heuristics.

Sept. 13th
8.30-10.00
Empedocle

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SPORT1.5

Analysis of the rail capacity network connecting marine terminals: a simulation-optimization method

Anna Sciomachen and Daniela Ambrosino

Sept. 13th
8.30-10.00
Empedocle

Abstract A simulation - optimization method is used to evaluate the efficiency of the railway connections from containerized maritime terminals. More precisely, a discrete event simulation model of a container terminal is first developed to analyze the handling performance indices related to the import flow and tuning their main parameters. In particular, the internal transport from the yard to the gateway rail exits is examined. Successively, these parameters are used in an optimization model to find the best solution to move containers into the landside. The goal is to improve the frequency of the trains and the outgoing modal split. Finally, the optimization results are used to set up the parameters of the simulation model. The simulation model has been implemented with the software environment Witness, while the optimization model has been created with MPL and solved with Gurobi 7.5.1. The results have been validated using as test bed a terminal belonging to the Port Authority system of the western Liguria Sea, Italy. The railway connections are analyzed due to the need in the forthcoming years to provide an efficient network to the hinterland to the arrivals of large size ships. In fact, the lack of spaces closed to the port of Genoa calls for new infrastructural investments and an increase of the number of trains departing from the port.

Keywords: Maritime terminal, Intermodal transport, Simulation-optimization.

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Optimization and Applications 1

Chair: S.V. Joubert

OPTAP1.1	**AIRO Prize** *Operational Research in modern wind park design* **M. Fischetti**, M. Fraccaro, M. Monaci and D. Pisinger
OPTAP1.2	*A clustering analysis of prescription and compliance patterns in antibiotic therapy* **I. Giordani**, A. Candelieri, F. Archetti and D. Castaldi
OPTAP1.3	*A linear integer programming approach for the optimal assignment of shifts to a team of employees in big stores* **S. Zanda**, C. Seatzu and P. Zuddas
OPTAP1.4	*On identifying nonlinear ODE parameters by optimisation* **S.V. Joubert**, M.Y. Shatalov and T.H. Fay

OPTAP1.1

AIRO Prize
Operational Research in modern wind park design

Martina Fischetti, Marco Fraccaro, Michele Monaci and David Pisinger

Sept. 13th
8.30-10.00
Majorana

Abstract Wind energy is a fast evolving field that has attracted a lot of attention and investments in the last decades. Being an increasingly competitive market, it is very important to minimize establishment costs and increase production profits already at the design phase of new wind farms. In this context, we will illustrate some of the practical needs defined by energy companies, showing how optimization can help the designers to increase production and reduce costs in the design of offshore farms.
More specifically, we will describe the outcome of our 4-years collaboration with Vattenfall BA Wind, a leading wind energy developer and wind power operator. The results obtainedusing mathematical optimization techniques had a large economic impact and encouraged Vattenfall to use the algorithms developed within this research project, and to look for new Operations Research applications . This motivated us to continue on this line of research, trying to produce even better algorithms, combining also Operations Research algorithms with techniques taken from the Machine Learning community.

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OPTAP1.2

A clustering analysis of prescription and compliance patterns in antibiotic therapy

Ilaria Giordani, Antonio Candelieri, Francesco Archetti and Davide Castaldi

Abstract Antimicrobial resistance has become a health emergency worldwide: bacteria are mutating and exchanging their genes at an extraordinary rate. Data analytics can give a major contribution to tackle this health and socioeconomic challenge: by means of insights originated from analytical results health authorities can plan informed actions. This study summarizes relevant insights obtained by the analysis of data related to about 650 general practitioners (GPs) and around 1'000'000 patients, during the period 2011 to 2017. After data cleaning the sample was reduced to about 500'000 patients, balanced in terms of gender, age, and therapeutic indication, and related to 140 different types of antibacterial agents. The data analysis process was focused on the identification of typical GPs prescription patterns and the possible relation with the features characterizing GPs. While time series clustering has been used to identify the typical prescription patterns, clustering on the features describing GPs allows to identify groups of "similar" GPs. More precisely, kernel-based k-means and spherical k-means have been used to obtain suitable clusterings for both pre-scription patterns and GPs. Thus, possible associations between the group which a GP belongs to and the typical prescription behavior is inferred. Finally, it was also possible to identify possible changes in prescription patterns over time for every GP or groups of GPs, as well as emerging/disappearing prescription patterns. The insights from this study allow to improve the effectiveness of health authorities informed actions.

Sept. 13th
8.30-10.00
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Keywords: Time series clustering, prescription patterns, antimicrobial resistance.

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OPTAP1.3

A linear integer programming approach for the optimal assignment of shifts to a team of employees in big stores

Simone Zanda, Carla Seatzu and Paola Zuddas

Abstract In this paper we deal with the problem of optimally scheduling the shift of employees in a big store. We propose a solution based on integer linear programming that allows us to keep into account the skills of the employees and a series of contractual rules, providing to the store manager a solution that keeps the maximum advantage from the available human resources, while guaranteeing a satisfactory quality of the employees working conditions.
A real case study is considered to test the effectiveness of the approach, namely a chain of bricolage stores in Sardinia, Italy.

Sept. 13th
8.30-10.00
Majorana

Keywords: manpower planning, scheduling, retail stores.

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OPTAP1.4

On identifying nonlinear ODE parameters by optimisation

Stephan V. Joubert, Michael Y. Shatalov and Temple H. Fay

Sept. 13th
8.30-10.00
Majorana

Abstract We recently introduced nonlinear anisotropic damping into the equations of motion of any axisymetric vibratory gyroscope (VG). Subsequent studies have revealed that a damping coefficient appears in the formulae for calculating the rate of rotation about any axis of a three-dimensional single unit VG. Ling Xu recently discussed a damping iterative estimation using nonlinear optimisation. In this paper, we tentatively examine the one-dimensional oscillator and demonstrate how a noniterative optimisation method based on least squares manipulation of given displacement data yields apparently accurate results for this elementary model.
Assuming that we have "enough" data pairs for displacement evolution over time, we set up an ordinary differential equation (ODE) representing a harmonically driven one-dimensional oscillator containing both linear, quadratic and cubic damping and stiffness terms. We numerically integrate the ODE and then use least squares optimisation to accurately determine the parameters.
In this theoretical study, we generate a data set assuming values for the coefficients of the ODE. We then apply our method to this data set, accurately identifying the "unknown parameters" in the ODE, and, we are thus able to verify the accuracy of the identified parameters and demonstrate the robustness of the method.

Keywords: Parameter identification, Nonlinear oscillator, Vibratory gyroscope.

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Spatial Planning and Location

Chair: J.W. Owsiński

SPLOC1	**AIRO Prize** *Optimization models to design a new cruise itinerary: Costa Crociere case study* **V. Asta**, D. Ambrosino and F. Bartoli
SPLOC2	*A mathematical approach to evaluate the cruise itineraries' offer* **V. Asta** and D. Ambrosino
SPLOC3	*An optimization model to rationalize public service facilities* **C. Piccolo**, M. Cavola and A. Diglio
SPLOC4	*Designing the municipality typology for planning purposes: the use of reverse clustering and evolutionary algorithms* **J.W. Owsiński**, J. Stanczak and S. Zadrozny

AIRO Prize
Optimization models to design a new cruise itinerary: Costa Crociere case study

Veronica Asta, Daniela Ambrosino and Federico Bartoli

Sept. 13th
10.30-12.00
Bellini

Abstract The decision process for defining new cruise's itineraries to offer on the market consists in three planning levels, that are a long, a medium and a day-by-day plan. The problem under investigation belongs to the class of the day by day planning and it is influenced by decisions taken at the previous levels. Given a ship of the fleet located in a specific world's basin, with a list of available ports which the ship can visit, given a duration and a homeport, the cruise itinerary design consists in deciding which ports the ship has to visit, the arrival and the departure time for each one. The objectives to pursue are the maximization of both the customer satisfaction and the revenue and the minimization of the costs. Appealing and accessibility values linked to the different ports have been used as customer satisfaction measure; the revenue included are from the sale of both the excursions tickets and the onboard services; the costs depend on fuel consumption and ports' services. The port's costs are fixed amounts paid when the port is visited. The fuel cost is function of the speed of the ship.
Itinerary design is in the class of cruise supply and few works deal with this problem. In [2] is stressed the function of the itineraries in the appeal of a cruise service. Moreover, the role of the different ports (and cities) within different itineraries has been analyzed in [1]. The model developed to solve the Cruise Itinerary Designing Problem is reported and the case study is presented. The model has been applied to determine a new itinerary within the West Mediterranean basin for Costa Crociere. It has been implemented in Mathematical Programming Language (MPL) software

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and solved by the commercial solver GUROBI. Thanks to the model, optimal solutions have been found and compared. The model proposed to define a new optimal cruise route according to the criteria described allows to obtain solutions applicable to the real world and can be used as a support to the decision-making process that has to face a cruise company.

Keywords: Optimization, Cruise itinerary designing problem, Integer linear programming model

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SPLOC2

A mathematical approach to evaluate the cruise itineraries' offer

Veronica Asta and Daniela Ambrosino

Abstract The development of cruises' itineraries to offer on the market is a long process involving three planning levels that are a long, a medium and a day-by-day plan. Generally, each cruise company develops its itineraries offer by a specialized department (the Itinerary Planning Department) that cooperates with, among others, Marketing, Budget and Revenue Departments, in order to keep in consideration the global strategy of the company. The itinerary design, recently included by Cusano et al. (2017) in the class of cruise supply, is a problem that received few attention, even if it has been recognized that it represents an important task having an impact on consumers' satisfaction. Sun et al. (2011) suggest the integration of the itinerary design and the revenue management, being a cruise a combination of transportation and accommodation. This work, after a description of the optimization problems arising in this complex decision process, focuses on the problem of evaluating and improving the current offer of a cruise company. In fact, the cruise offer must be analyzed when the market changes due to either customers demands variations or new actions of competitors. Given a planning horizon, a basin, a number of available ships, given the itineraries already offered in the basin and a set of new ones, the problem consists in selecting the best set of itineraries in such a way to satisfy the cruise demand and to maximize the revenue, the customers' satisfaction, the accessibility and minimize the operative costs. For defining the set of itineraries has been used a model recently proposed in the literature (Asta et al. 2018) for solving the cruise itinerary designing problem (CIDP). A mixed integer 0/1 linear programming model for solving this problem is proposed. A case study related to the Mediterranean sea cruise offer is presented. Preliminary results are given.

Sept. 13th
10.30-12.00
Bellini

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Keywords: Cruise offer decision process, Evaluation of cruise offer, Optimization.

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SPLOC3

An Optimization Model to rationalize Public Service Facilities

Carmela Piccolo, Manuel Cavola and Antonio Diglio

Abstract Facility Location Models (FLMs) have been widely applied in the context of both private and public sector, to decide the best configuration of new facilities to be located in a given area. In the last years, due to the general interest to reduce costs and improve efficiency, several works focused on problems aimed at modifying the territorial configuration of existing facilities, in terms of number, position and/or capacities, etc. In this work, we propose a new mathematical model to support territorial re-organization decisions in non-competitive contexts. The model assumes the presence of a set of facilities providing different types of services to users (multi-type facilities) and explores the possibility to improve the efficiency of the system by implementing different rationalization actions; i.e., facility closure, service closure, capacity reallocation among services at a given facility. The model aims at finding a trade-off solution between the service efficiency and the need of ensuring a given accessibility level to users. It has been tested on a set of randomly generated instances, to show that a good range of problems can be solved to optimality through the use of a commercial solver (CPLEX).

Sept. 13th
10.30-12.00
Bellini

Keywords: Facility Location Models, Territorial re-organization, public sector.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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SPLOC4

Designing the municipality typology for planning purposes: the use of reverse clustering and evolutionary algorithms

Jan W. Owsinski, Jaroslaw Stanczak and Slawomir Zadrozny

Sept. 13th
10.30-12.00
Bellini

Abstract The paper presents the preliminary results of a study, meant to determine the typology of the Polish municipalities (roughly 2500 in number), oriented at planning and programming purposes. An initial typology of this kind was elaborated by the geographers, based on a number of individual features, as well as location-related characteristics. This typology is "re-established" or "approximated" via the "reverse clustering" approach, elaborated by the authors, consisting in finding the parameters of the clustering procedure that yield the results the closest to the initial typology, for the set of municipalities, described by the definite set of variables. Altogether, one obtains the clusters (types, classes) of municipalities that are possibly similar to the original ones, but conform to the general clustering paradigm. The search for the clustering that is the most similar to the initial typology is performed with an evolutionary algorithm. The paper describes the concrete problem, the approach applied, its interpretations and conclusions, related to the results obtained.

Keywords: clustering, reverse clustering, municipalities, typology, planning, spatial planning.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Prin SPORT 2 (invited session)

Chair: E. Gorgone

SPORT2.1	*An automated approach to store and retrieve port regulations* **G. Di Tollo**, R. Pesenti and P. Pellegrini
SPORT2.2	*A multi-commodity and vehicle routing based model for long haul shipment* **G. Stecca** and V. Contente
SPORT2.3	*AEOLIX: Pan-European logistic platform for enhancing the competitiveness of goods transport in the Trieste port.* **G. Stecco**, W. Ukovich, M. Nolich, S. Mininel, M. Cipriano, S. Carciotti, C. Gelmini, R. Buqi, A. Locatelli, M.P. Fanti and A. M. Mangini
SPORT2.4	*A Lagrangian-based decomposition method on a new formulation of the capacitated concentrator location problem* **E. Gorgone**, M. Di Francesco, M. Gaudioso and I. Murthy

SPORT2.1

An automated approach to store and retrieve port regulations

Giacomo di Tollo, Raffaele Pesenti and Paola Pellegrini

Abstract Vessel operations are administered by statutory harbour authorities, which are subject to their own legislation tailored to the needs of the specific port. In the "Port of Venice", the harbour authorities produce regulations which state the requirements and constraints to be fulfilled by vessels requesting access to specific port infrastructures: a trajectory to their final destination is computed, and the harbour authority has to retrieve the regulations associated to the infrastructures belonging to this trajectory and verify its fulfillment; only when all constraints and regulations are satisfied, the vessel is granted access to the requested infrastructure. In our work we propose an automated approach to store and retrieve regulations: new regulations are encoded by specifying all former modified regulations, along with all constraints specified in Perl. In this way, when a vessel request access to a given area, the system retrieves all regulations (i.e., constraints) concerned with the concerned infranstructures, verify their fulfillment, and grant access accordingly.

Keywords: Port Regulations, Information Retrieval, Waterway Ship Scheduling Problem.

Sept. 13th
10.30-12.00
Empedocle

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SPORT2.2

A multi-commodity and vehicle routing based model for long haul shipment

Giuseppe Stecca and Valentina Contente

Abstract Efficient and reactive long haul transport network is crucial for the competitive development of multi-modal transportation. These networks connect global market with national destinations, giving to ports and hubs a central role in shifting transportation modes also by using standard equipment such as containers and pallets. In this work we focus our analysis in the transportation of pallets which have to be forwarded in a country-wide network with the aim to lower the used vehicles. The problem has been regarded with attention both for global supply chain (Liotta et al., 2015) and considering cooperation issues (Liotta et al., 2016). The planning should minimize the sum of traveling cost in a network of arcs while moving pallets from specif origins to specific destinations and considering the cost related to the time spent in the vehicle for long runs. Moreover the model considers pick-up and deliver of goods in mid-term stops. Each vehicle has a specif departure and arrival depot. The developed model has been tested against instances provided by an Italian logistics operator proving a substantial improvement in the forwarding process if addressed with the optimization model. While the real case instances can be solved in reasonable time with the exact approach, the complexity of the model give rise to approximation studies suitable for larger instances.

Sept. 13th
10.30-12.00
Empedocle

Keywords: Multi-modal transport, Long haul transport, Multi-commodity flow, Vehicle routing problem.

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SPORT2.3

AEOLIX: Pan-European Logistic platform for enhancing the competitiveness of goods transport in the Trieste port.

Gabriella Stecco, Walter Ukovich, Massimiliano Nolich, Stefano Mininel, Margherita Cipriano, Sara Carciotti, Chiara Gelmini, Raol Buqi, Alberto Locatelli, Maria Pia Fanti and Agostino Marcello Mangini

Abstract Targeting sustainability from environmental, economic and social perspectives, the project AEOLIX (Architecture for EurOpean Logistics Information eXchange) will improve the overall competitiveness of goods transport in supply chain. The aim will be obtained by enabling low-complexity and low cost connectivity of local ICT platforms and systems and thereby scalable, trusted and secure exchange of information, establishing a cloud-based collaborative logistics ecosystem. Supply chain visibility supported by easy access to, and exchange and use of relevant and abundant logistics related information is an important prerequisite for the deployment of pan-European logistics solutions that are needed to increase efficiency and productivity, and to reduce environmental impact. The project involves 12 Living Labs, including some of the most important European ports and locations affected by ITS corridors, through which the project will test, validate and demonstrate the collaborative logistics ecosystem. In particular, the port of Trieste, that is a free port goods since 1719 with busy container and oil terminals and that is connected with Istanbul by one of the busiest RO/RO routes in the Mediterranean Sea, works on the optimization of the customs procedures. The objectives are improving the pre-clearing operations and monitor the movements of trucks that have already performed the customs procedures at the Interporto di Trieste inland terminals. At the national (Italian) level, AEOLIX is coordinated with the PRIN SPORT project.

Keywords: ICT platform, Collaborative logistics, Port terminal.

Sept. 13th
10.30-12.00
Empedocle

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SPORT2.4

A Lagrangian-based decomposition method on a new formulation of the capacitated concentrator location problem

Enrico Gorgone, Massimo Di Francesco, Manlio Gaudioso and Ishwar Murthy

Sept. 13th
10.30-12.00
Empedocle

Abstract The Capacitated Concentrator Location Problem (CCLP) is a classic subject of network design and has relevant applications in freight transportation [1]. The problem can be described as the optimal design of a layered network, where a central node must be connected to a set of final nodes through a set of satellite nodes (the concentrators in the CCLP parlance). In this work, starting from a formulation introduced in [1], we introduce a new formulation of CCLP that is based on the notion of cardinality associated with each concentrator that is set up. The new formulation uses variables indexed by an integer value: i) node binary variables associated to concentrators, where the extra index indicates the number of clients and ii) arc variables where one endpoint, the concentrator, is associated to an integer value representing the number of clients assigned to. the concentrator. The Lagrangian relaxation of the new formulation is shown to be stronger than than of [1], thus it is suitable for a Lagrangian-based decomposition scheme, which will be presented in the talk.

Keywords: Concentrator Location, Network Design, Lagrangian relaxation.

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Transportation Planning

Chair: M. Gallo

TRPL1 *Testing demand responsive shared transport services via agent-based simulations*
G. Inturri, N. Giuffrida, M. Ignaccolo, M. Le Pira, A. Pluchino and A. Rapisarda

TRPL2 *A software for production-transportation optimization models building*
E. Parra

TRPL3 *Rerostering bus drivers*
M. Mesquita, A. Paias, M. Moz and M. Pato

TRPL4 *An origin-destination based parking pricing policy for improving equity in urban transportation*
M. Gallo and L. D'Acierno

TRPL1

Testing demand responsive shared transport services via agent-based simulations

Giuseppe Inturri, Nadia Giuffrida, Matteo Ignaccolo, Michela Le Pira, Alessandro Pluchino and Andrea Rapisarda

Sept. 13th
10.30-12.00
Majorana

Abstract In this paper, an agent-based model is presented to test the feasibility of different configurations of Demand Responsive Shared Transport (DRST) services in a real context. DRST services provide "just-in-time" mobility solutions by dynamically assigning a fleet of vehicles to passenger booking requests taking advantages of Information and Communication Technologies. First results show the impact of different route choice strategies on the system performance and can be useful to help the planning and designing of such services.

Keywords: shared mobility, flexible transit, dynamic ride sharing, mobility on demand, agent-based model.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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TRPL2

A software for production-transportation optimization models building

Enrique Parra

Abstract Corporations are using large mixed integer mathematical programming (MIP) models in strategic, medium term and short term planning. To build these models it is necessary a mathematical programming language and a set of optimizers. Some expert in the particular business must code the variables, constraints and objective function in the equations that reflect the actual problem. The person who do this must be both an expert in the field where company operates and a mathematical expert to write the mathematical model. A software to do this job easy for the planner (non-mathematical expert) is introduced. The software uses only some intuitive codes and data obtained from different sources. The purpose of this model builder software is to generate MIP supply chain optimization models. A previous version of the software has been used by large Spanish company for both medium term detailed planning and to analyze strategic investments.

Sept. 13th
10.30-12.00
Majorana

Keywords: MIP models, mathematical programming software, supply chain optimization.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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TRPL3

Rerostering bus drivers

Marta Mesquita, Ana Paias, Margarida Moz and Margarida Pato

Sept. 13th
10.30-12.00
Majorana

Abstract The bus Driver ReRostering Problem (DRRP) arises when drivers' non-planned absences disrupt the roster (plan of work for a predefined planning horizon) leaving uncovered crew duties. To restore the roster, uncovered crew duties must be re-assigned to drivers ensuring that: i) each crew duty is assigned to exactly one driver; ii) each driver rests a minimum number of hours between consecutive duties; iii) each driver works at most a predefined number of consecutive days; iv) each driver has at least a predefined number of day-off in the planning horizon; v) each driver has at least a predefined number of Saturdays or Sundays-off in the planning horizon. Depot drivers (drivers without crew duties assigned in the original roster) can be called to work. However this is not desirable for the company. Rerostering problems are usually addressed in airline or railway contexts (see for example Chen and Chou (2017) and Verhaegh et. al. (2017)). To solve the DRRP we propose a two phase algorithm based on a multicommodity flow assignment model. In the first phase, changes in previously assigned days-off are not allowed. Taking advantage of standby drivers and assuming there are enough depot drivers available to ensure feasibility, the algorithm determines a recovered roster that minimizes the number of depot drivers assigned to work, the dissimilarity between the recovered and the original roster and balances the workload. In the second phase the algorithm minimizes the number of depot drivers called to work. Based on the solution of the first phase, some local changes on drivers' days-off are allowed, ensuring that con-

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straints i) to v) are satisfied. Computational experience focusing real based instances is presented.

Keywords: Bus drivers, Rerostering, two phase algorithm.

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TRPL4

An Origin-Destination Based Parking Pricing Policy for Improving Equity in Urban Transportation

Mariano Gallo and Luca D'Acierno

Sept. 13th
10.30-12.00
Majorana

Abstract In this paper we propose to optimise parking pricing fares in urban areas with the aim to improve transportation equity; the optimisation approach is applied to an origin-destination parking pricing policy that can differentiate the tariffs for each origin-destination pair, considering the difference in accessibility, in particular with public transport services. An optimisation model is implemented, and a solution algorithm is proposed. Model and algorithm are tested on the case study of Naples, where the quality of transit services is very different between zones and OD pairs; therefore, to differentiate parking fares as a function of origin and destination of the trip may be very useful for rebalancing accessibilities among zones, aiming to improve transportation equity.

Keywords: Transportation; parking pricing; equity; optimisation; accessibility.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Supply Management Models

Chair: D. Bauso

SUPM1 *First-time interaction under revenue-sharing contract and asymmetric beliefs of supply-chain members*
T. Chernonog

SUPM2 *Power adjustment via negawatt trading based on regret matching*
T. Namerikawa and K. Nagami

SUPM3 *Situation awareness and environmental factors: the EVO oil production*
L. Rarità, M. De Falco, N. Mastrandrea and W. Mansoor

SUPM4 *An efficient and simple approach to solve a distribution problem*
C. Cerrone, R. Cerulli, C. D'Ambrosio and M. Gentili

SUPM1

First-time interaction under revenue-sharing contract and asymmetric beliefs of supply-chain members

Tatyana Chernonog

Sept. 13th
10.30-12.00
Pirandello

Abstract The paper provides a thorough investigation of a first-time interaction between a retailer and a manufacturer who are unreliable in a cost function of the manufacturer. We consider a two-echelon supply chain of a single customized product, where parties interact via a revenue-sharing contract. The general model is formulated as a Retailer-Stackelberg game with two-sided information asymmetry. We derive the equilibrium strategy and parties' profits when: (i) information is complete, (ii) hidden information asymmetry is present, and (iii) known information asymmetry is present. For a third scenario, we propose two different contracts to induce a Pareto-optimal information-sharing equilibrium.

Keywords: Revenue sharing contract; Asymmetric information; Supply chain management.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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SUPM2

Power adjustment via negawatt trading based on regret matching

Toru Namerikawa and Kentaro Nagami

Sept. 13th
10.30-12.00
Pirandello

Abstract In recent years, power demand tightness in peak time has led to an important problem, and there is a concern of power imbalance caused by the increased renewable energy in the future power system. In order to maintain power system stable, power demand needs to equal to the power supply at all time, and demand-supply management method called demand response attracts attention. In demand response, negawatt trading is expected as one of the most effective demand-supply management methods. Negawatt trading is the method that consumers save electricity by the request of power company and receive incentive as a reward and is expected to promote power reduction in peak time. In deregulated electricity market, power consumers and generators participate in the electricity market. The demand-supply adjustment methods need to guarantee the profit of market participants.
This paper proposes a demand-supply management method in negawatt trading using VCG mechanism design considering the stochastic action of consumers. Then, we apply regret matching (RM) to consumer's behavior. The regret matching algorithm is one of the repeated learning ones in the field of game theory and optimization. This approach does not need constraints of player's utilities' structures. Therefore, the assumptions of market participants could be relaxed. This paper is organized as follows. First, we present a model of the power grid in negawatt trading in Section Ⅱ. Next, Section Ⅲ shows model of power consumers to determine their power reduction using regret matching and model of incentive design to achieve demand-supply adjustment using VCG mechanism design. Then, Section Ⅳ shows our proposed algorithm. Finally, we verify the feasibility of proposed method through numerical simulation in Section V.

Keywords: Power Adjustment, Negawatt Trading, Regret Matching.

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SUPM3

Situation Awareness and environmental factors: the EVO oil production

Luigi Rarità, Massimo de Falco, Nicola Mastrandrea and Wathiq Mansoor

Abstract The paper considers simulation results for a supply network, that deals with Extra Virgin Olive (EVO) oil production, an activity that is typical of Southern Italy. The phenomenon is studied by differential equations, that focus on goods on arcs and queues for the exceeding goods. Different numerical schemes are used for simulations. A strategy of Situation Awareness allows defining a possible choice of the input flow to the supply network. The achieved results indicate that Situation Awareness permits to find good compromises for the modulation of production queues and the optimization of the overall system features.

Sept. 13th
10.30-12.00
Pirandello

Keywords: Situation Awareness, production systems, simulations.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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SUPM4

An Efficient and Simple Approach to Solve a Distribution Problem

Carmine Cerrone, Raffaele Cerulli, Ciriaco D'Ambrosio and Monica Gentili

Abstract We consider a distribution problem in a supply chain consisting of multiple plants, multiple regional warehouses, and multiple customers. We focus on the problem of selecting a given number of warehouses among a set of candidate ones, assigning each customer to one or more of the selected warehouses while minimizing costs. We present a mixed integer formulation of the problem of minimizing the sum of the total transportation costs and of the fixed cost associated with the opening of the selected warehouses. We develop a heuristic and a metaheuristic algorithm to solve it. The problem was motivated by the request of a company in the US which was interested both in determining the optimal solution of the problem using available optimization solvers, and in the design and implementation of a simple heuristic able to find good solutions (not farther than 1% from the optimum) in a short time. A series of computational experiments on randomly generated test problems are carried out. Our results show that the proposed solution approaches are a valuable tool to meet the needs of the company.

Sept. 13th
10.30-12.00
Pirandello

Keywords: Supply chain, Greedy, Carousel Greedy.

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Probabilistic Problem

Chair: R. Tadei

PROBP1	*Bayesian optimization for full waveform inversion* **A. Candelieri**, F. Archetti, B. Galuzzi and R. Perego
PROBP2	*Monte Carlo sampling for the probabilistic orienteering problem* **X. Chou**, L.M. Gambardella and R. Montemanni
PROBP3	*A recent approach to derive the multinomial logit model for choice probability* **R. Tadei**, D. Manerba and G. Perboli

PROBP1

Bayesian Optimization for Full Waveform Inversion

Antonio Candelieri, Francesco Archetti, Bruno G. Galuzzi and Riccardo Perego

Sept. 13th
12.00-13.30
Bellini

Abstract Full Waveform Inversion (FWI) is a computational method to estimate the physical features of Earth subsurface from seismic data, leading to the minimization of a misfit function between the observed data and the predicted ones, computed by solving the wave equation numerically. This function is usually multimodal, and any gradient-based method would likely get trapped in a local minimum, without a suitable starting point in the basin of attraction of the global minimum. The starting point of the gradient procedure can be provided by an exploratory stage performed by an algorithm incorporating random elements. In this paper, we show that Bayesian Optimization (BO) can offer an effective way to structure this exploration phase. The computational results on a 2D acoustic FWI benchmark problem show that BO can provide a starting point in the parameter space from which the gradient-based method converges to the global optimum.

Keywords: Bayesian Optimization, Full Waveform Inversion, Inversion problems.

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PROBP2

Monte Carlo Sampling for the Probabilistic Orienteering Problem

Xiaochen Chou, Luca Maria Gambardella and Roberto Montemanni

Sept. 13th
12.00-13.30
Bellini

Abstract The Probabilistic Orienteering Problem is a variant of the orienteering problem where customers are available with a certain probability. Given a solution, the calculation of the objective function value is complex since there is no linear expression for the expected total cost. In this work we approximate the objective function value with a Monte Carlo Sampling technique and present a computational study about precision and speed of such a method. We show that the evaluation based on Monte Carlo Sampling is fast and suitable to be used inside heuristic solvers. Monte Carlo Sampling is also used as a decisional tool to heuristically understand how many of the customers of a tour can be effectively visited before the given deadline is incurred.

Keywords: Orienteering Problem, Data Uncertainty, Monte Carlo Sampling.

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PROBP3

A recent approach to derive the Multinomial Logit model for choice probability

Roberto Tadei, Daniele Manerba and Guido Perboli

Sept. 13th
12.00-13.30
Bellini

Abstract It is well known that the Multinomial Logit model for the choice probability can be obtained by considering a random utility model where the choice variables are independent and identically distributed with a Gumbel distribution. In this paper we organize and summarize existing results of the literature which show that using some results of the extreme values theory for i.i.d. random variables, the Gumbel distribution for the choice variables is not necessary anymore and any distribution which is asymptotically exponential in its tail is sufficient to obtain the Multinomial Logit model for the choice probability.

Keywords: random utility, extreme values theory, asymptotic approximation, Multinomial Logit model.

The short paper related to this contribution will be published in ODS2018 Conference Proceedings as a special volume of the Springer AIRO Series.

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Optimization and Applications 2

Chair: R. Cerulli

OPTAP2.1	*A structure of P_5 - free locally split graphs*
	I. Hayat, A. Haddadene Hacene and K. Hamamache
OPTAP2.2	*Some generalizations of the minimum branch vertices problem*
	F. Laureana, F. Carrabs and R. Cerulli
OPTAP2.3	*Evaluation of cascade effects for transit networks*
	B. Galuzzi, A. Candelieri, I. Giordani and F. Archetti
OPTAP2.4	*Sparse recovery and convex quadratic splines*
	M.C. Pinar

OPTAP2.1

A structure of P_5 - free locally split graphs

Issaadi Hayat, Ait Haddadene Hacene and Kheddouci Hamamache

Abstract A graph is P_5-free if it contains no induced path of five vertices. A locally split graph is a graph in which the open neighborhood of each vertex induces a split graph. We consider P_5-free locally split graphs, together with two NP-hard problems, namely, the Minimum Coloring problem (MC) and the Minimum Clique Cover problem(MCC). The class of P_5 -free locally split graphs extends that of (P_5, triangle)-free graphs. From one hand, (P_5, triangle)-free graphs have bounded clique with (A. Brandstadt (P_5, diamond)-free revisited: structure and linear time optimization, Discrete Applied Mathematics 138 (2004) 325-356), and thus MC and MCC for (P_5 , triangle)-free graphs can be solved in polynomial time. From the other hand, P_5 -free locally split graphs have unbounded clique width [since split graphs have so], and the complexity of MC and MCC for P_5 -free locally split graphs is open. In this paper we prove that every prime P_5 - free locally split graph either has a bounded number of vertices, or is a matched co-bipartite graph, or is a split graph. This characteriza-tion will solve the optimization problems mentioned above.

Sept. 13th
12.00-13.30
Majorana

Keywords: P_5 -free locally split graphs, Prime graphs.

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OPTAP2.2

Some generalizations of the minimum branch vertices problem

Federica Laureana, Francesco Carrabs and Raffaele Cerulli

Abstract We investigate some generalizations of the Minimum Branch Vertices problem (MBV). MBV consists in finding, given an undirected graph $G = (V, E)$, a spanning tree T with the minimum number of branch vertices, where a vertex is branch if it has degree greater than two in T. This problem is known to be NP-Hard and arises in the context of optical networks. We introduce two generalizations of the MBV: the Minimum Branch Clusters problem (MBC), and the Generalized Minimum Branch Vertices problem (GMBV). Let us assume that the set of nodes V is partitioned into k clusters, $V_1, ..., V_k$. The aim of MBC is to find a spanning tree T with the minimum number of branch clusters. A cluster is said to be branch when the number of edges incident to it in T is greater than two. GMBV consists in finding a tree containg exactly, or at least, one vertex for each cluster, and that minimizes the number of branch vertices. These problems are NP-Hard, indeed they reduce to MBV when every cluster is a singleton. For these problems we propose exact approaches and some preliminary results.

Sept. 13th
12.00-13.30
Majorana

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OPTAP2.3

Evaluation of cascade effects for transit networks

Bruno G. Galuzzi, Francesco Archetti, Antonio Candelieri and Ilaria Giordani

Sept. 13th
12.00-13.30
Majorana

Abstract This paper presents a network analysis approach to simulate cascading effects in a transit network with the aim to assess its resilience and efficiency. The key element of a cascade is time: as time passes by, more locations or connections of the transit network which are nodes and edges of the associated graph can be affected consecutively as well as change their own condition. Thus, modifications in terms of efficiency and resilience are also dynamically evaluated and analysed along the cascade. Results on the two case studies of the RESOLUTE project (i.e., Florence, in Italy, and the Attika region, in Greece) are presented. Since the two case studies are significantly different, important differences are reflected also on the impacts of the relative cascades, even if they were started in both the two cases from the node with the highest betweenness centrality.

Keywords: Network Analysis, Resilience, Cascading effects, Urban Transport System.

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OPTAP2.4

Sparse recovery and convex quadratic splines

Mustafa C. Pinar

Sept. 13th
12.00-13.30
Majorana

Abstract Given an underdetermined system of linear equations $Ax = Aw$, where w is a sparse vector, the problem of exact recovery is usually attacked by solving the L1 problem:

$$\min_x \{||x||_1 : Ax = Aw\}, \tag{1}$$

an approach known as Basis Pursuit (BP). If the problem (1) has unique solution w, then we have exact recovery. Several sufficient (and necessary) conditions for exact recovery by BP have been studied in the past. We address the exact recovery problem by minimizing a convex quadratic spline function approximating the L1 norm, and investigate sufficient/necessary conditions for exact recovery.

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Delivery Problem

Chair: L. Amodeo

DELP1	*A freight adviser for a delivery logistics service e-marketplace* **A. De Maio**, P. Beraldi, D. Laganà and A. Violi
DELP2	*Towards real-time urban-scale ride-sharing via federated optimization* **C. Gambella**, J. Monteil and A. Simonetto
DELP3	*Fleet size and mix pickup and delivery problem with time windows: a new column generation algorithm* **M.A. Noumbissi Tchoupo**, L. Amodeo, P. Flori, A. Yalaoui and F. Yalaoui

DELP1

A freight adviser for a delivery logistics service e-marketplace

Annarita De Maio, Patrizia Beraldi, Demetrio Laganà and Antonio Violi

Abstract We introduce the study of an application for the Macingo Technologies, a company that manages an e-marketplace for logistics services. A carrier has to pick-up and delivery freight from different points and is able to accept further delivery requests through the web company platform. In order to investigate the convenience in accepting extra-deliveries, the company wants to develop a decisional support system that suggests a list of convenient deliveries, and as a consequence, the best itinerary for the pick-up and delivery points. We study a *Vehicle Routing Problem* in which a subset of mandatory customers has to be visited by the vehicle, while the goal consists of maximizing the net revenue with respect to the routing cost to serve the set of mandatory customers. Some preliminary computational results are presented, showing the validity of the proposed approach.

Sept. 13th
12.00-13.30
Pirandello

Keywords: Vehicle routing, pick-up and delivery, time windows.

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DELP2

Towards real-time urban-scale ride-sharing via federated optimization

Claudio Gambella, Julien Monteil and Andrea Simonetto

Sept. 13th
12.00-13.30
Pirandello

Abstract Ride-sharing services are gradually spread nowadays, and involve challenging optimization problems. We propose a novel dynamic ride-sharing algorithm that is highly flexible and parallelizable. The beneficial computational properties of the algorithm arise from casting the ride-sharing problem as a linear assignment problem between fleet vehicles and customer trip requests in a federated optimization architecture. Current literature showcases the ability of state-of-the-art ride-sharing algorithms to tackle very large fleets and customer requests in near real-time, by the means of high performance programming languages and powerful computing machines, and the benefits of ride-sharing seem limited to centralized systems. With our algorithm, we demonstrate that this does not need to be the case. First, our algorithm is implemented in Python and runs on a standard laptop. Second, by leveraging the New York City taxi database, we show that with our algorithm, real-time ride-sharing offers clear benefits with respect to more traditional taxi fleets in terms of number of used vehicles, even if one considers partial adoption of the system. This makes real-time urban-scale very attractive to small enterprises and city authorities alike.

Keywords: Ride-sharing, Dynamic optimization, Pickup and delivery.

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Fleet size and mix pickup and delivery problem with time windows: A new column generation algorithm

Moïse Noumbissi Tchoupo, Lionel Amodeo, Pauline Flori, Alice Yalaoui and Farouk Yalaoui

Abstract In this paper, a new efficient column generation algorithm is proposed to tackle the Fleet Size and Mix Pick-up and Delivery Problem with Time Windows (FSMPDPTW). This work is motivated by fleet sizing for a daily route planning arising at a Hospital centre. Indeed, a fleet of heterogeneous rented vehicles is used every day to pick up goods to the locations and to deliver it to other locations. The heterogeneous aspect of the fleet is in term of fixed cost, capacity, and fuel consumption. The objective function is the minimization of the total fixed cost of vehicles used and the total routing cost. The problem is modelled as a set partitioning problem, and an efficient column-generation algorithm is used to solve it. In the resolution, the pricing problem is decomposed in sub-problems, such that each vehicle type has its own sub-pricing problem. A mixed integer linear program, a powerful labelling algorithm and the regret heuristic is provided to solve the pricing sub-problems. Based on Li and Lims benchmark (altered Solomons benchmark) for demands and from Lui and Shens benchmark for vehicles types; a new set of benchmarks is proposed to test the efficiency of the propound algorithm.

Sept. 13th
12.00-13.30
Pirandello

Keywords: Pickup and delivery with time windows; Fleet size and mix vehicle routing problem; column generation algorithm.

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