

Book of Abstracts

8th International Conference on Computational Management Science CMS 2011

28-30 April 2011, University of Neuchâtel, Switzerland

Computer Science Department
University of Neuchâtel
Rue Emile-Argand 11, CH-2000 Neuchâtel
Switzerland

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PROGRAMME AND ABSTRACTS

8th International Conference on Computational Management Science (CMS 2011)

<http://www.dcs.bbk.ac.uk/cms2011>

Computer Science Department, University of Neuchâtel, Switzerland
28-30 April 2011



Dear Friends and Colleagues,

We warmly welcome you to Neuchâtel, for the 8th International Conference on *Computational Management Science* (CMS 2011). The CMS conference is an annual meeting associated with the journal of *Computational Management Science* published by Springer. The aim of this conference is to provide a forum for theoreticians and practitioners from academia and industry to exchange knowledge, ideas and results in a broad range of topics relevant to the theory and practice of computational methods, models and empirical analysis for decision making in economics, finance, management, and engineering. The CMS 2011 programme consists of 3 plenary talks and over 80 presentations. Peer reviewed papers will be considered for publication in special and regular issues of the journal *Computational Management Science*.

The co-chairs have endeavoured to provide a balanced and stimulating programme that will appeal to the diverse interests of the participants. The international organizing committee hopes that the conference venue will provide the appropriate environment to enhance your contacts and to establish new ones. We acknowledge the work and the support of our hosts and sponsors, and particularly the Computer Science Department, University of Neuchâtel.

Looking forward, the CMS 2012 will take place at Imperial College London, UK. You are invited and encouraged to actively participate in this conference.

We wish you a productive, stimulating conference and a memorable stay in Neuchâtel.

The CMS 2011 co-chairs and the International Organizing Committee.

CMS 2011 International Organizing Committee:

C. Gatu, M. Gilli, T. Kondylis, E.J. Kontoghiorghes, P. Kropf and M. Paoletta.

CMS 2011 Co-chairs:

E.J. Kontoghiorghes and D. Kuhn

CMS 2011 Programme Committee:

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Local Organization:

Computer Science Department, University of Neuchâtel.

SCHEDULE CMS 2011
Thursday 28th April 2011

09:45 - 09:55	Opening (Room AUM)
09:55 - 10:45	Plenary Session A
10:45 - 11:15	Coffee Break
11:15 - 13:20	Parallel Sessions B
13:20 - 14:55	Lunch Break
14:55 - 17:00	Parallel Sessions C
18:30 - 20:00	Reception (Salle des Chevaliers, Château de Neuchâtel)

Friday 29th April 2011

08:45 - 10:25	Parallel Session D
10:25 - 10:55	Coffee Break
10:55 - 13:00	Parallel Sessions E
13:00 - 14:30	Lunch Break
14:30 - 15:20	Plenary Session F
15:20 - 15:50	Coffee Break
15:50 - 17:55	Parallel Sessions G
20:00 -	Conference Dinner (Hotel DuPeyrou)

Saturday 30th April 2011

09:00 - 10:40	Parallel Session H
10:40 - 11:10	Coffee Break
11:10 - 12:00	Plenary Session I
12:00 - 12:10	Closing (Room AUM)
12:10 - 13:30	Lunch Break

MEETINGS AND SOCIAL EVENTS**SPECIAL MEETINGS by invitation to group members**

- CMS Editorial Board meeting, *Room B104*, Saturday 30th April 2011, 12:15-13:15.

SOCIAL EVENTS

- *Coffee Breaks.*

The coffee breaks will take place in the first floor of UniMail. You must have your conference badge in order to attend the coffee breaks.

- *Welcome Reception, Thursday 28th of April, 18:00.*

The reception is open to all registrants. It will take place in the Neuchâtel Castle (Salle des Chevaliers, Château de Neuchâtel). You must have your conference badge in order to attend the reception.

- Lunches will be served at the UniMail cafeteria on Friday and Saturday. You must have your Lunch ticket of the appropriate day in order to attend the lunch. On Thursday and those not registered for the lunch they can have meals at the various restaurants of the shopping centre, which is 15 walking minutes from the venue.

- *Conference Dinner, Friday 29th of April, 20:00.*

The Conference Dinner will take place at the gastronomic restaurant Hotel DuPeyrou, Avenue DuPeyrou 1, CH-2000 Neuchâtel. The restaurant is 20 walking minutes from UniMail and 10 minutes from the town centre. For the students the conference dinner is optional and registration is required. You must have your Conference Dinner ticket in order to attend the conference dinner.

GENERAL INFORMATION

Venue

Université de Neuchâtel, UniMail, Rue Emile-Argand 11, CH-2000 Neuchâtel, Switzerland (see map of UniMail in page VII).

Lecture Rooms

The paper presentations will take place at the main building of UniMail, University of Neuchâtel. There are three lecture rooms: AUM (basement), B013 (ground floor) and B103 (first floor). There will be signs indicating the location of the lecture rooms, but we advise that you visit the venue in advance.

The opening, keynote and closing talks will take place at the AUM Auditorium. Papers should be presented in the order they are listed in the programme for the convenience of attendees who may wish to change rooms mid-session to hear particular papers. In the case of a presenter not attending, please use the extra time for a break or a discussion so that the remaining papers stay on schedule.

Presentation Instructions

The lecture rooms will be equipped with a PC and a computer projector. The session chairs should obtain copies of the talks on a USB stick before the session starts (use the lecture room as the meeting place), or obtain the talks by email prior to the start of the conference. Presenters must provide to the session chair with the files for the presentation in PDF (Acrobat) or PPT (Powerpoint) format on a USB memory stick. This must be done ten minutes before each session. The PC in the lecture rooms should be used for presentations. *The session chairs are kindly requested to have a laptop for backup.* Please note that Swiss plugs / power outlets differ from those in the rest of Europe and beyond. We cannot provide adapters, so please do not forget to take your adapters if needed.

Internet

There will be access to PCs connected to the Internet at the main entrance of the UniMail. The wireless Internet connection is also freely available at UniMail (select the *public-unine* network, and under the label *Login pour invités* give your email address).

Information and Messages

You may leave messages for each other on the bulletin board by the registration desks.

PUBLICATIONS OUTLETS

Journal of Computational Management Science, Springer

A special issue of Computational Management Science will be devoted to peer reviewed papers from the Conference. The Guest Editors are: Panos Parpas (Email: pp500@doc.ic.ac.uk) and Wolfram Wiesemann (Email: w.wiesemann06@imperial.ac.uk). Papers should be submitted via CMS Editorial Manager while informing by email the editor-in-chief and the Guest Editors.

Inform the Guest Editors of your intention to submit a paper:	30 June 2011
Deadline for submission of full papers:	15 September 2011
Notification of decision:	15 January 2012
Publication of the CMS Special Issues:	15 June 2012

Any questions may be directed via email to the Guest Editors.

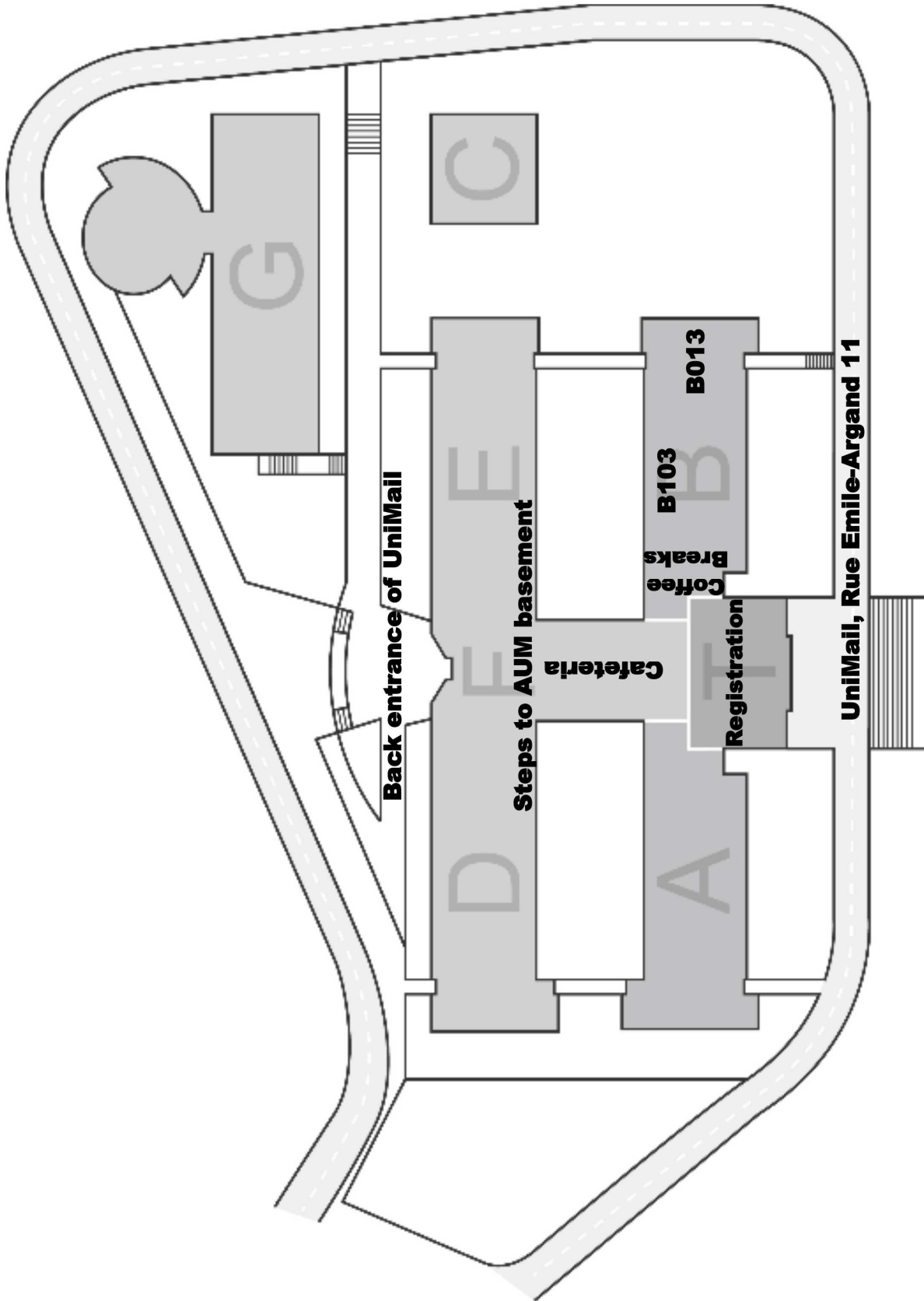
SPONSORS

- Computer Science Department, University of Neuchâtel, Switzerland (URL <http://www2.unine.ch/iiun>).
- République et Canton de Neuchâtel (URL <http://www.ne.ch/>).
- FINRISK (The National Centre of Competence in Research "Financial Valuation and Risk Management") (URL <http://www.nccr-finrisk.uzh.ch>).
- Banque Cantonale Neuchâteloise (URL <http://www.bcn.ch>).
- Tourisme Neuchâtelois (URL <http://www.neuchatel-tourisme.ch/>).

Map of Neuchâtel



Map of UniMail



CFE 2011 & ERCIM 2011

The CFE 2011 & ERCIM 2011 will take place in Senate House, London. It will be organized by Queen Mary, University of London, Birkbeck, University of London, and London School of Economics. The 3-day conference will take place 17-19 December 2011. You are invited and encouraged to actively participate in these events. For further information please contact cfe-ercim@cfe-csda.org.

Endorsed by:

- Journal of Computational Statistics and Data Analysis (CSDA).
- Annals of Computational and Financial Econometrics.
- Society for Computational Economics.
- ERCIM (European Research Consortium for Informatics and Mathematics).
- International Association for Statistical Computing.

**4th International Conference of the ERCIM WG on
COMPUTING & STATISTICS (ERCIM'11)
17-19 December 2011, Senate House, University of London, UK
<http://www.cfe-csda.org/ercim11>**

All topics within the Aims and Scope of the ERCIM Working Group Computing & Statistics will be considered for oral and poster presentation. Topics includes, but not limited to: robust methods, statistical algorithms and software, high-dimensional data analysis, statistics for imprecise data, extreme value modeling, quantile regression and semiparametric methods, model validation, functional data analysis, Bayesian methods, optimization heuristics in estimation and modelling, computational econometrics, quantitative finance, statistical signal extraction and filtering, small area estimation, latent variable and structural equation models, mixture models, matrix computations in statistics, time series modeling and computation, optimal design algorithms and computational statistics for clinical research. The organization of sessions within the framework of the Working Group is strongly encouraged

Publication: papers containing strong computational statistical, or substantive data-analytic elements will be considered for publication in a special peer-reviewed, or regular, issue of the Journal CSDA (Computational Statistics and Data Analysis). The CSDA planned special issues for 2011-2012 can be found at the conference's web site.

**5th CSDA International Conference on
Computational and Financial Econometrics (CFE'11)
17-19 December 2011, Senate House, University of London, UK
<http://www.cfe-csda.org/cfe11>**

This conference invites oral and poster presentations that contain computational or financial econometric components. Computational and financial econometrics comprise a broad field that has clearly interested a wide variety of researchers in economics, finance, statistics, mathematics and computing. Examples include financial time series analyses that focus on efficient and robust portfolio allocations over time, asset valuations with emphases on option pricing, volatility measurements, models of market microstructure effects and credit risk. While such studies are often theoretical, they can also have a strong empirical element measuring risk and return and often have a significant computational aspect dealing with issues like high-dimensionality and large numbers of observations. Algorithmic developments are also of interest since existing algorithms often do not utilize the best computational techniques for efficiency, stability, or conditioning. So also are developments of environments for conducting econometrics, which are inherently computer based. Integrated econometrics packages have grown well over the years, but still have much room for development. The organization of sessions and minisymposia is encouraged.

Publication: the new CSDA Annals of Computational and Financial Econometrics is associated with this conference. The Annals are published as a supplement to Computational Statistics and Data Analysis to serve as an outlet for distinguished research papers in computational econometrics and financial econometrics. Papers containing strong computational, statistical, or econometric components or substantive data-analytic elements will be considered for publication either in the Annals of CFE or in the regular issues of CSDA.

Contents

General Information	I
Welcome and Committees	II
Programme Schedule, Meetings and Social Events Information	III
Venue, Lecture Rooms, Presentation Instructions, Internet Access, Publications Outlet, Sponsors	IV
Map of Neuchâtel	V
Map of UniMail	VI
Call For Papers: CFE 2011 & ERCIM 2011	VII
Keynote Talks (Room: AUM)	1
Keynote talk CMS 1 (Berc Rustem, Imperial College London, UK) Thursday 28.04.2011 at 09:55-10:45	
Robust optimisation and its guarantees	1
Keynote talk CMS 2 (Christodoulos Floudas, Princeton University, USA) Friday 29.04.2011 at 14:30-15:20	
Advances in biclustering methods for re-ordering dense and sparse data matrices in systems biology and drug discovery	1
Keynote talk CMS 3 (John Lygeros, ETH Zurich, Switzerland) Saturday 30.04.2011 at 11:10-12:00	
Randomized optimization for stochastic systems: Finite sample bounds and applications	1
Parallel Sessions	2
Parallel Session B – CMS (Thursday 28.04.2011 at 11:15 - 13:20)	2
CMS01: COMPUTATIONAL AND FINANCIAL ECONOMETRICS (Room: B013)	2
CMS02: DECISION MAKING UNDER UNCERTAINTY 1 (Room: AUM)	3
CMS03: COUNTING PROCESSES (Room: B103)	4
Parallel Session C – CMS (Thursday 28.04.2011 at 14:55 - 17:00)	5
CMS05: STOCHASTIC PROGRAMMING (Room: B013)	5
CMS16: OPTIMISATION WITH APPLICATIONS (Room: AUM)	6
CMS18: COMPUTATION IN STATISTICS, ECONOMICS AND FINANCE (Room: B103)	7
Parallel Session D – CMS (Friday 29.04.2011 at 08:45 - 10:25)	8
CMS09: DECISION MAKING UNDER UNCERTAINTY 2 (Room: AUM)	8
CMS15: COMPUTATION IN ECONOMICS AND FINANCE (Room: B013)	9
CMS14: ROBUST STATISTICS (Room: B103)	10
Parallel Session E – CMS (Friday 29.04.2011 at 10:55 - 13:00)	11
CMS06: OPTIMAL DECISION MAKING UNDER UNCERTAINTY 1 (Room: AUM)	11
CMS13: ADVANCES IN DATA ANALYSIS (Room: B103)	12
CMS17: OPTION PRICING: CALIBRATION AND MODEL UNCERTAINTY (Room: B013)	13
Parallel Session G – CMS (Friday 29.04.2011 at 15:50 - 17:55)	14
CMS10: STOCHASTIC OPTIMIZATION IN ENERGY MARKET (Room: B103)	14
CMS07: OPTIMAL DECISION MAKING UNDER UNCERTAINTY 2 (Room: AUM)	15
CMS04: CONTRIBUTIONS IN MANAGEMENT SCIENCE 1 (Room: B013)	16
Parallel Session H – CMS (Saturday 30.04.2011 at 09:00 - 10:40)	17
CMS11: FINANCIAL TIME SERIES MODELLING AND FORECASTING (Room: B103)	17
CMS12: QUANTITATIVE RISK MANAGEMENT AND FINANCIAL MODELING (Room: AUM)	18
CMS08: CONTRIBUTIONS IN MANAGEMENT SCIENCE 2 (Room: B013)	19
Authors index	20

Keynote Talks

Thursday 28.04.2011 09:55-10:45 Room: AUM Chair: Erricos John Kontoghiorghes Keynote talk CMS 1

Robust optimisation and its guarantees

Speaker: **Berc Rustem, Imperial College London, UK**

The level of guarantee provided by robust optimisation is important for decision makers. We introduce the subject with a portfolio model that provides one level of guarantee when the realised uncertainty lies within the given uncertainty set and another level if uncertainty realisation is outside the set. The same is also achievable in the more interesting case of international portfolios where we need to consider uncertainties arising from local currency returns and those arising from exchange rates. Additionally, a triangular relationship exists among exchange and cross rates to exclude arbitrage. Thus, the separate consideration of the local returns and currencies introduces non-linearities. The resulting apparently nonconvex problem can be reformulated it as a tractable SDP. The robust optimisation framework guarantees a minimum portfolio return conditional on the uncertainty set. Furthermore, through the use of options, we can also establish additional guarantees should the returns materialise outside the uncertainty set in adverse market conditions. Finally, we consider algorithms for computing general robust nonlinear optimisation problems that arise in engineering and finance. Their solution requires complex computational strategies. We introduce three algorithm models: a saddlepoint method and two minimax algorithms that compute the global worst-case of nonlinear problems.

Friday 29.04.2011 14:30-15:20 Room: AUM Chair: Daniel Kuhn Keynote talk CMS 2

Advances in biclustering methods for re-ordering dense and sparse data matrices in systems biology and drug discovery

Speaker: **Christodoulos Floudas, Princeton University, USA**

Biclustering has emerged as an important problem in the analysis of gene expression data since genes may only jointly respond over a subset of conditions. Many of the methods for biclustering, and clustering algorithms in general, utilize simplified models or heuristic strategies for identifying the “best” grouping of elements according to some metric and cluster definition and thus result in suboptimal clusters. In the first part of the presentation, we present a rigorous approach to biclustering, OREO, which is based on the Optimal RE-Ordering of the rows and columns of a data matrix so as to globally minimize the dissimilarity metric. In the second part of the talk, we will focus on novel methods for clustering of data matrices that are very sparse. In the third part of the presentation, we combine the strengths of integer linear optimization and machine learning to predict in vivo toxicities for a library of pesticide chemicals using only in vitro data.

Saturday 30.04.2011 11:10-12:00 Room: AUM Chair: Jacques Savoy Keynote talk CMS 3

Randomized optimization for stochastic systems: Finite sample bounds and applications

Speaker: **John Lygeros, ETH Zurich, Switzerland**

Simulated annealing, Markov Chain Monte Carlo, and genetic algorithms are all randomized methods that can be used in practice to solve (albeit approximately) complex optimization problems. They rely on constructing appropriate Markov chains, whose stationary distribution concentrates on “good” parts of the parameter space (i.e. near the optimizers). Many of these methods come with asymptotic convergence guarantees, that establish conditions under which the Markov chain converges to a globally optimal solution in an appropriate probabilistic sense. An interesting question that is usually not covered by asymptotic convergence results is the rate of convergence: How long should the randomized algorithm be executed to obtain a near optimal solution with high probability? Answering this question allows one to determine a level of accuracy and confidence with which approximate optimality claims can be made, as a function of the amount of time available for computation. In this talk we present some results on finite sample bounds of this type for stochastic optimization with expected value criteria using Markov Chain Monte Carlo methods. The discussion will be motivated by the application of these methods to collision avoidance in air traffic management and parameter estimation for biological systems.

C017: UFO: Utility-Focused Optimization

Presenter: **Maria Putintseva**, University of Zurich, Switzerland

Econometric models are most typically estimated using widely used and standard statistical methods, e.g. Maximum Likelihood. However, new models developed to describe sophisticated dependencies of multivariate sets of assets often fail to beat simple naive models on the field of portfolio optimization, despite their prominent statistical dominance. In the light of this phenomenon it might be reasonable to tailor the optimization problem solved by the parameter estimation to a particular economic problem, e.g. maximization of investor's utility. Such a decision-based estimator has been already proposed, and empirically it outperforms the likelihood-based procedure. Since only the bivariate case (a riskless asset and an index) is considered in the current literature, a natural extension of the study is to apply the method to the multivariate case. The estimation procedure for the famous DCC model is developed and show that there is a substantial improvement in portfolio characteristics. Moreover, the method allows to speed up the computation, because the portfolio is optimized simultaneously with the model's parameters, while the standard procedure implies two steps.

C049: Realized news impact curves

Presenter: **Sven Christian Steude**, University of Zurich, Switzerland

Co-authors: Kerstin Kehrle, Marc S. Paoella

We introduce News Impact Curves that are based on model innovations, realized returns and realized news. We adopt a class of mixed normal conditional heteroskedastic models which is an ideal candidate to account for the asymmetric feedback mechanism between news and volatility. The model is generalized such that market wide, sector wide and firm specific high frequency news are governing the mixing components of the model and as such future volatility. We demonstrate that news data and in particular news sentiment data can improve volatility forecasting enormously.

C028: Stable mixture GARCH models

Presenter: **Jochen Krause**, University of Zurich, Switzerland

Co-authors: Simon A. Broda, Markus Haas, Marc S. Paoella, Sven C. Steude

A new model class for univariate asset returns is proposed, based on a finite mixture of time-varying conditional stable Paretian distributions. It nests numerous models currently in use, including the unconditional stable-Paretian, unconditional mixtures of normals, normal-GARCH, stable-GARCH, and mixed-normal GARCH, and is shown to provide a significantly better fit than all its special cases. Estimation issues related to problems associated with mixture models are discussed, and a new, general, method is proposed to successfully circumvent this. An extensive out-of-sample risk forecasting exercise for six major FX and equity indices confirms the superiority of the general model compared to its special cases and other competitors. The results provide evidence that the stable Paretian assumption, in a multi-component setting coupled with a rich GARCH-type structure, is a tenable assumption for modeling asset returns. The model is extended to the multivariate case by using an independent component analysis framework, which is operational for small and medium-sized (in the hundreds) numbers of assets. In the context of this multivariate extension, the portfolio selection problem using expected shortfall as the downside risk measure can be solved efficiently.

C033: Regime switching for dynamic dependency structure

Presenter: **Pawel Polak**, University of Zurich, Switzerland

We propose a new multivariate conditional heteroskedastic model with dynamics in conditional dependency structure for modeling the vector returns series. This model extends the regime switching for dynamic correlations model. We relax the normality assumption and use a more general class of distributions, the symmetric multivariate variance gamma mixture of normals class of distributions. The standard deviations are modeled by using the multivariate conditional heteroskedastic model, while the dependency structure is assumed to be in one of N possible states of the Markov chain. A Generalized Expectation Maximization (GEM) algorithm in conjunction with shrinkage via a quasi-Bayesian prior is developed. It allows to handle the estimation for a large number of assets. An empirical example for the stocks included in the Dow Jones Industrial Index (DJ-30) and a forecasting performance comparison with base models in the literature are also presented.

C025: Multivariate asset return prediction with mixture models

Presenter: **Marc Paoella**, University of Zurich, Switzerland

The use of mixture distributions for modeling asset returns has a long history in finance. New methods of demonstrating evidence for their necessity in the multivariate case is provided. The use of a two-component multivariate normal mixture distribution, coupled with shrinkage via a quasi-Bayesian prior, is motivated, and shown to be numerically trivial and reliable to estimate, unlike the majority of multivariate GARCH models in existence. Equally important, it provides a clear improvement over use of GARCH models feasible for use with a large number of assets, such as CCC, DCC, and their extensions, with respect to out-of-sample density forecasting. A generalization to a mixture of multivariate Laplace distributions is motivated via univariate and multivariate analysis of the data, and an EM-algorithm is developed for its estimation in conjunction with a quasi-Bayesian prior. It is shown to deliver significantly better forecasts than the mixed normal, with fast and numerically reliable estimation. Crucially, the distribution theory required for portfolio theory and risk assessment is developed.

C005: Optimal electricity generation portfolios: The impact of spread price modelling*Presenter:* **Daniel Ziegler**, University Duisburg-Essen, Germany*Co-authors:* Katrin Schmitz, Christoph Weber

It is common practice to base investment decisions on price projections which are gained from simulations using price processes. The choice of the underlying process is crucial for the simulation outcome. The core question is the existence of stable long-term cointegration relations. Therefore we investigate the impacts of different ways to model price movements in a portfolio selection model for the German electricity market. Three different approaches of modeling fuel prices are compared: Initially, all prices are modeled as correlated random walks. Thereafter the coal price is modeled as random walk and leading price while the other prices follow through mean-reversion processes. Last, all prices are modeled as mean reversion processes with correlated residuals. The prices of electricity base and peak futures are simulated using historical correlations with gas and coal prices. Yearly base and peak prices are transformed into an estimated price duration curve followed by the steps power plant dispatch, operational margin and NPV calculation and finally the portfolio selection. The analysis shows that the chosen price process assumptions have significant impacts on the resulting portfolio structure and the weights of individual technologies.

C006: Scenario tree approach for stochastic dual dynamic programming*Presenter:* **Steffen Rebennack**, Colorado School of Mines, USA*Co-authors:* Bruno Flach, Mario Pereira

In the hydro-thermal scheduling problem, one is interested in determining the optimal operating policy for the use of hydro and thermal resources. The goal is to minimize total expected costs of fulfilling the demand for electricity over a given time horizon. Since the 1990s, Stochastic Dual Dynamic Programming (SDDP) remains to date as the most efficient algorithm which is able to cope with inflow uncertainty and a detailed representation of a system's characteristics. We propose an extension of the methodology by embedding the SDDP algorithm into a scenario tree framework, thus allowing us to additionally deal with uncertainties related to the evolution of demand and fuel prices. The importance of such approach was made evident by the global economic crisis of 2008 when several countries experienced huge variations in demand and faced sudden and sharp increases in fuel costs due to oil price swings, with implications not only on total incurred costs but also regarding security of supply. The proposed approach is computationally tractable and, given its naturally parallelizable nature, may ultimately require the same amount of computational time as that in which demand and fuel price uncertainties are disregarded. We provide an illustration of the applicability of our method by studying the cases of the Panama and the Costa Rica power systems.

C060: Scenario reduction for futures market trading in electricity markets*Presenter:* **Salvador Pineda**, University of Castilla-La Mancha, Spain*Co-authors:* Antonio J. Conejo, Juan Miguel Morales, Miguel Carrion

In order to make informed decisions in electricity derivatives markets, stochastic programming models are commonly used. Such models treat the uncertainty involved via a set of scenarios, which are plausible realizations of the stochastic processes throughout the decision-making horizon. The number of scenarios needed to accurately represent the uncertainty involved is generally large, which may render the associated stochastic programming problem intractable. Hence, scenario reduction techniques are needed to trim down the number of scenarios while keeping most of the stochastic information embedded in such scenarios. We propose two novel scenario reduction techniques that advantageously compare with existing ones for electricity-market problems tackled via two-stage stochastic programming. Two case studies illustrate the performance of the proposed technique to reduce scenarios pertaining to both continuous and discrete uncertain parameters.

C037: An approximate dynamic programming framework for modeling global climate policy under uncertainty*Presenter:* **Nidhi Santen**, Massachusetts Institute of Technology, USA*Co-authors:* Mort Webster

Analyses of global climate policy as a sequential decision under uncertainty have been severely restricted by dimensionality and computational burdens. Therefore they have limited the number of decision stages, discrete actions, or number of uncertainties considered. We present a stochastic dynamic programming formulation of the Dynamic Integrated Model of Climate and the Economy (DICE), and the application of approximate dynamic programming techniques to numerically solve for the optimal policy. We demonstrate the improvement in computation speed over a traditional backward induction approach, and present preliminary results from alternative value function approximation methods, including regression, piecewise linear, and sparse grid approaches, and heuristic approaches to the explore-exploit tradeoffs.

C038: An approximate dynamic programming approach for designing train timetables with punctuality constraints*Presenter:* **Maite Pena-Alcaraz**, Massachusetts Institute of Technology, USA*Co-authors:* Mort Webster, Andres Ramos, Adekunle Adeyemo

We present a timetabling model to design tactical operation strategies robust to possible delays, based on the modeling and algorithmic framework of approximate dynamic programming. The objective is to efficiently dimension time slacks to ensure certain punctuality level. Both, the state space and the action space are highly multidimensional. We present a Q-learning algorithm and compare the performance of discretizing the state and the action spaces with several alternative continuous function approximation techniques, including approximation with basis functions and mesh-free techniques. Compared to a Mixed-Integer Programming (MIP) approach, where the classical decomposition algorithms cannot be directly used to solve this non-convex problem, this framework enables efficient computation of problems with high dimensionality. The algorithms have been tested in some railway systems study cases. The objective is to design robust, efficient train timetables for different railway systems. The efficiency is measured in terms of use of the capacity, energy consumption, etc., while the robustness is guaranteed since the model includes constraints to ensure a minimum punctuality level.

C004: Modelling a bivariate counting process. An application to the occurrence of extreme heat events*Presenter:* **Ana C. Cebrian**, University of Zaragoza, Spain*Co-authors:* J. Abaurrea, J. Asin

The occurrence of extremes in a stochastic bivariate framework using an approach based on the common Poisson shock model (CPSM) is considered. This model is a bivariate point process with univariate marginal Poisson processes that takes into account the dependence between them. One advantage of the CPSM is that it can be represented by three independent Poisson processes. Due to this simple representation, we can generalise the model to allow for time varying parameters and readily apply to real data. The required tools to fit and validate the model, including a procedure to check the joint independence between the three Poisson processes, are presented. Amongst other extremes, the bivariate model is adequate to model heat waves, a complex phenomenon which cannot be properly characterized by only one variable and can seriously affect regional economies (catastrophic crop failures, physical damages, etc.) and energy management due to increased air conditioning use. The modelling of the occurrence of extreme heat events in daily maximum and minimum temperatures in a Spanish location is presented.

C013: A new second order function to analyse spatial point patterns with functional marks*Presenter:* **Carlos Comas**, UdL-IRTA Foundation, Spain*Co-authors:* Pedro Delicado, Jorge Mateu

A new second order approach based on the mark correlation function to analyse spatial point patterns with functional marks is presented. This new function permits to analyse point patterns where the features of interest are functions (i.e. curves) instead of qualitative or quantitative variables. Examples of such complex spatial configurations include forest patterns where for each tree we have a growth function and curves representing the incidence of an epidemic over a period of time. The study of such configurations permits to analyse the effects of the spatial structure on individual functions. An edge corrected estimator is illustrated considering two data sets involving two spatially explicit demographic functions, namely, the town population pyramid and the demographic evolution from 1996 to 2008 involving 121 towns. Our results confirm the usefulness of our approach compared with other well-established spatial statistical tools such as the mark correlation function.

C031: Nonlinearly interacting Poisson processes*Presenter:* **Stefano Cardanobile**, University of Freiburg, Germany*Co-authors:* Stefan Rotter

Nonlinearly interacting point processes represent a very convenient formalism for the analysis of many natural phenomena. In particular they have attracted much attention in the computational neuroscience community. A novel framework based on multiplicative interactions between Poisson processes is presented, in which every event from a node in the network is assumed to have a multiplicative effect on connected nodes. From this definition, Lotka-Volterra systems arise naturally as the expected behavior of the network. Precisely, the corresponding Lotka-Volterra systems predict exactly the expected behavior of every node in the network, also in the case of structured, nonrandom networks. Furthermore, there is a precise mapping between the stability properties of the equation and the behavior of the system in the multistable case. Some application of the theory are presented and it is shown how is possible to exploit this new framework to design functional microcircuitry. Finally it is shown how the theory can be extended for the case of multiplicatively coupled stochastic processes.

C093: The Coxian hidden Markov model*Presenter:* **Adele Marshall**, Queen's University Belfast, UK

A Coxian phase-type distribution is a type of continuous-time Markov model in which the underlying Markov process allows transitions between transient states or a transition to an absorbing state. It can be used for modelling the survival time of a process. A new modelling approach called a Coxian hidden Markov model is introduced. It is similar to both a hidden Markov model and a Coxian phase-type distribution but overcomes many of the limitations associated with each of these models. The Coxian hidden Markov model uses a hidden Markov model approach to model a variable of interest about a patient which cannot be observed directly but can be inferred from repeated clinical measurements. The hidden Markov process is modeled as a Coxian phase-type distribution and the clinical measurements are modelled using dynamic Bayesian network theory. The purpose of this new model is to aid the analysis of how a disease is progressing and to predict the future survival time distribution for a patient. An example is how the model could be used to assist in the diagnosis of which state of kidney disease a patient is in given repeated measurements of clinical variables such as creatinine levels and blood pressure.

C020: Turning points modelled as a Cox process*Presenter:* **Nuria Ruiz-Fuentes**, University of Jaen, Spain*Co-authors:* Paula R. Bouzas, George Atsalakis

Turning points in the stock prices are important to make decisions on transactions in the stock market. Forecasting them is a very challenging task and many researchers have tried to solve this problem by several different methods like using a Bayesian panel VAR model, developed a dynamic bi-factor model with Markov-switching, by non-parametric estimation, using a neuro-fuzzy system, etc. The present work gives another point of view. The counting process of the number of turning points in the stock prices is proposed to be modelled as a Cox process. This process is a very flexible one due to its stochastic intensity. The stochastic mean number of turning points is first modelled by means of an *ad hoc* functional data analysis estimation and then its mode, the most probable value of the number of turning points. Using principal components prediction, the mean and the mode are also forecasted in any instant within a given future interval of time. Both estimation and forecasting are illustrated with two applications to daily data prices of stocks listed in Athens and New York stock exchange.

C007: Optimization over integer efficient set under uncertainty*Presenter:* **Djamal Chaabane**, USTHB, Algeria*Co-authors:* Farida Mebrek, Fatma Mebrek

The problem of optimizing over an efficient set of a stochastic Integer Linear Programming problem (MOILPS) is considered. Once the problem is converted into a deterministic problem by adapting the approach of recourse to 2-levels, a pivoting technique is applied to generate the whole optimal efficient solution without having to enumerate all of them. This method combines both techniques: an algorithm developed in deterministic environment and the L-Shaped method. A didactic example is given to illustrate our new approach as well as some experimental results.

C029: On obtaining the scenario cluster based Lagrangean bound for two-stage stochastic integer optimization*Presenter:* **Laureano F. Escudero**, Universidad Rey Juan Carlos, Spain*Co-authors:* M. Araceli Garin, Gloria Perez, Aitchiver Unzueta

We present a scenario cluster based Lagrangean Decomposition (LD) scheme for obtaining a strong lower bound to the optimal solution of two-stage stochastic mixed 0-1 problems. Instead of dualizing the nonanticipativity constraints (NAC) that link the scenario submodels in the splitting variable representation of the problem, we propose to decompose the model into a set of scenario clusters, such that the NAC within the clusters are implicitly satisfied in the related compact representation of the cluster submodel and, then, the dualization is only performed on the NAC that link the different cluster submodels. We compare the computational performance of several Lagrangean dual schemes, as the Subgradient Method, the Volume Algorithm and the Progressive Hedging Algorithm for several choices of the number of the scenario clusters and different dimensions of the original problem. Our computational experience shows how the bound value and its computational effort depend on the number of scenario clusters to consider. In any case, we can observe in the computational results reported for an extensive set of pilot instances that the scenario cluster LD scheme outperforms the traditional LD scheme for single scenarios both in lower bound's quality and computing effort.

C045: Multistage stochastic programming in strategic telecommunication network planning*Presenter:* **Jonas Schweiger**, Zuse Institute Berlin (ZIB), Germany*Co-authors:* Andreas Eisenblaetter

Mobile communication is nowadays taken for granted. Having started primarily as a service for speech communication, data service and mobile Internet access are now driving the evolution of network infrastructure. Operators are facing the challenge to match the demand by continuously expanding and upgrading the network infrastructure. However, the evolution of the customer's demand is uncertain. We introduce a novel (long-term) network planning approach based on multistage stochastic programming, where demand evolution is considered as a stochastic process and the network is extended as to maximize the expected profit. The approach proves capable of designing large-scale realistic UMTS networks with a time-horizon of several years. Our mathematical optimization model, the solution approach, and computational results are presented.

C079: Robustness in stochastic programs with risk constraints*Presenter:* **Milos Kopa**, Charles University in Prague, Czech Republic*Co-authors:* Jitka Dupacova

The robustness analysis for stochastic programs whose set of feasible solutions depends on the probability distribution P is considered. For various reasons, probability distribution P may not be precisely specified and we study robustness of results with respect to perturbations of P . The main tool is the contamination technique. For the optimal value, local contamination bounds are derived and applied to robustness analysis of the optimal value of a portfolio performance under risk-shaping CVaR constraints.

C084: The value of information in multistage linear stochastic programming*Presenter:* **Francesca Maggioni**, University of Bergamo, Italy*Co-authors:* Elisabetta Allevi, Marida Bertocchi

Stochastic programs, especially multistage programs, which involve sequences of decisions over time, are usually hard to solve in realistically sized problems. In the two-stage case, several approaches and measures of levels of available information on a future realization has been adopted in literature such as the Value of the Stochastic Solution VSS with relative bounds (SPEV and EPEV) and measures of badness/goodness of deterministic solutions such as the loss of using the skeleton solution LUSS and the loss of upgrading the deterministic solution LUDS. We extend the above measures to the multistage framework defining the multi-stage expected value of the average/reference scenario MVSS, the multistage loss using skeleton solution MLUSS and the multistage loss of upgrading the deterministic solution MLUDS. Approximations of the optimal solution such as the multistage sum of pairs expected values MSPEV, the multistage expected value of the reference scenario MEVRS and the multistage expectation of pairs expected value MEPEV are introduced too, by solving a series of sub-problems more computationally tractable than the initial one and related to standard approaches. The above measures are computed and compared on a simple single-sink transportation problem.

C050: An exact and flexible model for cell formation

Presenter: **Dmitry Krushinsky**, University of Groningen, Netherlands

Co-authors: Boris Goldengorin, Jannes Slomp

Despite its 50-years history the problem of cell formation (CF) in group technology still lacks a flexible approach leading to guaranteed optimal solutions. We propose a model based on the minimum multicut problem that models CF exactly and in many cases can be solved to optimality. An industrial example is used to demonstrate the applicability of our model, that can deal with additional constraints (e.g. capacity limits) and factors (e.g. the presence of equivalent machines, leading to the emergence of alternative parts routings).

C091: Critical node detection problems in weighted graphs

Presenter: **Altannar Chinchuluun**, Imperial College London, UK

Co-authors: Ashwin Arulselvan, Efstratios N. Pistikopoulos, Neng Fan, Panos Pardalos

The critical node detection problem can be stated as follows: Given a graph $G(V; E)$, with a set V of nodes and a set E of edges, and an integer k , the objective of the problem is to find a set of k nodes in V in the graph whose deletion results in the maximum network fragmentation. The problem has a number of applications in different fields such as social science, management, military, biomedicine, transportation and supply chain management. Here, we discuss some extensions of the problem in weighted graphs and present mathematical programming formulations. A heuristic approach is proposed for solving the problem. We also discuss a robust version of the problem.

C002: Optimization over Integer efficient set using Tchebychev norm

Presenter: **Djamal Chaabane**, University of Sciences and Technology - USTHB-, Algeria

Co-authors: Zoubir Ramdani, Boualem Brahmi

The problem of optimizing a linear function over the set of integer efficient solutions of multicriteria linear programming problem has been previously considered. This problem is very hard due to the non convexity and the absence of any prior information of the feasible set (solutions of Multiple Objective Integer Linear Programming problem: MOILP). Unfortunately, this latter can not be known until the MOILP problem is solved; a process which can be extremely expensive. In order to overcome this delicate situation, we developed a new algorithm solving a sequence of mono criteria integer linear programming problem using the Simplex algorithm and Branch and bound technique without enumerating all efficient solutions. Our technique is mainly based on solving a weighted Tchebychev programs avoiding resolution of sub-programs that is used so far and produces a subset of non dominated solutions that can attract decision makers. In our approach the quality of the solution is targeted, therefore exact algorithms are used instead of meta heuristics techniques.

C083: Energy planning optimization using Semidefinite programming

Presenter: **Agnes Gorge**, University Paris-Sud, France

Co-authors: Abdel Lisser, Riadh Zorgati

Semidefinite Programming is a relatively new field in optimization that involves minimizing a linear function in the cone of the positive semidefinite matrices. In spite of excellent theoretical results, only few industrial applications of this approach have been reported. As a substantial user of optimization techniques, EDF R&D plans to investigate the application of such a method to its energy management problems. In particular, using Semidefinite Programming to provide a tight convex relaxation for combinatorial problems, seems to be a promising direction to explore. The problem that we address here is the scheduling of the nuclear outages, which is inherently a combinatorial problem, getting noticeably bigger by taking scenarios of uncertainties into account. We start by building a simplified model for this problem, that emphasizes its combinatorial structure, then we apply the Semidefinite relaxation. Finally, by applying a randomized rounding, we find a feasible solution that we compare to the one obtained via linear programming.

C015: Optimal operation of combined heat and power under uncertainty and risk aversion

Presenter: **Afzal Siddiqui**, University College London, UK

Co-authors: Lajos Maurovich-Horvat

We apply stochastic programming to find the optimal operation of a gas-fired CHP plant as part of a cost-minimising microgrid and to assess its profitability and operational risk. We assume that the microgrid has to satisfy the following load requirements at all time: electricity and heat. To do so, it can purchase electricity and natural gas from the macrogrid and can also generate electricity using the purchased natural gas. Our aim is to investigate the tradeoff between cost and risk of meeting energy loads given predetermined consumption and stochastic electricity and gas prices. By doing so, we aim to find insights about optimal operational policies given two sources of input uncertainty (electricity and gas prices) and two outputs (power and heat). Cost reduction via on-site generation comes at a tradeoff in the form of higher risk measured by conditional value-at-risk, which could be a deterrent for investors. Since the risk originates from the uncertainties in gas and electricity prices, policy responses could include general tax exemption, the introduction of carbon taxation, and subsidies to build gas-storage facilities or to expand capacity. We aim to incorporate such features in this study along with the possibility to hedge risk via forward contracts and to extend the model to include the investment stage.

C097: The numerics of non-convex single-state discrete-time dynamic economic optimisation problems

Presenter: **Saeed M. Moghayer**, University of Amsterdam- and TNO Delft, Netherlands

Co-authors: Florian Wagener

We study non-convex discrete time optimal control problems with one-dimensional state spaces over an infinite time horizon. Previously we had investigated the discrete time indifference-attractor bifurcation of this problem and analysed the consequences for the optimal solutions. In particular, we characterised the bifurcation value at which indifference thresholds appear by a geometric condition. Here we solve this problem numerically. The proposed algorithms are based on the state-costate dynamical system. They enable us to determine indifference points, at which the policy function is multi-valued, in an efficient manner. We can moreover compute indifference-attractor bifurcation curves, which bound the parameter set for which indifference thresholds (i.e. Skiba points) exist. We apply our results to a modified version of the lake pollution management problem.

C088: Evolutionary multi-stage financial scenario tree generation

Presenter: **Ronald Hochreiter**, WU Vienna University of Economics and Business, Austria

Multi-stage financial decision optimization under uncertainty depends on a careful numerical approximation of the underlying stochastic process, which describes the future returns of the selected assets or asset categories. Various approaches towards an optimal generation of discrete-time, discrete-state approximations (represented as scenario trees) have been previously suggested. A new evolutionary algorithm to create scenario trees for multi-stage financial optimization models is shown. Numerical results and implementation details are presented.

C102: Strategies for estimating the general linear and SUR models after deleting observations

Presenter: **Stella Hadjiantoni**, University of Cyprus, Cyprus

Co-authors: Erricos Kontoghiorghes

The problem of deleting observations (downdating) from the general linear (GLM) and the Seemingly Unrelated Regressions (SUR) model is considered. It is shown that the downdating problem is equivalent in updating the GLM (or the SUR model) with the imaginary deleted observations. This results in a model with negative defined dispersion matrix and comprising complex covariance values. Its solution is obtained by treating the problem as a generalised linear least squares problem (GLLSP) and obtains the solution by using the QR decomposition. Although hyperbolic reflections are used, computations do not involve complex arithmetic. The computational complexity of the proposed strategy does not depend on the remaining number of observations in the model, but on the number of the deleted observations and variables. A block strategy exploiting the non-dense triangular structure of the matrices is developed. Efficient algorithms for the re-estimation of the SUR model after deleting observations are also presented.

C019: A graph approach to find the best grouping for each possible number of clusters

Presenter: **Cristian Gatu**, University of Cyprus, Cyprus

Co-authors: Erricos Kontoghiorghes

A graph structure which can be employed to enumerate and evaluate all possibilities to cluster a number of observation points is introduced. Any complete traversal of the graph generates all possible cluster solutions. The structure of the graph is exploited in order to design an efficient branch-and-bound algorithm that finds the optimal solution for each number of clusters without traversing the whole graph. The new proposed strategy is compared with Ward's method in terms of solution quality and execution time. Furthermore, a heuristic version of the branch-and-bound algorithm that improves the execution speed at the expense of the solution quality is also presented. Experimental results are presented and analyzed. The proposed algorithm is based on exhaustive search and therefore provides the optimum solution. It is found to be a viable approach to the clustering problem when the number of observation points is not too large.

C086: A numerical method for solving PDEs arising in finance

Presenter: **Paolo Foschi**, University of Bologna, Italy

In the context of option pricing, a number of analytical approximations for the fundamental solution of parabolic PDEs are available. These small-time approximations include the Hagan formula, the Ait-Sahalia's Hermite series and saddle-point expansions and the Parametrix method. Using these approximated fundamental solution it is possible to precisely evolve the PDE solution for a small interval of time. Thus, iterating these approximations allows to span a larger amount of time. This approach results in an alternative method for the numerical solution to parabolic PDEs. The implementation of the method and numerical experiments performed on usual option pricing models are here presented.

C022: Optimal pricing and inventory control policy with quantity discounts

Presenter: **Ye Lu**, City University of Hong Kong, Hong Kong

Co-authors: Frank Chen, Miao Song, Xiaoming Yan

We consider a retailer facing stochastic demand who wishes to maximize the total expected profit over a finite/infinite horizon. The retailer, besides the regular unit selling price, can use quantity discounts to promote sales and hence at the beginning of each period, she needs to make three decisions: the unit selling price, the quantity discount price, and the order-up-to inventory level. We characterize the optimal inventory control policy as well as how the optimal pricing strategy depends on the inventory level. We also study how the value of quantity discounts depend on the various cost in the system.

C056: Information sets and relations

Presenter: **Christoph Graf**, University of Vienna, Austria

Co-authors: Magdalena Six

We study the effect of additional information on the quality of decisions. Hence, we define the polar case of complete information about probabilities as our reference scenario. There, decision makers (DMs) can avail themselves of expected utility theory to evaluate the best alternative. Starting in the worst case – where DMs have no information at all about probabilities – we find a method of constantly increasing the information by limiting the ranges for the probabilities systematically. In our simulation-based study, we measure the effects of the constant increase in information by using different accuracy indices. We define these indices as the relative frequency of probabilities within stepwisely narrowing boundaries which lead to the same decision as with the probability in the reference scenario. Thus, they account for the quality of information. Combining input and output, we find a certain degree of decreasing returns to scale on information. Moreover, we show that more available alternatives influence the decision process negatively. Finally, we analyze the quality of decisions in processes where more states of nature prevail. We find that this degree of complexity in the decision process influences the quality of decision.

C059: Robust convex risk measures

Presenter: **David Wozabal**, University of Vienna, Austria

Co-authors: Georg Pflug, Alois Pichler

We introduce a framework for robustifying convex, version independent risk measures with respect to ambiguity in the distribution of the asset returns. The robustified risk measure is defined as the worst case risk, where the worst case is taken over the so called ambiguity set. The ambiguity set is modeled as a Kantorovich ball around a reference measure which represents the investors beliefs about the asset returns. We demonstrate how to solve the resulting infinite dimensional optimization problem and obtain closed form solution for the robustified risk measures. The resulting robustified risk measures are again convex, version independent risk measures which are computationally of the same complexity as their non-robust counterparts. We conclude with several examples and a numerical study.

C072: Robust Markov decision processes

Presenter: **Wolfram Wiesemann**, Imperial College London, UK

Co-authors: Daniel Kuhn, Berc Rustem

Markov decision processes (MDPs) are powerful tools for decision making in uncertain dynamic environments. However, the solutions of MDPs are of limited practical use due to their sensitivity to distributional model parameters, which are typically unknown and have to be estimated by the decision maker. To counter the detrimental effects of estimation errors, we consider robust MDPs that offer probabilistic guarantees in view of the unknown parameters. To this end, we assume that an observation history of the MDP is available. Based on this history, we derive a confidence region that contains the unknown parameters with a pre-specified probability $1 - \beta$. Afterwards, we determine a policy that attains the highest worst-case performance over this confidence region. By construction, this policy achieves or exceeds its worst-case performance with a confidence of at least $1 - \beta$. Our method involves the solution of tractable conic programs of moderate size.

C047: Trading activity and public news arrival

Presenter: **Kerstin Kehrlé**, University of Zurich, Switzerland

This paper extends the market microstructure PIN (probability of informed trading) model by introducing additional trader heterogeneity. We investigate the role of public information on the arrival of privately informed and uninformed traders. Our results show that public information increases the arrival rate of uninformed buyers and sellers. The arrival sensitivity of uninformed traders to public news is highly related to liquidity and return volatility. We find evidence that an increase in the arrival of buyers due to public news increases stock returns while an increase of sellers decreases stock returns. These results are more pronounced for privately informed traders than for uninformed traders.

C085: Assessing the efficient market hypothesis in stock exchange markets via a universal prediction statistic

Presenter: **Armin Shmilovici**, Ben-Gurion University, Israel

Co-authors: Irad Ben-Gal

We consider the Variable Order Markov model as a universal prediction model. We use it to measure the predictability of financial time-series (measured by the fraction of correct predictions). We test the Efficient Market Hypothesis (EMH) on four different international stock exchanges: 30 stocks composing of the German DAX index, 30 stocks composing of the American Dow-Jones30 index, 20 stocks of the Austrian ATX index and 16 stocks of the Danish KFX index. A significant predictability is detected: all the Vienna ATX (Austria) and the Copenhagen KFX (Denmark) stock series demonstrate significant predictability (above the random prediction reference). In these two markets the EMH is rejected. To test the relation between stock volume and predictability we further test the Fama and French three factors model for the predictability of the stocks composing the ATX top 22 index of Vienna. The experiment corroborate Fama and French's hypothesis that small stocks behave differently than large stocks.

C040: New insights into optimal control of nonlinear dynamic econometric models: application of a heuristic approach

Presenter: **Dmitri Blueschke**, University of Klagenfurt, Austria

Co-authors: Viktoria Blueschke-Nikolaeva, Ivan Savin

Optimal control of dynamic econometric models has a wide variety of applications including economic policy relevant issues. There are several algorithms, which extend the basic case of a linear-quadratic optimization problem and take nonlinearity and stochastics into account. But these methods are still limited in a variety of ways, e.g., symmetry of the objective function or different frequency of the data. In order to solve these problems, we propose an alternative approach based on a heuristic algorithm. To this end, we apply both a 'classical' algorithm (OPTCON) and a heuristic approach (Differential Evolution) to three different econometric models and compare their relative performance. Among scenarios considered are symmetric and asymmetric quadratic objective functions and different data frequency between control variables. Our results provide a strong support for the heuristic approach encouraging its further application to optimum control problems.

C018: Comparing clock-proxy auction outcomes

Presenter: **Asuncion Mochon**, UNED, Spain

Co-authors: Yago Saez, Jose Luis Gomez Barroso, Pedro Isasi

Clock-proxy auctions are becoming a powerful mechanism for allocating public goods such as spectrum licenses. Nevertheless, this auction format can yield different outcomes depending on the pricing rule established. This paper deals with the impact of the choice of a particular pricing rule for this mechanism. The simplest and easiest for bidders to understand is the first-price pricing rule, but it does not yield to an efficient outcome as bidders have incentives to shade their bids. The Vickrey-Clarke-Groves (VCG) mechanism is the generalization of the second-price Vickrey rule for single-item for combinatorial auctions, which is incentive compatible but it also has to many drawbacks and the outcome is not a core allocation. The bidder-Pareto-optimal core pricing rule is a good alternative as it is an approximate VCG mechanism that yields core outcomes. In order to simulate the auction outcome we have developed an agent-based model, assuming bidders with bounded rationality. The final outcome have been compared in terms of efficient allocation and fair payments in three scenarios of a simulated radio-wave spectrum auction.

C048: Robust simulation based estimation of income distributions

Presenter: **Stephane Guerrier**, University of Geneva, Switzerland

Co-authors: Maria-Pia Victoria-Feser

We propose an estimation method to estimate in a robust fashion the parameter vector θ given an independently and identically distributed sample supposedly generated by F_θ . Indeed, it is well known that maximum likelihood estimators are not robust to model deviations and, therefore, robust estimators are needed. However, since the models F_θ we consider are models for income distributions, they are generally highly skewed to accommodate extreme values, and standard robust estimators which need a consistency correction are generally difficult to obtain numerically. Here we propose to correct a robust M -estimator for consistency using the principle of indirect inference. The performance of the proposed estimator is illustrated by means of a simulation study on the Dagum and the Singh-Maddala distributions with and without data contaminations.

C054: Local depth for functional data

Presenter: **Claudio Agostinelli**, Ca' Foscari University, Italy

Co-authors: Mario Romanazzi

Depth functions provide center-outward ranks which are monotonically decreasing along any given ray from the deepest point. As a consequence, they are unable to reveal multiple centers and data clustering occurring in multimodal and mixture distributions. To overcome this problem, we introduce the class local depth functions. Essentially, local depth evaluates centrality conditional on a neighbourhood of each point of the reference space. These generalized depth functions are able to record local fluctuations of the density function and they can be used in mode detection, identification of components in mixture models and in cluster analysis. Here we concentrate on the analysis of functional data, e.g., continuous trajectories of a process, time series, irregularly spaced time series. We suggest a local version for the band and the half-region depths. Several real data set examples are illustrated with a comparison of different definitions.

C042: Higher-order infinitesimal robustness

Presenter: **Daive La Vecchia**, Universita' della Svizzera Italiana, Switzerland

Co-authors: Elvezio Ronchetti, Fabio Trojani

Using higher-order von Mises expansions, we study the higher-order infinitesimal robustness properties of a general M -functional and characterize its second-order robustness features. We show that second-order robustness is equivalent to the boundedness of both the estimator's estimating function and its derivative with respect to the parameter. We prove that second-order robustness implies, at the same time, the robustness of (i) the second-order bias of an estimator (second-order B-robustness), (ii) its asymptotic variance functional (V-robustness) and (iii) higher-order approximations to the estimator's finite sample density, as derived from saddlepoint methods. Since many infinitesimally robust estimators in the literature are not second-order robust, we introduce a new class of admissible second-order robust M -estimators and show that their estimating function can be redescending. Finally, we study the finite sample properties of second-order robust estimators by Monte Carlo simulation and in a real-data application to the estimation of the tail of maximal losses of Nikkei 225 index returns. Our findings show that the new robust estimators improve on both Maximum Likelihood and optimal first-order B-robust M -estimators in moderate to small sample sizes and in the presence of deviations from a given reference parametric model.

C058: Stabilizing least median of squares estimation via quadratic programming

Presenter: **Keith Knight**, University of Toronto, Canada

Least median of squares (LMS) estimation in regression is notable for its high breakdown point, slow convergence rate, and computational complexity. The latter is due to the highly non-smooth nature of the LMS objective function, which also leads to some instability of the LMS estimator in finite samples. For example, the set of near minimizers of the LMS objectives may be quite large, particularly when the underlying noise is heteroscedastic and the LMS estimator need not be consistent even under very mild heteroscedasticity. However, the set of observations whose absolute residuals are less than the median absolute residual tends to be much more stable. Here, using a generalization of Chebyshev (L_∞) estimation on this set of observations to stabilize the LMS estimator is discussed. The proposed estimator is the solution of a quadratic programming problem and has good asymptotic properties in situations where LMS estimation is unstable.

C046: Data mining approach to forecasting gas flow on exits of gas transmission networks*Presenter:* **Radoslava Mirkov**, Humboldt University Berlin, Germany*Co-authors:* Ronald Hochreiter

The flow of natural gas within a gas transmission network is studied with the aim to predict gas loads for very low temperatures. Several models for describing dependence between the maximal daily gas flow and the temperature on network exits are proposed. We present a data mining approach for forecasting including further covariates like daily outflow cycle, geographic location and type of nodes within the network. The comparison of prediction based on data mining and statistical modeling techniques for a specific node is included.

C036: Dynamic international portfolio management with affine policies*Presenter:* **Raquel Fonseca**, Imperial College, UK*Co-authors:* Daniel Kuhn, Berc Rustem

While dynamic decision making has traditionally been represented as scenario trees, these may become severely intractable and difficult to compute with an increasing number of time periods. We present an alternative approach to multiperiod international portfolio optimization based on an affine dependence between the decision variables and the past returns. Because local asset and currency returns are modelled separately, the original model is non-linear and non-convex. With the aid of robust optimization techniques, however, we develop a tractable semidefinite programming formulation of our model, where the uncertain returns are contained in an ellipsoidal uncertainty set. We compare our formulation with the minimization of the worst case value-at-risk and show the close relationship with robust optimization. Numerical results demonstrate the potential gains from considering a dynamic multiperiod setting relative to a single stage approach.

C062: A hybrid robust/multi-parametric programming approach to process scheduling under uncertainty*Presenter:* **Martina Wittmann-Hohlbein**, Imperial College London, UK*Co-authors:* Efstratios N. Pistikopoulos

A hybrid methodology to address process scheduling problems under bounded uncertainty is considered. A MILP formulation for short-term scheduling of batch processes is adopted. We assume that the model is contaminated with uncertain data in the objective function (OFC), the right-hand side vector (RHS) and in the constraint matrix (LHS), introduced by price, demand, and processing time uncertainty respectively. Multi-parametric programming algorithms aim to derive the optimal solution as a function of the varying parameters without exhaustively enumerating the parameter space. However, not all types of uncertainty in MILP models can be addressed alike and, unlike OFC- and RHS-uncertainty, LHS-uncertainty still poses a major challenge. In order to deal with all types of parameter variation in the scheduling model, we apply a combined robust/multi-parametric procedure for its approximate solution. In the first step a partial immunization of the model against LHS-uncertainty is performed, whereas in the second step explicit solutions of the partially robust counterpart are derived. We demonstrate that this hybrid approach is computationally efficient. Furthermore, it is shown to be an attractive alternative to the rigorous robust optimization approach employed in process scheduling under uncertainty in terms of providing a tight estimate of the overall solution.

C024: Managing uncertainties in a safety-constrained process system for economic performance enhancement*Presenter:* **Vasiliki Kazantzi**, Technological Educational Institute of Larissa, Greece*Co-authors:* Ali El-Halwagi, Mahmoud M. El-Halwagi, Nikolas Kazantzis

This paper addresses the problem of managing uncertainties in a safety-constrained process system for economic performance enhancement. Within such a context, a typical solvent selection problem involves a number of different solvents with nominal property values that are utilized in various process units and requires the minimization of the total operating cost while satisfying certain process safety constraints. Practically, in any process system, property values of streams are not exact; they are usually functions of operating variables and market conditions that change over time inevitably introducing irreducible uncertainties in system performance. A key aim of the present study is to systematically explore the effect of volatility in solvent prices on process economic performance. Appropriate sensitivity analysis and Monte Carlo simulation work have been carried out to assist the decision maker in taking into account the continuously changing market conditions, while identifying operationally safe feasibility regions for solvents with different risk characteristics in the underlying optimization problem. The aforementioned uncertain inputs are shown to cause shifts of the associated Pareto front of optimal solutions towards feasibility regions that can be characterized in a more realistic manner. Finally, an illustrative case study is considered in order to evaluate the proposed method.

C021: Optimal policy for an inventory system under convex variable ordering cost*Presenter:* **Miao Song**, The University of Hong Kong, Hong Kong*Co-authors:* Ye Lu

We study the optimal policy for a periodic-review inventory system where the variable ordering cost is defined by a piece-wise linear convex function. The optimal policy is fully characterized for the case without the fixed ordering cost. For the system with a fixed ordering cost, we fully characterize the optimal policy of the model by introducing the notion of strong K,c,q-convexity. We also identify some sufficient conditions under which the (s,S) policy is optimal.

C009: Different linearity tests for a regression model with an imprecise response

Presenter: **Maria Brigida Ferraro**, Sapienza Universita di Roma, Italy

Co-authors: Gil Gonzalez Rodriguez, Ana Colubi

Recently a new linear regression model with fuzzy response and scalar explanatory variables has been introduced and deeply analyzed. Since the inferences developed for such a model are meaningful only if the relationship is indeed linear, it is important to check the linearity for the regression model. Two different linearity tests have been introduced. The first one is based on the comparison of the simple linear regression model and the nonparametric regression. In details, the test statistic is constructed based on the variability explained by the two models. The second one consists in using the empirical process of the regressors marked by the residuals. Both tests have been analyzed by means of a bootstrap approach. In particular, a wild bootstrap and a residual bootstrap have been investigated.

C082: Statistical inference of stochastic processes from multiscale data

Presenter: **Panos Parpas**, Massachusetts Institute of Technology, USA

The statistical inference of stochastic processes from multiple scale data is a problem that arises often in practice. Yet there exists little understanding of the effects of processes that are faster (or slower) than the processes we are performing the inference on. Using perturbation theory we formalize the problem of multiscale inference for continuous time Markov Processes. We give necessary and sufficient conditions for any consistent estimator to converge to an estimator of a stochastically continuous process. We argue that these conditions are restrictive in practice. We then suggest a way to perform statistical inference on multiscale data that yields consistent estimators that are asymptotically well behaved.

C071: A flexible multiple linear regression model for interval data

Presenter: **Marta Garcia Barzana**, University of Oviedo, Spain

Co-authors: Ana Colubi, Erricos Kontoghiorghes

A multiple regression model based on interval-valued data has been recently considered. Each explanatory variable of the model is associated with a unique parameter. Such a model was too restrictive since interval data is parameterized with two real components (mid and spread). Additionally, the non-negativity condition on the spreads led to a computationally infeasible estimation problem, which is set off by obtaining a new expression of the parameters in terms of the moments of the mid-points and spreads of the involved random intervals. A more flexible model overcoming these drawbacks is considered. This multiple model is an extension of a simple model based on an orthogonal decomposition of intervals. This allows to consider separately mid and spread while using interval arithmetic. The advantages of the new model are assessed. The least-squares estimation of the model's parameters entails quadratic minimization problems with linear constraints which can be solved with standard procedures. The empirical behaviour of the estimators is illustrated by means of simulations and the application in a real-case example.

C012: The invisible handshake and price stickiness: evidence from customer-level scanner data

Presenter: **Benjamin Verhelst**, Ghent University, Belgium

Co-authors: Dirk Van den Poel

This paper uses scanner data at the individual customer level, compiled from the loyalty card database of a European retailer, to determine the importance of implicit contracts as a source of price stickiness. Drawing from Customer Relationship Management (CRM), we use segmentation techniques to split up the customer base according to their behavioral loyalty to the retailer. The latter is measured by the frequency and monetary value of consumers' purchases. Using cluster analysis, we split the customer base in three groups, and perform a demand analysis on the loyal and non-loyal segments in parallel, discarding the large middle cluster. Our results from estimating a Quadratic Almost Ideal Demand System (QUAIDS) for numerous product categories establish fairness as an important constraint for price setting at the retail level. Loyal customers demonstrate considerable asymmetry in their price elasticity of demand, being significantly higher for price increases than decreases, whereas non-loyal customers react symmetrically to price changes. This contains the seeds of an invisible handshake, as retailers will not risk to lose their high-value loyal shoppers by changing prices time and again. This result can prove useful for the calibration of macro models with heterogeneous customers.

C008: A nonparametric dependence measure for random variables based on the one-to-one correspondence between Copulas and Markov operators

Presenter: **Wolfgang Trutschnig**, European Centre for Soft Computing, Spain

Using the one-to-one correspondence between copulas and Markov operators and expressing the Markov operators in terms of regular conditional distributions (Markov kernels) allows to define a new metric d on the space of all copulas. This metric is not only a metrization of strong operator convergence of the corresponding Markov operators but it also induces a natural dependence measure with various good properties by simply defining the dependence of a copula A as the d -distance between A and the product copula Π . In particular it can be shown that the class of copulas that have maximum d -distance to the product copula is exactly the class of all deterministic copulas (i.e. copulas that are induced by a Lebesgue-measure preserving transformation on $[0, 1]$). Expressed in terms of the dependence measure this means that exactly deterministic copulas are assigned maximum dependence. As a consequence, the product copula can not be approximated arbitrarily well by deterministic copulas with respect to the metric d - this is quite the contrary when considering Schweizer and Wolff's sigma and the uniform convergence, in which case for instance the family of all shuffles of the minimum copula are dense in the space of all copulas.

C032: Assessing the quality of volatility estimators via option pricing

Presenter: **Simona Sanfelici**, University of Parma, Italy

The availability of intraday financial data has motivated a growing literature devoted to measuring and forecasting volatility. Several nonparametric estimators of daily volatility have been proposed, which allows to exploit the information contained in intraday high frequency data neglecting microstructure effects. The effectiveness of such estimators is generally analyzed and tested from a statistical and econometric viewpoint. The aim is to measure and assess the accuracy of different volatility estimators based on high frequency data in an option pricing context. For this we use a stochastic volatility model based on Auto-Regressive-Gamma (ARG) dynamics for the volatility. First, ARG processes are presented both under historical and risk-neutral measure, in an affine stochastic discount factor framework. The model parameters are estimated exploiting the informative content of historical high frequency data. Secondly, option pricing is performed via Monte Carlo techniques. This framework allows us to measure the quality of different volatility estimators in terms of mispricing with respect to real option data, leaving to the ARG volatility model the role of a tool. The empirical analysis is conducted on European options written on S&P index.

C074: Fast and stable algorithms for advanced equity model calibration

Presenter: **Michael Aichinger**, RICAM, Austria

Co-authors: Johannes Furst, Christian Kletzmayer, Andreas Binder

For the analysis of many exotic financial derivatives more and more importance is attached to advanced equity models including stochastic volatility and/or jumps. The model specific parameters have to be identified from sets of options market data with different strike prices and maturities, leading to a minimization problem for the least square error between the model prices and the market prices. Depending on the market data the identification process may lead to poor results if local techniques are used. On the other hand global optimization tools often have unacceptable long computation times. We address these problems by introducing a fast and robust hybrid calibration algorithm which is applied to different advanced equity models. This algorithm is based on combinations of quasi-random number sequences and the Levenberg Marquardt algorithm. For the valuation of the objective function, we use a Fourier cosine method. To further speed up the calibration we made extensive use of GPU computing. This led to calibration times below ten seconds, where during the calibration process more than one million options had been priced.

C081: Analytical approximation of the SABR model with jumps

Presenter: **Stefano Pagliarani**, Università di Padova, Italy

Co-authors: Andrea Pascucci, Paolo Foschi

It is widely recognized that perturbation theory is a very powerful and effective tool in option pricing. We show how to adapt singular perturbation methods to derive closed-form approximate pricing formulas in some stochastic volatility jump-diffusion model. We also briefly discuss the case of some path-dependent option. Considering European options the main results are approximate density formulas for an underlying asset in some stochastic volatility models. Here we demonstrate high precision as well as easy integrability of this approximate density formula. We also show similar results for arithmetic Asian options obtained by using analogous methods in a bidimensional framework.

C064: Model based Monte Carlo pricing of energy and temperature quanto options

Presenter: **Massimiliano Caporin**, University of Padova, Italy

Co-authors: Hipolit Torro, Juliusz Pres

Weather derivatives have become very popular tools in weather risk management in recent years. One of the elements supporting their diffusion has been the increase in volatility observed on many energy markets. Among the several available contracts, Quanto options are now becoming very popular for a simple reason: they take into account the strong correlation between energy consumption and certain weather conditions, so enabling price and weather risk to be controlled at the same time. These products are more efficient and, in many cases, significantly cheaper than simpler plain vanilla options. Unfortunately, the specific features of energy and weather time series do not enable the use of analytical formulae based on the Black-Scholes pricing approach, nor other more advanced continuous time methods that extend the Black-Scholes approach, unless under strong and unrealistic assumptions. We propose a Monte Carlo pricing framework based on a bivariate time series model. Our approach takes into account the average and variance interdependence between temperature and energy price series. Furthermore, our approach includes other relevant empirical features, such as periodic patterns in average, variance, and correlations. The model structure enables a more appropriate pricing of Quanto options compared to traditional methods.

C057: A procedure for estimating state-dependent project volatility using Monte Carlo simulation

Presenter: **Pedro Godinho**, GEMF, INESC-Coimbra and University of Coimbra, Portugal

The volatility of project value is important for both real options analysis and risk analysis. Several procedures exist for the estimation of project volatility based on Monte Carlo simulation. These procedures usually address the estimation of the first period volatility, but they may be easily extended to the following periods provided that the volatility in each period is independent of the state of the project. Here it is argued that in most projects the volatility is state dependent after the first period. This means that the existing approaches cannot properly estimate the volatility in these cases. A project with a single state variable is proposed, and a procedure to estimate its volatility based on a regression procedure is proposed. The results of an application of this procedure are analyzed, and its extension to the case in which there are multiple state variables is discussed.

C030: On cutting plane algorithms and dynamic programming for hydroelectricity generation

Presenter: **Anes Dallagi**, EDF R&D, France

Co-authors: Andy Philpott, Emmanuel Gallet

We consider dynamic programming (DP) approximations to hydro-electric reservoir scheduling problems. The first class of approximate DP methods uses decomposition and multi-modelling heuristics to produce policies that can be expressed as the sum of one-dimensional Bellman functions. These heuristics allow us to take into account non-convexities (appearing in models with head-effect) by solving MIPs at each time stage. The second class of methods uses cutting planes and sampling. It is able to provide multidimensional policies. We first present the two methods, their advantages and their drawbacks. Then, we apply these methods to two problem formulations of different types. The results are illustrated using tests on two river valley systems at EDF.

C095: Deterministic and stochastic models for the investment decision problem of a power producer.

Presenter: **Maria Teresa Vespucci**, University of Bergamo, Italy

Co-authors: Stefano Zigrino, Marida Bertocchi, Mario Innorta

Deterministic and stochastic models are developed for assessing the impact on capacity expansion decisions of generation companies of constraints imposed on CO₂ emissions and on the ratio between the amount of energy produced using fossil-fuel and the amount produced from renewable energy sources. The impact of different scenarios of energy prices and fuel prices (gas, coal and nuclear fuel) are also taken into account. The objective function represents the total profit over the planning period, the constraints take into account the availability of plants locations for each new technology as well as budget and CO₂ emission restrictions. A case study is presented related to the Italian electricity market.

C014: Measuring and controlling the potential impact of PHEV recharging load on power systems

Presenter: **Lizhi Wang**, Iowa State University, USA

Co-authors: Pan Xu

We propose a new approach to measure the potential impact of plug-in hybrid electric vehicles (PHEV) recharging load on power systems. This approach adopts a bilevel optimization framework, in which the lower level represents the power system, and the upper level tries to determine the minimal and maximal cost to the power system for a given budget of recharging cost. The range of difference between the cost to the power system and the cost to PHEV users is then used as the measure of potential impact on power systems. This measure can be used to design effective electric rates to control the potential impact on power systems. A case study is conducted using empirical data from the Pennsylvania-New Jersey-Maryland Interconnection. Numerical results suggest that carefully designed electric rates can effectively and efficiently control PHEV recharging and lead to a win-win situation for electricity consumers, PHEV users, and utilities.

C075: Stochastic bilevel problems in electricity trading

Presenter: **Raimund Kovacevic**, University Vienna, Austria

Co-authors: Georg Pflug

Bilevel problems arise in natural manner in the context of long term electricity contracts. For example, the swing options: The seller can set the price for buying electricity (under some additional exercising rules) while the buyer decides about the amount of electricity to buy, after knowing the sellers price. Optimal decisions in such a context are classical bilevel decisions and can be seen as a kind of stochastic Stackelberg game. Typically stochastic bilevel problems are hard to treat, both theoretically and numerically. While – depending on the exact problem formulation – different approaches are possible (e.g. sample average or even fixed point methods), in the present talk we discuss a simple stochastic gradient algorithm and its application to one- and multistage stochastic bilevel problems of the above type.

C026: Linear decision rule approximation scheme for quadratic stochastic programs

Presenter: **Paula Rocha**, Imperial College London, UK

Co-authors: Daniel Kuhn

We consider quadratic stochastic programs with random recourse – a class of problems which is perceived to be computationally demanding. Instead of using mainstream scenario tree-based techniques, we reduce computational complexity by restricting the space of decision rules to those linear in the observations, thereby obtaining an upper bound on the original problem. To estimate the loss of accuracy of this approach, we further derive a lower bound by dualising the original problem and solving it in linear decision rules. By employing robust optimisation techniques, we show that both bounding problems may be approximated by tractable conic programs. Finally, we illustrate the efficacy of the proposed approximation scheme in the context of a mean-variance portfolio optimisation problem.

C080: Scenario-free stochastic programming with polynomial decision rules

Presenter: **Dimitra Bampou**, Imperial College London, UK

Co-authors: Daniel Kuhn

Multi-stage stochastic programming provides a versatile framework for optimal decision making under uncertainty, but it gives rise to hard functional optimization problems since the adaptive recourse decisions must be modeled as functions of some or all uncertain parameters. We propose to approximate these recourse decisions by polynomial decision rules and show that the best polynomial decision rule of a fixed degree can be computed efficiently. We also show that the suboptimality of the best polynomial decision rule can be estimated efficiently by solving a dual version of the stochastic program in polynomial decision rules.

C069: Decision-dependent information in multi-stage stochastic and robust optimization

Presenter: **Phebe Vayanos**, Imperial College London, UK

Co-authors: Daniel Kuhn, Berc Rustem

Stochastic programming and robust optimization are disciplines concerned with optimal decision-making under uncertainty over time. Traditional models and solution algorithms have been tailored to problems where the order in which the uncertainties unfold is *independent* of the controller actions. Nevertheless, in numerous real-world decision problems, the time of information discovery can be influenced by the decision maker, and uncertainties only become observable following an (often costly) investment. Such problems can be formulated as mixed-binary multi-stage stochastic programs with decision-dependent non-anticipativity constraints. Unfortunately, these problems are severely computationally intractable. We propose an approximation scheme for multi-stage problems with decision-dependent information discovery which is based on techniques commonly used in modern robust optimization. In particular, we obtain a conservative approximation in the form of a mixed-binary linear program by restricting the spaces of measurable binary and real-valued decision rules to those that are representable as piecewise constant and linear functions of the uncertain parameters, respectively. We assess our approach on a problem of infrastructure and production planning in offshore oil fields from the literature.

C063: Distributionally robust joint chance constraints with second-order moment information

Presenter: **Steve Zymler**, Imperial College London, UK

Co-authors: Daniel Kuhn, Berc Rustem

We develop tractable semidefinite programming (SDP) based approximations for distributionally robust individual and joint chance constraints, assuming that only the first- and second-order moments as well as the support of the uncertain parameters are given. It is known that robust chance constraints can be conservatively approximated by Worst-Case Conditional Value-at-Risk (CVaR) constraints. We first prove that this approximation is exact for robust individual chance constraints with concave or (not necessarily concave) quadratic constraint functions. We also show that robust individual chance constraints are equivalent to robust semi-infinite constraints with uncertainty sets that can be interpreted as ellipsoids lifted to the space of positive semidefinite matrices. By using the theory of moment problems we then obtain a conservative approximation for joint chance constraints. This approximation affords intuitive dual interpretations and is provably tighter than two popular benchmark approximations. The tightness depends on a set of scaling parameters, which can be tuned via a sequential convex optimization algorithm. We show that the approximation becomes in fact exact when the scaling parameters are chosen optimally. We further demonstrate that joint chance constraints can be reformulated as robust semi-infinite constraints with uncertainty sets that are reminiscent of the lifted ellipsoidal uncertainty sets characteristic for individual chance constraints. We evaluate our joint chance constraint approximation in the context of a dynamic water reservoir control problem and numerically demonstrate its superiority over the two benchmark approximations.

C027: Computational assessment of sampling methods in stochastic dual dynamic programming

Presenter: **Berk Ustun**, Massachusetts Institute of Technology, USA

Co-authors: Panos Parpas, Mort Webster

Stochastic dual dynamic programming is a popular method for multi-stage stochastic programming problems. The algorithm does not explicitly construct a scenario tree. Instead, it relies on sampling from a set of scenarios and then using these samples to construct an approximation of the recourse function through cutting plane methods. We compare the application of different sampling strategies to stochastic dual dynamic programming, including quasi-random sequences, importance sampling and Markov Chain Monte Carlo methods. We also introduce an open source implementation of the algorithm and report on initial numerical results.

C068: A fuzzy integrated share-of-choice model for service design: a methodological development adapted to the airline industry

Presenter: **Neda Javanmardi**, Haute Ecole de Gestion de Geneve, Switzerland

Co-authors: Emmanuel Fragniere, Francesco Moresino

In recent decades, the airline industry has been opened to competition with almost all companies facing the question of *which service design can best meet the customers' demands?*. In order to answer this question, all attributes which may affect a customer's decision should be considered. However, the evaluation of different designs is a complicated process, since it must take into account vague and subjective human perceptions. Setting an appropriate price level is another great challenge to the industry. We propose a new integrated model that will help companies find the best service design with a suitable price level. Our approach is as follows. First, a pre-selection of attributes is conducted based on a logical survey and expert testing procedures under the fuzzy environment. Second, final designs are selected based on d-optimality criterion. Finally, the best design with the corresponding price level is found using the mathematical share-of-choice model. To evaluate the performance of the proposed model, we employed it in the design of flights between Tehran and Dubai. By comparing our results with those of classical models, which are based on conjoint analysis, one can conclude that the results achieved with our model are closer to real case scenaria.

C076: Analysis of variance in OLAP information systems

Presenter: **Hennie Daniels**, University of Tilburg, Netherlands

Co-authors: Emiel Caron

We describe a method for the discovery of exceptional values in OLAP information systems. We also show how exceptional values can be explained by underlying causes. OLAP applications offer a support tool for managers in analyzing financial data because of the availability of different views and reporting facilities. The purpose of the methods and algorithms presented here, is to extend OLAP based systems with more powerful analysis and reporting functions. We describe how exceptional values at any level in the data, can be automatically detected by statistical models. Secondly a generic model for diagnosis of atypical values is realized in the OLAP context. By applying it, a full explanation tree of causes at successive levels can be generated. If the tree is too large, the analyst can use appropriate filtering measures to prune the tree to a manageable size. This methodology has a wide range of applications such as interfirm comparison, analysis of sales data and the analysis of any other data that possess a multi-dimensional hierarchical structure. The method is demonstrated in a case study on sales data.

C039: Nonparametric block bootstrap for quasi-likelihood ratio tests

Presenter: **Lorenzo Camponovo**, University of Lugano and Yale University, Switzerland

We introduce a nonparametric block bootstrap approach for quasi-likelihood ratio type tests of nonlinear restrictions. Our method applies to extremum estimators, such as quasi-maximum likelihood and generalized method of moments estimators. Unlike existing parametric bootstrap procedures for quasi-likelihood ratio type tests, our procedure constructs bootstrap samples in a fully nonparametric way. We study the higher order properties of our nonparametric block bootstrap and show the asymptotic refinements implied with respect to classic asymptotic theory. Our approach delivers the same higher order properties of the nonparametric block bootstrap methods introduced for Wald and Lagrange Multiplier tests. Monte Carlo simulations confirm the accuracy of our bootstrap procedure.

C087: Market self-organization under limited information

Presenter: **Gregor Reich**, University of Basel, Switzerland

Co-authors: Dietmar Maringer

The process of gradually finding an economic equilibrium, the so called *tâtonnement* process, is investigated in this paper. In contrast to classical general equilibrium modelling, where a central institution with perfect information about consumer preferences and production technologies (*Walrasian auctioneer*) organizes the economy, we simulate this process with learning consumer and producer agents, but no auctioneer. These agents lack perfect information on consumption preferences and are unable to explicitly optimize utility and profits. Rather, consumers base their consumption decision on past experience – formalized by reinforcement learning – whereas producers do regression learning to estimate aggregate consumer demand for profit maximization. Our results suggest that, even without perfect information or explicit optimization, it is possible for the economy to converge towards the analytically optimal state.

C061: Determinants of multiple states business exit: a competing risk approach*Presenter:* **Marialuisa Restaino**, University of Salerno, Italy*Co-authors:* Alessandra Amendola, Luca Sensini

A companies may leave the market in several ways such as merger, voluntary liquidation or bankruptcy. Each form of exit can be caused by different factors. We study the determinants of the probability of different exit forms and investigate the differences in some possible states of corporate financial distress by analysing microeconomic indicators on a sample of Italian building firms during the crisis period. In particular we develop a competing risk model in order to identify the factors leading firms to exit the market and compare the performance over single risk approach. Our findings reveal dissimilarity between the determinants of each disease and give evidence in favour of considering multiple causes approach.

C066: The dependence structure between carbon emission allowances and financial markets - A Copula analysis*Presenter:* **Marc Gronwald**, IFO Institute for Economic Research, Germany*Co-authors:* Janina Ketterer, Stefan Truck

This paper applies different copulas in order to investigate the complex dependence structure between EU emission allowance (EUA) futures returns and those of other commodities, equity and energy indices. This analysis yields interesting insights in the relationship between carbon, commodities and financial markets. We, firstly, find a significant relationship between the considered variables. As the Student-t copula provides the best fit, there is some evidence of symmetric tail dependence. These results contradict some earlier studies that report no statistically significant or even negative correlations between returns of emission allowances and other financial variables. Secondly, considering time-varying copulas shows that the estimated copula parameters are not stable over time. We find in particular that the dependence is stronger during the period of the financial crisis. In a Value-at-Risk analysis, finally, we further illustrate the advantages of copula methods. This analysis shows that ignoring the actual nature of dependence might lead to an underestimation of the risk for portfolios combining EUAs with commodities or equity investments.

C041: Financial density selection*Presenter:* **Genaro Sucarrat**, BI Norwegian School of Management, Norway*Co-authors:* Juan Miguel Marin

Financial returns are often characterised by autoregressive conditional heteroscedasticity (ARCH), and by heavier tails than the normal—possibly skewed—even after standardising the returns. One may consider modelling everything simultaneously, say, by means of an ARCH type model that admits both skewed and heavy-tailed errors. However, in practice this is not always desirable and may not even be feasible. We propose and study simple but flexible methods for conditional density selection of skewed versions of the two most popular density classes in finance, the exponential power distribution (or GED) and the t -distribution. For the first type of method, which simply consists of selecting a density by means of an information criterion, the Schwarz criterion stands out since it performs well across density categories, and in particular when the Data Generating Process (DGP) is normal. For the second type of method, General-to-Specific (GETS) density selection, the simulations suggest that it can improve the recovery rate in predictable ways by changing the significance level. This is useful because it enables us to increase (reduce) the recovery rate of non-normal densities by increasing (reducing) the significance level, if one wishes to do so. Finally, the methods are illustrated in an empirical application.

C078: A comparison of different procedures for combining high-dimensional multivariate volatility forecasts*Presenter:* **Alessandra Amendola**, University of Salerno, Italy*Co-authors:* Giuseppe Storti

Model uncertainty is a relevant problem in multivariate volatility prediction. Furthermore, when working with vast dimensional datasets, the need for tractable model structures requires the imposition of severe constraints on the volatility dynamics. It follows that a risk of model misspecification is particularly sizeable in vast dimensional problems. Although recently there was a focus on the evaluation of forecast accuracy for Multivariate GARCH models, less attention has been paid to the combination of volatility forecasts as a strategy for improving the predictive accuracy. The aim is to compare some alternative forecast combination techniques for vast dimensional multivariate volatility forecasts and empirically evaluate their predictive performance.

C089: The relationship between Omega ratio and CVaR

Presenter: **Michalis Kapsos**, Imperial College, Cyprus

Co-authors: Berc Rustem

The Omega Ratio is a new performance measure that aims to surpass the known drawbacks of the Sharpe Ratio. Until recently, it was believed that optimizing the Omega Ratio is computationally intractable, and research was focused on heuristic optimization procedures. However, today it is known that the Omega Ratio optimization problem is equivalent to a linear program that can be solved exactly in polynomial time. Thus, more complex and realistic variants of the problem can now be investigated. We show that the similarities between the Omega Ratio maximization and Conditional Value-at-Risk allow the transformation of a CVaR minimization problem to the equivalent for Omega Ratio maximization. Here, we investigate the case where the probability distribution of the asset returns is only partially known. We introduce the robust variant of the conventional Omega Ratio which hedges against uncertainty in the probability distribution. We then examine the Worst-Case Omega Ratio optimization problem under frameworks that have been studied for CVaR and present a procedure that can transform a CVaR optimization problem to the Omega Ratio equivalent.

C100: On improving conditional Value-at-Risk portfolio performance with conditional average and a portfolio insurance strategy

Presenter: **Adam Krzemienowski**, Warsaw University of Technology, Poland

Conditional Value-at-Risk (CVaR) is a downside risk measure which is defined as the mean within the specified portion (quantile) of the worst cases. For any type of distribution, it preserves consistency with the axiomatic models of preferences for choice under risk. CVaR is based on the second degree stochastic dominance order (SSD), and leads to linear solvable optimization models. However, despite its theoretical and computational attractiveness, it is a quite pessimistic measure. Sometimes, this may lead to inferior decisions with respect to risk, since CVaR focuses only on an underperformance. It is possible to overcome this flaw by utilizing Conditional Average (CAVG) and hedging the risk connected with extreme losses. CAVG is a new risk measure that can be viewed as a generalization of CVaR. It is defined as the integral over the central part of the quantile function. Here an application of this measure to portfolio optimization with a protective put option strategy as a portfolio insurance is demonstrated. The technique will be illustrated by the results of a computational exercise conducted on historical values of S&P 100 stocks and options on these stocks.

C092: Coping with estimation errors in portfolio optimization

Presenter: **Hercules Vladimirov**, University of Cyprus, Cyprus

Co-authors: Demetris Antoniou

Portfolio optimization models require a representation of the distribution of uncertain asset returns. In the mean-variance setting, the key input parameters are the expected return vector and the covariance matrix of asset returns. These are typically set to their sample counterparts, estimated on the basis of past market data and thus, are prone to estimation errors. Past research has demonstrated the substantial impact of estimation errors. The solutions of models are sensitive to input parameter settings. Portfolios optimized using sample estimates of parameters typically have poor out-of-sample performance. Here we investigate alternative approaches that have been proposed to mitigate the impact of estimation errors, ranging from Bayesian methods to moment *shrinkage* approaches and robust optimization over uncertainty sets of parameter estimates. We study analytically the connections and distinctions of alternative methods. Additionally, we numerically test their performance. The numerical experiments involve both static tests – whereby asset returns are simulated from controlled distributions – as well as dynamic backtesting using market data.

C067: FX trading: an empirical study

Presenter: **Manfred Gilli**, University of Geneva, Switzerland

Co-authors: Enrico Schumann, Gerda Cabej, Jonela Lula

Given a set of tick by tick data of five currency pairs we analyze several traditional asset allocation techniques as well as technical trading rule based models. In particular we explore appropriate levels of time aggregations and rebalancing frequencies. We also suggest a triggered rebalancing strategy which results in better performances and lower transaction costs. For the asset allocation approach multiple objectives are optimized using heuristic optimization techniques.

C090: Analysis of organisational communication network topologies for optimizing collective problem solving*Presenter:* **Loretta Latronico**, ESA-ESTEC, Netherlands*Co-authors:* Luis F. Simoes, Leopold Summerer

Network of social acquaintances and interactions can be approximated through email-flows analysis. We argue that mailing-lists add information related to longer-standing organisational setups. The analysis of mailing-lists co-memberships leads to weighted complex networks characterizing organisational units, based on anonymised data from a large organisation. The topology of the resulting networks are analysed for their efficiency at spreading information. In a departure from similar studies, networks are considered as collectives of agents solving concrete tasks and communication as spreading of clues about how to best solve them. This approach bridges with studies of how optimizers perform under different topologies for different problem classes (i.e. dynamic/uncertain objective values, multi-modal distributions, constraints, multiple objectives, etc). Assuming that organisations develop structures most suited for solving their tasks, the analysis allows comparing how well the organisational pattern is suited to solve established theoretical problem classes and deducing which problem-types match those addressed by the organisation(s). The analysis furthermore allows analysing how organisational changes (topology changes), would change the efficiency in solving different problem types. This situation is formulated as a meta-optimization multi-objective problem, seeking network reconfigurations that achieve highest improvements in information spread, with least amounts of restructuring.

C099: Assignment problem applied to a university timetabling problem*Presenter:* **Sacha Varone**, Haute Ecole de Gestion de Geneve, Switzerland*Co-authors:* David Schindl

We consider a variant of the axial 3-index assignment problem that arises in a university. Students have to follow several courses from a set of courses, and express their preferences about the courses. A minimal number of students is required to open a course, and a maximal number of students is specified for each course. The courses have to be scheduled on a limited number of periods, so that several courses have to be done simultaneously. Here we express the IP model we have built, how we solved this problem, and give some practical considerations on our experience.

C051: Text categorization: An application with political speeches*Presenter:* **Jacques Savoy**, University of Neuchatel, Switzerland*Co-authors:* Olena Zubaryeva

Text categorization aims to automatically classify texts according to a predefined set of categories (or labels). To represent text items (sentence, paragraph, article, etc.), words have been used in various applications but we may also consider short sequences of letters, lemmas (headword) or sequence of words. Assuming a binomial distribution for word occurrence, we propose computing a standardized Z score to define the specific vocabulary of a subset compared to that of the entire corpus. This approach can be applied to select and weight terms which characterize a document compared to others. We then show how the Z score values can be used to derive a simple and efficient categorization scheme. To evaluate this proposition and demonstrate its effectiveness, we develop two experiments. First, the system must categorize speeches given by B. Obama as being either electoral or presidential speech. In a second experiment, sentences are extracted from these speeches and then categorized under the headings electoral or presidential. Based on these evaluations, the proposed classification scheme tends to perform better than a Support Vector Machine (SVM) model for both experiments, on the one hand, and on the other, shows at better performance level than a Naive Bayes classifier on the first test and a slightly lower performance on the second (10-fold cross validation).

Authors index

- Abaurrea, J., 4
 Adeyemo, A., 3
 Agostinelli, C., 10
 Aichinger, M., 13
 Allevi, E., 5
 Amendola, A., 17
 Antoniou, D., 18
 Arulseivan, A., 6
 Asin, J., 4
 Atsalakis, G., 4

 Bampou, D., 15
 Ben-Gal, I., 9
 Bertocchi, M., 5, 14
 Binder, A., 13
 Blueschke, D., 9
 Blueschke-Nikolaeva, V., 9
 Bouzas, P., 4
 Brahmi, B., 6
 Broda, S., 2

 Cabej, G., 18
 Camponovo, L., 16
 Caporin, M., 13
 Cardanobile, S., 4
 Caron, E., 16
 Carrion, M., 3
 Cebrian, A., 4
 Chaabane, D., 5, 6
 Chen, F., 8
 Chinchuluun, A., 6
 Colubi, A., 12
 Comas, C., 4
 Conejo, A., 3

 Dallagi, A., 14
 Daniels, H., 16
 Delicado, P., 4
 Dupacova, J., 5

 Eisenblaetter, A., 5
 El-Halwagi, A., 11
 El-Halwagi, M., 11
 Escudero, L., 5

 Fan, N., 6
 Ferraro, M., 12
 Flach, B., 3
 Floudas, C., 1

 Fonseca, R., 11
 Foschi, P., 7, 13
 Fragniere, E., 16
 Furst, J., 13

 Gallet, E., 14
 Garcia Barzana, M., 12
 Garin, M., 5
 Gatu, C., 7
 Gilli, M., 18
 Godinho, P., 13
 Goldengorin, B., 6
 Gomez Barroso, J., 9
 Gonzalez Rodriguez, G., 12
 Gorge, A., 6
 Graf, C., 8
 Gronwald, M., 17
 Guerrier, S., 10

 Haas, M., 2
 Hadjiantoni, S., 7
 Hochreiter, R., 7, 11

 Innorta, M., 14
 Isasi, P., 9

 Javanmardi, N., 16

 Kapsos, M., 18
 Kazantzi, V., 11
 Kazantzis, N., 11
 Kehrle, K., 2, 9
 Ketterer, J., 17
 Kletzmayer, C., 13
 Knight, K., 10
 Kontoghiorghes, E., 7, 12
 Kopa, M., 5
 Kovacevic, R., 14
 Krause, J., 2
 Krushinsky, D., 6
 Krzemienowski, A., 18
 Kuhn, D., 8, 11, 15

 La Vecchia, D., 10
 Latronico, L., 19
 Lissner, A., 6
 Lu, Y., 8, 11
 Lula, J., 18
 Lygeros, J., 1

 Maggioni, F., 5
 Marin, J., 17
 Maringer, D., 16
 Marshall, A., 4
 Mateu, J., 4
 Maurovich-Horvat, L., 6
 Mebrek, F., 5
 Mirkov, R., 11
 Mochon, A., 9
 Moghayer, S., 7
 Morales, J., 3
 Moresino, F., 16

 Pagliarani, S., 13
 Paolella, M., 2
 Pardalos, P., 6
 Pappas, P., 12, 15
 Pascucci, A., 13
 Pena-Alcaraz, M., 3
 Pereira, M., 3
 Perez, G., 5
 Pflug, G., 8, 14
 Philpott, A., 14
 Pichler, A., 8
 Pineda, S., 3
 Pistikopoulos, E., 6, 11
 Polak, P., 2
 Pres, J., 13
 Putintseva, M., 2

 Ramdani, Z., 6
 Ramos, A., 3
 Rebennack, S., 3
 Reich, G., 16
 Restaino, M., 17
 Rocha, P., 15
 Romanazzi, M., 10
 Ronchetti, E., 10
 Rotter, S., 4
 Ruiz-Fuentes, N., 4
 Rustem, B., 1, 8, 11, 15, 18

 Saez, Y., 9
 Sanfelici, S., 13
 Santen, N., 3
 Savin, I., 9
 Savoy, J., 19
 Schindl, D., 19

 Schmitz, K., 3
 Schumann, E., 18
 Schweiger, J., 5
 Sensini, L., 17
 Shmilovici, A., 9
 Siddiqui, A., 6
 Simoes, L., 19
 Six, M., 8
 Slomp, J., 6
 Song, M., 8, 11
 Steude, S., 2
 Storti, G., 17
 Sucarrat, G., 17
 Summerer, L., 19

 Torro, H., 13
 Trojani, F., 10
 Truck, S., 17
 Trutschnig, W., 12

 Unzueta, A., 5
 Ustun, B., 15

 Van den Poel, D., 12
 Varone, S., 19
 Vayanos, P., 15
 Verhelst, B., 12
 Vespucci, M., 14
 Victoria-Feser, M., 10
 Vladimirou, H., 18

 Wagener, F., 7
 Wang, L., 14
 Weber, C., 3
 Webster, M., 3, 15
 Wiesemann, W., 8
 Wittmann-Hohlbein, M., 11
 Wozabal, D., 8

 Xu, P., 14

 Yan, X., 8

 Ziegler, D., 3
 Zigrino, S., 14
 Zorgati, R., 6
 Zubaryeva, O., 19
 Zymler, S., 15

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