



Croatian Operational
Research Society



Faculty of Economics in
Osijek, University of
Osijek



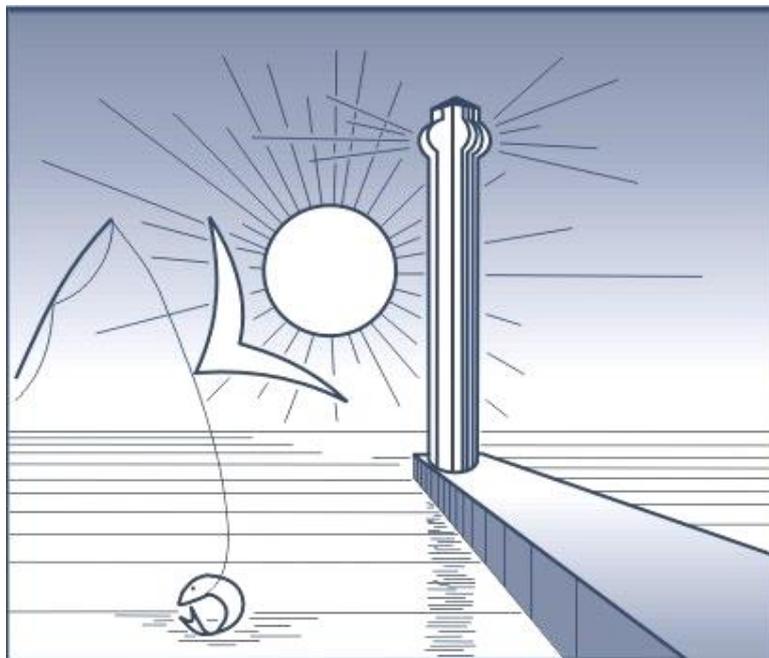
Department of
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University of Osijek

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Book of Abstracts

15th International Conference on Operational Research KOI 2014



Editors:

Rudolf Scitovski, Marijana Zekić-Sušac, Zrinka Lukač

Osijek, Croatia, 24-26 September, 2014.



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The Association of European
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Embassy of the United States,
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15th International Conference on Operational Research KOI 2014

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Preface

This Book of abstracts consists of abstracts of invited and contributed papers presented at the 15th International Conference on Operational Research KOI 2014, organized by Croatian Operational Research Society (CRORS), Faculty of Economics in Osijek, and Department of Mathematics, University of Osijek. The conference was held at Faculty of Economics in Osijek, from September 24 to September 26, 2014.

The **International Conference on Operational Research (KOI)** is the major event organized by the Croatian Operational Research Society since 1991. In the period from 1991 to 1996 it was organized every year, while from 1996 to today, it is organized every two years (in odd years). The objective of the KOI conference is to bring together researchers and practitioners from operational research and related scientific disciplines (such as applied mathematics, statistics, quantitative methods in business, simulations, and machine learning) for introducing new operational research achievements in business process improvement. Conference topics include linear and non-linear programming, combinatorial and discrete optimization, multi-objective programming, stochastic models, game theory, statistics, econometrics, information and decision support systems, neural networks and fuzzy systems, data mining, business analytics, control theory simulations, practical OR and applications. Main intention of the conference is to exchange ideas and experiences through direct contacts with researches of common interest, particularly including young researchers in order to improve their scientific work. KOI conferences were successfully held so far in different cities of Croatia, such as: Rab, Rovinj, Trogir, Pula, Split, and Zagreb. The conference consists of the following eight sections:

- Invited papers
- OR Theory and Applications
- Mathematical Programming
- Multicriteria Decision Making
- Quantitative Methods in Banking and Finance
- Statistics and Econometrics
- Machine Learning, Data Mining and Analytics
- Special Section in Honor of Luka Neralic

This year, on occasion of 70th birthday of professor Luka Neralić, one of the founder and the first president of the Croatian Operational Research Society, we organized a **Special section in honor of Luka Neralić**, dedicated to the areas of his research interest, such as Data Envelopment Analysis (DEA) and related areas.

Also, the **Teaching Effectiveness Colloquium (TEC) Croatia 2014** workshop is organized in conjunction with the KOI 2014 conference. The TEC workshop is chaired by James J. Cochran from University of Alabama. Besides James J. Cochran, the instructors of the TEC were also Jeffrey D. Camm and Michael J. Fry from University of Cincinnati, USA.

The scientific program of this conference includes 5 invited lectures by eminent international experts and 104 contributed papers in 21 sessions. The total of 209 authors participate from 31 different countries: Australia, Belarus, Bosnia and Herzegovina, Canada, China, Croatia, Colombia, Czech Republic, Egypt, Finland, France, Greece, Hungary, India, Iran, Italy, Japan, Lithuania, Macedonia, Netherlands, Peru, Poland, Portugal, Russia, Serbia, Slovakia, Slovenia, Spain, Turkey, United Kingdom, and United States of America.

The conference has an international Program Committee and is held in English language.

Editors



Croatian Operational
Research Society



Faculty of Economics in
Osijek, University of
Osijek



Department of
Mathematics,
University of Osijek

15th International Conference on
Operational Research KOI 2014

KOI 2014 Conference Program

Osijek, Croatia, 24-26 September, 2014.

Organizers:

Croatian Operational Research Society

In collaboration with
Faculty of Economics in Osijek, University of Osijek, Croatia
&
Department of Mathematics, University of Osijek, Croatia

Conference venue:

Faculty of Economics in Osijek, Trg Lj. Gaja 7, 31000 Osijek, Croatia

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15th International Conference on Operational Research KOI 2014, Osijek, Croatia
Program Overview

Day/Time	8:00-9:00	9:00-10:00	10:15-11:00	11:00-11:30	11:30-13:00	13:00-14:00	14:00-14:45	15:00-16:30	16:30-16:45	17:00-18:30	19:30
Wednesday September 24, 2014	Registration at the registration desk*	Opening session	Plenary Lecture 1 James Cochran University of Alabama, USA	Coffee break	Parallel sessions A, B, C, and Special Section in Honor of L.Neralic	Lunch break	Plenary Lecture 2 Goran Lešaja Georgia Southern University, USA	Teaching Effectiveness Colloquium – part 1	Coffee break	Parallel sessions A, B, C	Welcome reception - Light boat dinner on Drava river
Day/Time	8:00-8:30	8:30-9:15	9:20-10:50	10:50-11:05	11:05-12:35	12:35-14:00	14:00-15:00	15:15-20:00		20:00	
Thursday September 25, 2014	Registration at the registration desk*	Plenary Lecture 3 Ali Emrouznejad Aston University, UK	Parallel sessions A, B, C, and Special Section in Honor of L. Neralić	Coffee break	Parallel sessions A, B, C	Lunch break	Teaching Effectiveness Colloquium – part 2	Excursion to Baranya region (Park of nature Kopacki rit, Belje winery with wine tasting)		Traditional Slavonian dinner with folk music	
Day/Time	8:00-8:30	8:30-9:15	9:20-10:50	10:50-11:05	11:05-12:35	12:35-14:00	14:00-14:45	15:00-16:30	16:30-16:45	16:45-17:30	17:30-18:30
Friday September 26, 2014	Registration at the registration desk*	Plenary Lecture 4 Janez Povh Faculty for Information Studies in Novo mesto, Slovenia	Parallel sessions A, B, C, and Special Section in Honor of L. Neralić	Coffee break	Parallel sessions A, B, C	Lunch break	Plenary Lecture 5 Amir Nakib Université Paris Est Créteil, France	Teaching Effectiveness Colloquium – part 3	Coffee break	Closing session	CRORS (HDOI) Annual meeting

* Registration and Information desk working hours: from Wednesday to Friday 8.00-18.00

Duration of plenary lectures: 40 minutes lecture + 5 minutes for discussion

Duration of contributed presentations: 15 minutes presentation + 3 minutes for discussion

15th International Conference on Operational Research KOI 2014, Osijek, Croatia
Detailed program

Wednesday September 24, 2014 – 1st day

Event / Session	Time	Room	Paper title	Author name and institution
Registration at the registration desk	8:00-9:00	Ground floor		
Opening session	9:00-10:00	Room 1 (ground floor)		
Plenary Lecture 1 James J. Cochran , University of Alabama, Tuscaloosa, USA Chair: Luka Neralić	10:15-11:00	Room 1 (ground floor)	How are Analytics and Operations Research Related?	James J. Cochran , Department of Information Systems, Statistics, and Management Science, University of Alabama, Tuscaloosa, USA
Coffee break	11:00-11:30	Room 3 (ground floor)		
Parallel sessions A, B, C, and Special Section in Honor of L. Neralić	11:30-13:00			
Session A1 – OR Theory and Application Chair: Mirjana Pejić Bach Time for each presentation: 15 minutes presentation + 3 minutes for discussion	11:30-13:00	Room 12 (2nd floor)	A1-1. Decision-Making Under Non-Probabilistic Uncertainty	Moshe Sniedovich , Department of Mathematics and Statistics, University of Melbourne, Australia
			A1-2. Algorithm for The Nonlinear Generalized Transportation Problem	Marcin Anholcer , Department of Operations Research, Poznań University of Economics, Poland
			A1-3. Using Artificial Neural Networks in The Prediction of Incorrect Values of Coal Drying Experiments	Mustafa Tahir Akkoyunlu, Mehmet Cabir Akkoyunlu, Şaban Pusat, Coskun Özkan , YTU Faculty of Mechanical Engineering , Yildiz Technical University, Turkey
			A1-4. Testing the Sustainability of Croatian Military Forces: System Dynamics Approach	Emil Tustanovski, Mirjana Pejić Bach, Ilko Vrankić , Faculty of Economics & Business, University of Zagreb, Croatia
Session B1 – Mathematical Programming Chair: Karlo Kotarac Time for each	11:30-13:00	Room 13 (2nd floor)	B1-1. Min-Max Optimal Public Service System Design	Marek Kvet , University Science Park, University of Žilina, Slovakia Jaroslav Janaček , Faculty of Management Science and Informatics, University of Žilina, Slovakia

Event / Session	Time	Room	Paper title	Author name and institution
<p>presentation: 15 minutes presentation + 3 minutes for discussion</p>			<p>B1-2. Finding An Optimal Seating Arrangement for Employees Traveling to An Event</p>	<p>Ninoslav Čerkez, IN2 d.o.o., Croatia Rebeka Čordaš, Mateja Đumić, Domagoj Matijević, Department of Mathematics, J.J. Strossmayer University of Osijek, Croatia</p>
			<p>B1-3. Evaluating The Innovation Efficiency of European Countries by DEA and Malmquist-TFP Index</p>	<p>Ilker Murat Ar, Department of Business Administration, Karadeniz Technical University, Turkey</p>
			<p>B1-4. An Integer Programming Model for Assigning Students to Elective Courses</p>	<p>Ivo Beroš, Joško Meter, Department of Applied Mathematics and Computer Science, VERN' University of Applied Sciences, Croatia</p>
			<p>B1-5. Min-Max Optimization with Radial Approach to The Public Service System Design with Generalized Utility</p>	<p>Jaroslav Janaček, Faculty of Management Science and Informatics, University of Žilina, Slovakia Marek Kvet, University Science Park, University of Žilina, Slovakia</p>
<p>Session C1 – Multicriteria Decision Making Chair: Samo Drobne</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>11:30- 13:00</p>	<p>Room 14 (2nd floor)</p>	<p>C1-1. Accounting for Asymmetry Between Strengths, Weaknesses, Opportunities and Threats in Decision Making: The SPADE Outranking Approach</p>	<p>Nassim Dehouche, Daniel Vanderpooten, Université Paris-Dauphine – LAMSADE, France</p>
			<p>C1-2. A Computational Study of Labelling Algorithms for Multi-Objective Shortest Path Problems With or Without Resource Constraints</p>	<p>Yi Qu, Tolga Bektas, Julia Bennell, Southampton Management School, University of Southampton, United Kingdom</p>
			<p>C1-3. Stability Analysis in Multi-Criteria Discrete Optimization Models: Quantitative and Qualitative Approaches</p>	<p>Vladimir Korotkov, Department of Mathematics and Statistics, University of Turku, Finland Kuzmin Kirill, Department of Mechanics and Mathematics, Belarusian State University, Belarus Nikulín Yury, Department of Mathematics and Statistics, University of Turku, Finland</p>

Event / Session	Time	Room	Paper title	Author name and institution
			C1-4. Application of Markov Decision Processes in Minimization of the Expected Costs	Marija Rukav, Nenad Šuvak, Zoran Tomljanović , Department of Mathematics, J. J. Strossmayer University of Osijek
			C1-5. Project Management in Mine Actions Using Multi-Criteria-Analysis-Based Decision Support System	Marko Mladineo , Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Croatia Nenad Mladineo, Jajac Niksa , Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia
<p>Session LN1 - Special Section in Honor of Luka Neralic Chair: Zrinka Lukač</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>11:30-13:00</p>	<p>Room 1 (ground floor)</p>	LN1-1. Satisficing DEA: Bayesian Predictive Analytics for Peer Mining	Vincent Charles , CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Peru
			LN1-2. Sensitivity Analysis of Input Relaxation Super Efficiency Measure in Data Envelopment Analysis	Mohammad Khodabakhshi, Saba Rashidi , Department of Mathematics, Faculty of sciences, Lorestan University, Iran Masoud Asgharian , Department of Mathematics and statistics, McGill University, Canada Luka Neralić , Faculty of Economics and Business, University of Zagreb, Croatia
			LN1-3. Improving Efficiency of Efficient Decision Making Unit	Valter Boljunčić , Faculty of Economics and Tourism "Dr. Mijo Mirković" Juraj Dobrila, University of Pula
			LN1-4. Efficiency Evaluation of Stock Portfolios based on Multiple Risk Measures: a DEA-like Envelopment Approach	Yongjun Li, Hengxuan Gao, Liang Liang, Wei Lu , Management School, University of Science and Technology of China, China
			LN1-5. DEA for Performance Evaluation and Benchmarking: Two Case Studies for Optimal Ecosystem Management	Lidija Zadnik Stirn , Biotechnical Faculty, University of Ljubljana, Slovenia
Lunch break	13:00-14:00			

Event / Session	Time	Room	Paper title	Author name and institution
Plenary Lecture 2 Goran Lešaja , Georgia Southern University, USA Chair: Rudolf Scitovski	14:00-14:45	Room 1 (ground floor)	Interior-Point Methods for Linear Complementarity Problems and Generalizations	Goran Lešaja , Department of Mathematical Sciences, Georgia Southern University, USA
Teaching Effectiveness Colloquium (TEC) Croatia Workshop – part 1	15:00-16:30	Room 1 (ground floor)	Modeling for Insights	Jeffrey D. Camm , Department of Operations, Business Analytics, and Information Systems, University of Cincinnati, USA
Coffee break	16:30-16:45	Room 3 (ground floor)		
Parallel sessions A, B, C	17:00-18:30			
Session A2 – OR Theory and Application Chair: Darija Marković Time for each presentation: 15 minutes presentation + 3 minutes for discussion	17:00-18:30	Room 12 (2nd floor)	A2-1. Harmony Search Algorithm for Solving Hybrid Flow Shop Scheduling Problems A2-2. Single-Objective and Multi-Objective Optimization Using HUMANT Algorithm A2-3. Solving the Utility Maximization Problem with The Cobb-Douglas and CES Utility Function Without The Use of Calculus A2-4. On The Existence of The Nonlinear Weighted Least Squares Estimate for Some Special Exponential Type Models	Mehmet Cabir Akkoyunlu , YTU Faculty of Mechanical Engineering, Yildiz Technical University, Turkey Orhan Engin , Faculty of Engineering, Selcuk University, Turkey Marko Mladineo, Ivica Veza, Nikola Gjeldum , Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Croatia Vedran Kojić , Department of Mathematics, Faculty of Economics and Business, University of Zagreb, Croatia Darija Marković, Luka Borozan , Department of Mathematics, J.J. Strossmayer University of Osijek, Croatia
Session B2 – Mathematical Programming Chair: Kristian Sabo Time for each presentation: 15 minutes presentation + 3 minutes for discussion	17:00-18:30	Room 13 (2nd floor)	B2-1. Approximation of k-Minimum Hamiltonian Cover Problem B2-2. Multiple Ellipse Fitting by Center-Based Clustering	Michael Khachay, Ekaterina Neznakhina , Krasovsky Institute of Mathematics and Mechanics, Russia Tomislav Marošević, Rudolf Scitovski , Department of Mathematics, J.J. Strossmayer University of Osijek, Croatia

Event / Session	Time	Room	Paper title	Author name and institution
			B2-3. Heuristic Methods for The Solution of The Tariff Zones Design	Michal Koháni , Department of mathematical methods and operations research, University of Žilina, Slovakia
			B2-4. A Comparison of Tabu Search Algorithm and Mathematical Model in a Pipeline Network	Engin Pekel, Selin Soner Kara , Department of Industrial Engineering, Yildiz Technical University, Turkey
			B2-5. Run-time Parameter Tuning of Optimization Systems	Péter Tar, József Smidla, István Maros , Department of Computer Science and Systems Technology, University of Pannonia, Hungary
Session C2 – Multicriteria Decision Making Chair: Danijela Rabar Time for each presentation: 15 minutes presentation + 3 minutes for discussion	17:00- 18:30	Room 14 (2nd floor)	C2-1. Fuzzy Group Decision Support System Based on AHP and SWOT for Solving Natural Resource Management Problem in Slovenia	Petra Grošelj, Lidija Zadnik Stirn , Biotechnical Faculty, University of Ljubljana, Slovenia
			C2-2. Performance Concept in Cost-Effective Construction Management of Educational Facilities	Ivona Gudac, Ivan Marović, Diana Car-Pušić , Faculty of Civil Engineering, University of Rijeka, Croatia
			C2-3. Stock Selection using A Hybrid MCDM Approach	Tea Poklepović, Zoran Babić , Faculty of Economics, University of Split, Croatia
			C2-4. Cost Effectiveness of ATM's Automatic Deposit Service	Marko Hell , Faculty of Economics, University of Split, Croatia Ivica Županović , Splitska banka - Societe Generale Group, Croatia Dino Pavlić , Faculty of Economics, University of Split, Croatia
Welcome reception - Light boat dinner on Drava river	19:30			

Thursday, September 25th, 2014 – 2nd day

Event / Session	Time	Room	Paper title	Author name and institution
Registration at the registration desk	8:00-8:30	Ground floor		
Plenary Lecture 3 Ali Emrouznejad , Aston University, UK Chair: Luka Neralić	8:30-9:15	Room 1 (ground floor)	A Systematic Process for Measuring Efficiency of Decision Making Units using Data Envelopment Analysis	Ali Emrouznejad , Operations & Information Management Group, Aston Business School, Birmingham, United Kingdom
Parallel sessions A, B, C, and Special Section in Honor of L. Neralić	9:20-10:50			
Session A3 – OR Theory and Application Chair: Kristina Šorić Time for each presentation: 15 minutes presentation + 3 minutes for discussion	9:20-10:50	Room 12 (2nd floor)	A3-1. A Partial Backlogging Inventory Model for Deteriorating Items with Time-Varying Demand and Holding Cost: An Interval Number Approach	Debashis Dutta, Pavan Kumar , Department of Mathematics, National Institute of Technology, India
			A3-2. A Framework in The Formulation and Solution of Inventory Routing Problems	Raúl Roldán, Rosa Basagoiti , Electronics and Computing Department, Mondragon University, Spain Enrique Onieva , Deusto Institute of Technology (DeustoTech), University of Deusto, Spain
			A3-3. A Mathematical Model for Centralization of Humanitarian Relief Logistics Networks	Erkan Celik, Alev Taskin Gumus , Department of Industrial Engineering, Yildiz Technical University, Turkey
			A3-4. Hybrid Dynamic Cross Impact Analysis with Markov Chain and Trend Impact Analysis	Amany Mohamed Mamdouh, Mohamed M. Saleh, Abd El-Hadi N. Ahmed, Nedaa Mohamed Ezzat Agami , Operations Research & Decision Support Department, Faculty of Computers & Information, Cairo University, Egypt
			A3-5. Inventory Sharing with Speculations	Andrija Raguž, Kristina Šorić, Ivan Šutalo , Zagreb School of Economics and Management, Croatia
Session B3 – Quantitative Methods in Banking and Finance	9:20-10:50	Room 13 (2nd floor)	B3-1. From Diagnosis to Prognosis of Financial (In)stability – Auditors' Opinion Approach	Robert Zenzerović , Faculty of Economics and Tourism "Dr. Mijo Mirković", Juraj Dobrila, University of Pula, Croatia

Event / Session	Time	Room	Paper title	Author name and institution
Chair: Mirjana Čizmešija Time for each presentation: 15 minutes presentation + 3 minutes for discussion				Martin Valić Vale , Riviera Adria d.d., Croatia
			B3-2. Testing for Regime-Switching CAPM on Zagreb Stock Exchange	Tihana Škrinjarić , Faculty of Economics and Business, University of Zagreb, Croatia
			B3-3. Estimating Investors Preferences Towards Portfolio Return Distribution Moments: Empirical Evidence from Croatian Investment Funds	Margareta Gardijan, Tihana Škrinjarić , Faculty of Economics and Business, University of Zagreb, Croatia
			B3-4. The Application of Portfolio Optimization Methods in Investment Risk Management – Evidence from Zagreb Stock Exchange	Jovan Njegić, Nataša Papić Blagojević , Novi Sad Business School, Serbia Marijana Ćurak , Faculty of Economics, University of Split, Croatia
			B3-5. A Comparison of Four Different Block Bootstrap Methods	Boris Radovanov, Aleksandra Marcikić , Faculty of Economics Subotica, University of Novi Sad, Serbia
Session C3 – Multicriteria Decision Making Chair: Petar Sorić Time for each presentation: 15 minutes presentation + 3 minutes for discussion	9:20-10:50	Room 14 (2nd floor)	C3-1. Planning Support Concept to Implementation of Sustainable Parking Development Projects in Ancient Mediterranean Cities	Nikša Jajac , Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia Ivan Marović , Faculty of Civil Engineering, University of Rijeka, Croatia Marko Mladineo , Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Croatia
			C3-2. Technology Competency Evaluation of The Manufacturing Companies Via Multi-Criteria Approaches	Ufuk Bolukbas, Ali Fuat Guneri , Department of Industrial Engineering, Yildiz Technical University, Turkey
			C3-3. The Setting of Key Performance Targets for Croatian Shipyards	Danijela Rabar , Faculty of Economics and Tourism “Dr. Mijo Mirković”, Juraj Dobrila University of Pula, Croatia
			C3-4. Ranking Zones Model – A Multicriterial Approach for Spatial Management of Urban Areas	Ivan Marović , Faculty of Civil Engineering, University of Rijeka, Croatia Nikša Jajac , Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Croatia

Event / Session	Time	Room	Paper title	Author name and institution
				Ivica Završki , Faculty of Civil Engineering, University of Zagreb, Croatia
			C3-5. Maximizing the Number of Effective 2-Cycles in Kidney Exchange Programs	Filipe Avelos , Department of Production and Systems Engineering, University of Minho, Portugal Xenia Klimentova , INESC TEC, Portugal Ana Viana , INESC TEC and ISEP - School of Engineering, Polytechnic of Porto, Portugal Abdur Rais , Department of Production and Systems Engineering, University of Minho, Portugal
<p>Session LN2 - Special Section in Honor of Luka Neralic Chair: Richard E. Wendell</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	9:20-10:50	Room 1 (ground floor)	N2-1. On Local Search Based Heuristics for Optimization Problems	Janez Žerovnik , Faculty of Mechanical Engineering, University of Ljubljana, Slovenia
			N2-2. On Solving Hard Optimization Problems Using SDP	Renata Sotirov , Department of Econometrics and Operations Research, Tilburg University
			N2-3. Improved Full-Newton-Step Interior-Point Methods for LO and LCP	Goran Lešaja , Department of Mathematical Sciences, Georgia Southern University, USA
			N2-4. Analysis of The Applicability of Goal Programming Procedure for Solving Fuzzy Multiobjective Linear Fractional Programming Problems	Tunjo Perić , Faculty of Economics & Business, University of Zagreb, Croatia Zoran Babić , Faculty of Economics, University of Split, Croatia Sead Rešić , Faculty of Science, University of Tuzla, Bosnia and Herzegovina
			N2-5. Tolerance Sensitivity in DEA	Luka Neralić , Faculty of Economics and Business, University of Zagreb, Croatia Richard E. Wendell , Joseph M. Katz Graduate School of Business, University of Pittsburgh, USA
Coffee break	10:50-11:05	Room 3 (ground floor)		
Parallel sessions A, B, C	11:05-12:35			

Event / Session	Time	Room	Paper title	Author name and institution
<p>Session A4 – OR Theory and Application Chair: Ivan Marović</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>11:05- 12:35</p>	<p>Room 12 (2nd floor)</p>	A4-1. Linear Programming Model for Rostering Ambulance Crew	Aleksandra Marcikić, Boris Radovanov , Faculty of Economics Subotica, University of Novi Sad, Serbia
			A4-2. Modeling Emergency Department Patient Surge in Disaster Conditions by Simulation	Muhammet Gul, Ali Fuat Guneri , Department of Industrial Engineering, Yildiz Technical University, Turkey
			A4-3. Performance Evaluation and Regulation Influence on The Portuguese Water Sector	Rui Cunha Marques, Pedro Simões CESUR, IST, University of Lisbon, Portugal
			A4-4. A Market Structure Analysis of The Brazilian Water Sector	Pedro Carvalho, Pedro Simões, Rui Cunha Marques , CESUR, IST, University of Lisbon, Portugal
			A4-5. Integrated Forest Road Maintenance and Harvest Scheduling With Endogenous Costs	Sándor F.Tóth , School of Environmental & Forest Sciences University of Washington, USA Kai Ross , Quantitative Ecology & Resource Management, University of Washington, USA Weikko Jaross , Washington State Department of Natural Resources, USA
<p>Session B4 – Quantitative Methods in Banking and Finance Chair: Tihana Škrinjaric</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>11:05- 12:35</p>	<p>Room 13 (2nd floor)</p>	B4-1. Multivariate Approach to Determination of Intermediate Target of Monetary Policy Strategy in CEE Countries	Mario Pečarić, Snježana Pivac, Josip Visković , Faculty of Economics, University of Split, Croatia
			B4-2. Stochastic Programming Framework for Lithuanian Pension Payout Modelling	Audrius Kabašinskas, Kristina Štutienė, Valakevičius Eimutis , Department of Mathematical Modeling, Kaunas University of Technology, Lithuania Francesca Maggioni , Department of Management, Economics and Quantitative Methods, University of Bergamo, Italy
			B4-3. Testing The Effects of Financial Literacy on Debt Behavior of Croatian Financial	Vlasta Bahovec, Dajana Cvrlje, Irena Palić , Faculty of Economics and Business, University of

Event / Session	Time	Room	Paper title	Author name and institution
			Consumers Using Multivariate Analysis Methods	Zagreb, Croatia
			B4-4. Statistical Analyses of Investment and Pension Funds' Performances from South-Eastern Europe	Petar Taleski , NLB Nov penziski fond Skopje, Euro College – Kumanovo, Macedonia Vasko Bogdanovski , NLB Nov penziski fond Skopje, Macedonia
			B4-5. Measurement of European Banking Industry Cost Efficiency	Alen Stojanović, Branka Jurčević , Faculty of Economics and Business, University of Zagreb, Croatia
Session C4 – Statistics and Econometrics Chair: Ksenija Dumičić Time for each presentation: 15 minutes presentation + 3 minutes for discussion	11:05-12:35	Room 14 (2nd floor)	C4-1. Which Distance-Decay Function for Migration and Which One for Commuting? The Case Study of Slovenia	Samo Drobne, Mitja Lakner , Faculty of Civil and Geodetic Engineering, University of Ljubljana, Slovenia
			C4-2. Adjusting for A Calendar Effects of Real Retail Trade Turnover Time Series in Croatia	Josip Arnerić, Anita Čeh Časni , Faculty of Economics and Business Zagreb, University of Zagreb, Croatia Marko Čular , Faculty of Economics, University of Split, Croatia
			C4-3. Development Index: Do Weights Matter? An Application of Data-Driven Weights and Restrictions in The Construction of Composite Indicators	Ana Perišić , Polytechnic of Šibenik, Croatia
			C4-4. Research and Evaluation of The Effectiveness of E-Learning: a Linear Programming Case Study	Ljiljana Miletić , Gimnasium Pozega, Croatia
Lunch break	12:35-14:00			
Teaching Effectiveness Colloquium (TEC) Croatia Workshop – part 2	14:00-15:00		Excel-Based Tools for Teaching Analytics	Michael J. Fry , Department of Operations, Business Analytics & Information Systems, Carl H. Lindner College of Business, University of Cincinnati, USA

Event / Session	Time	Room	Paper title	Author name and institution
Excursion to Baranya region (Park of nature Kopacki rit, Belje winery with wine tasting)	15:15-20:00			
Traditional Slavonian dinner with folk music	20:00			

Friday, September 26th, 2014 – 3rd day

Event / Session	Time	Room	Paper title	Author name and institution
Registration at the registration desk	8:00-8:30	Ground floor		
Plenary Lecture 4 Janez Povh , Faculty for Information Studies Novo mesto, Slovenia Chair: Dragan Jukić	8:30-9:15	Room 1 (ground floor)	From Combinatorial Optimization to Real Algebraic Geometry and Back	Janez Povh , Faculty for Information Studies in Novo mesto, Slovenia
Parallel sessions A, B, C, and Special Section in Honor of L. Neralić	9:20-10:50			
Session A5 – OR Theory and Application Chair: Snježana Pivac Time for each presentation: 15 minutes presentation + 3 minutes for discussion	9:20-10:50	Room 12 (2nd floor)	A5-1. Modifications of The Omega Ratio for Decision Making Under Uncertainty	Helena Gaspars-Wieloch , Department of Operations Research, Faculty of Informatics and Electronic Economy, Poznań University of Economics, Poland
			A5-2. Impacts on Internet Booking for Travel and Holiday Accommodation in European Countries: Multivariate Analysis Approach	Ksenija Dumičić, Berislav Žmuk, Anita Čeh Časni , Department of Statistics, Faculty of Economics and Business – Zagreb, University of Zagreb, Croatia
			A5-3. A Group Decision Support System for Evaluating The Efficiency of Academic Units	Gregory Koronakos, Dimitris Sotiros, Athanasios Zigomitros, Dimitris Apostolou, Dimitris Despotis , Department of Informatics, University of Piraeus, Greece
			A5-4. Comparison of Discrete Event Simulation Tools in An Academic Environment	Mario Jadrić, Maja Čukušić, Antonia Bralić , Faculty of Economics, University of Split, Croatia
Session B5 – Machine Learning,	9:20-10:50	Room 13 (2nd floor)	B5-1. A New Fusion Algorithm for Fuzzy Clustering	Ivan Vidović, Dražen Bajer , Faculty of Electrical Engineering, University of

Event / Session	Time	Room	Paper title	Author name and institution
<p>Data Mining and Analytics Chair: Nataša Šarlija</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>				Osijek, Croatia Rudolf Scitovski , Department of Mathematics, J.J. Strossmayer University of Osijek, Croatia
			B5-2. Color Image Segmentation Based on Intensity and Hue Clustering - Least Square and Least Absolute Deviation Approaches Comparison	Petar Taler, Kristian Sabo , Department of Mathematics, J.J. Strossmayer University of Osijek, Croatia
			B5-3. Customer Segmentation Using Neural Networks	Dajana Ćorić , Faculty of Economics & Business, University of Zagreb, Croatia
			B5-4. Aligning Classification Schemas of The Croatian Encyclopedia and Wikipedia Through Supervised Machine Learning	Ozren Kubelka , Department of Applied Mathematics and Computer Science, VERN' University of Applied Sciences, Croatia Nikola Ljubešić , Faculty of Humanities and Social Sciences, University of Zagreb, Croatia
			B5-5. Business Clusters in Croatian Furniture Industry	Martina Briš Alić , Faculty of Economics in Osijek, Josip Juraj Strossmayer University of Osijek, Croatia Alen Alić , Aurea Grupa d.o.o., Croatia Rudolf Scitovski , Department of Mathematics, J.J. Strossmayer University of Osijek, Croatia
<p>Session C5 – Statistics and Econometrics Chair: Nataša Erjavec</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	9:20-10:50	Room 14 (2nd floor)	C5-1. Entrepreneurial Intention Modeling Using Hierarchical Multiple Regression	Marina Jeger , Faculty of Economics in Osijek, University of Josip Juraj Strossmayer in Osijek, Croatia Zoran Sušanj , Faculty of Humanities and Social Sciences, University of Rijeka, Croatia Josipa Mijoč , Faculty of Economics in Osijek, University of Josip Juraj Strossmayer in Osijek, Croatia
			C5-2. Liquidity Indicator for The Croatian Economy –	Mirjana Čižmešija, Nataša Kurnoga, Vlasta Bahovec , Faculty of

Event / Session	Time	Room	Paper title	Author name and institution
			Factor Analysis Approach	Economics and Business, University of Zagreb, Croatia
			C5-3. Baltic Dry Index and Performance Excellence in The Crisis Environment	Elza Jurun, Nada Ratković , Faculty of Economics, University of Split, Croatia Franjo Moro , Moro & Moro j.d.o.o., Croatia
			C5-4. System Dynamics Modelling and Simulation of The Intellectual Capital Influence on The Economy Growth in The Republic of Croatia	Ivona Milić Beran , Maritime Department, University of Dubrovnik, Croatia
			C5-5. How (I)Rrational Are We? Case of Croatian Inflation	Nataša Erjavec, Ivana Lolić, Petar Sorić , Faculty of Economics & Business Zagreb, University of Zagreb, Croatia
<p>Session LN3 - Special Section in Honor of Luka Neralic Chair: Tunjo Perić</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>9:20-10:50</p>	<p>Room 1 (ground floor)</p>	LN3-1. Measuring The Efficiency of Macedonian Banks: A Non-Parametric Approach	Violeta Cvetkoska, Elena Naumovska , Faculty of Economics, Ss. Cyril and Methodius University in Skopje, Macedonia
			LN3-2. The Model of Firm's Innovation Orientation - Case of Slovenia	Majda Bastič, Igor Vrečko , Slovenia Faculty of Business and Economics, University of Maribor
			LN3-3. Performance Evaluation of Central European Firms	Petr Fiala, Josef Jablonsky , Department of Econometrics, University of Economics Prague, Czech Republic
			LN3-4. Assessing the Quality of Academic Staff Using Multiple-Criteria Decision Making	Karlo Kotarac, Zrinka Lukač , Faculty of Economics and Business, University of Zagreb, Croatia
			LN3-5. Equity Portfolio Optimization: A DEA Based Methodology Applied on Zagreb Stock Exchange	Margareta Gardijan, Tihana Škrinjarić , Faculty of Economics and Business – Zagreb, University of Zagreb, Croatia
Coffee break	10:50-11:05	Room 3 (ground floor)		
Parallel sessions A, B, C	11:05-12:35			

Event / Session	Time	Room	Paper title	Author name and institution
<p>Session A6 – OR Theory and Application Chair: Zoran Tomljanović</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>11:05-12:35</p>	<p>Room 12 (2nd floor)</p>	A6-1. An Optimal Pair of Members of Forming Relations to A Liaison With Long Communication Lengths in The Same Level of An Organization Structure	Kiyoshi Sawada , Department of Policy Studies, University of Marketing and Distribution Sciences, Japan
			A6-2. Approximating The Solution of The Two-Part Tariff Problem	Ilko Vrankić, Mira Krpan, Zrinka Lukač , Faculty of Economics and Business, University of Zagreb, Croatia
			A6-3. Optimisation of Workshop Layout in A Furniture Development Company	Tadej Kanduč, Blaž Rodič , Faculty of Information Studies in Novo mesto, Slovenia
			A6-4. Roman Domination Number on Cardinal Product of Paths and Cycles	Antoaneta Klobučar , Faculty of Economics in Osijek, University of Josip Juraj Strossmayer in Osijek, Croatia Ivona Puljić , Ernestinovo, Croatia
			A6-5. An Efficient Parallel Implementations of Approximation Algorithms for Guarding 1.5D Terrains	Goran Martinović , Faculty of Electrical Engineering, University of Osijek, Croatia Domagoj Matijević, Domagoj Ševerdija , Department of Mathematics, University of Osijek, Croatia
<p>Session B6 – Machine Learning, Data Mining and Analytics Chair: Marijana Zekić-Sušac</p> <p>Time for each presentation: 15 minutes presentation + 3 minutes for discussion</p>	<p>11:05-12:35</p>	<p>Room 13 (2nd floor)</p>	B6-1. Decision Tree Learning for Turning Points Detection in Business Process Orientation: Case of Croatia	Ljubica Milanović Glavan, Vesna Bosilj Vukšić, Nikola Vlahović , Faculty of Economics and Business, University of Zagreb, Croatia
			B6-2. Predicting Students' Course Satisfaction from Log Data in Virtual Learning Environment – Neural Networks and Classification Tree Model	Ivana Đurđević Babić , Faculty of Teacher Education, University of J. J. Strossmayer in Osijek, Croatia
			B6-3. Web Analytics Tools and Web Metrics Tools: An Overview and The Tool Comparative Analysis	Ivan Bekavac, Daniela Garbin Praničević , Faculty of Economics, University of Split, Croatia
			B6-4. Cluster Analysis in Retail Segmentation for Credit Scoring	Sanja Scitovski , University of J.J. Strossmayer in Osijek, Croatia Nataša Šarlija , Faculty of Economics, University of

Event / Session	Time	Room	Paper title	Author name and institution
				J.J. Strossmayer in Osijek, Croatia
			B6-5. Discovering Patterns in Market Basket by Hierarchical Association Rules	Marijana Zekić-Sušac, Adela Has , Faculty of Economics, University of J.J. Strossmayer in Osijek, Croatia
Session C6 – Statistics and Econometrics Chair: Josip Arnerić Time for each presentation: 15 minutes presentation + 3 minutes for discussion	11:05-12:35	Room 14 (2nd floor)	C6-1. An Application of Interactive Multiobjective Dynamic Programming in Project Portfolio Selection	Maciej Nowak, Tadeusz Trzaskalik , Department of Operations Research, University of Economics in Katowice, Poland
			C6-2. Measuring Real Exchange Rate Misalignment in Croatia: Cointegration Approach	Irena Palić, Ksenija Dumičić, Petra Šprajac , Faculty of Economics and Business, University of Zagreb, Croatia
			C6-3. Application and Development of Human Resource Information System and Electronic Recruitment in Croatian Companies	Snježana Pivac, Ivana Tadić, Branka Marasović , Faculty of Economics, University of Split, Croatia
			C6-4. A VECM Approach to Detangling Growth, Export, Import and FDI Knot in Selected CEE Countries	Saša Žiković, Ivana Tomas Žiković, Maja Grdinić , Faculty of Economics, University of Rijeka, Croatia
			C6-5. GARCH Based Artificial Neural Networks in Forecasting Conditional Variance of Stock Returns	Josip Arnerić , Faculty of Economics and Business Zagreb, University of Zagreb, Croatia Tea Poklepović, Zdravka Aljinović , Faculty of Economics, University of Split, Croatia
Lunch break	12:35-14:00			
Plenary Lecture 5 Prof. Amir Nakib , Université Paris Est Créteil, France Chair: Kristina Šorić	14:00-14:45	Room 1 (ground floor)	From Static to Dynamic Metaheuristics: Design and Applications	Prof. Amir Nakib , Faculty of Sciences, Université Paris Est Créteil, France
Teaching Effectiveness Colloquium (TEC) Croatia Workshop – part 3	15:00-16:30	Room 1 (ground floor)	Engaging and Re-Engaging Students with Active Learning	James J. Cochran , Department of Information Systems, Statistics, and Management Science, University of Alabama, Tuscaloosa, USA

Event / Session	Time	Room	Paper title	Author name and institution
Coffee break	16:30-16:45	Room 3 (ground floor)		
Closing session and award giving	16:45-17:30	Room 1 (ground floor)		
CRORS (HDOI) Annual meeting	17:30-18:30	Room 1 (ground floor)		We invite all CRORS (HDOI) members to attend this meeting

IMPORTANT NOTICES

- Contributed authors have 15 minutes to present their paper and 3 minutes for discussion, while plenary speakers have 40 minutes to present their paper and 5 minutes for discussion.
- Registration desk will be on the ground floor at the hallway of the Faculty of Economics, open each day of the conference from 08:00 to 18:00.
- Room 1 is located on the ground floor. Rooms 12-14 are located on the 2nd floor with an elevator access. Every room is equipped with a personal computer and a projector to support presentations using Power Point, Word and PDF files.
- All participants will receive a certificate of participation at the KOI 2014. Participants of the TEC Croatia 2014 Workshop (who attend all three parts of the workshop) will receive a certificate of participation at the workshop.

CONTENTS

KEYNOTE SPEAKERS	1
James J. Cochran	2
Goran Lešaja	3
Ali Emrouznejad	4
Janez Povh.....	5
Amir Nakib	6
SPECIAL SECTION IN HONOR OF LUKA NERALIĆ	7
TEACHING EFFECTIVENESS COLLOQUIUM (TEC) Croatia 2014 Workshop	9
PLENARY LECTURES	11
James J. Cochran , How are Analytics and Operations Research Related?.....	12
Goran Lešaja , Interior-Point Methods for Linear Complementarity Problems and Generalizations	13
Ali Emrouznejad , A Systematic Process for Measuring Efficiency of Decision Making Units using Data Envelopment Analysis.....	14
Janez Povh , From Combinatorial Optimization to Real Algebraic Geometry and Back.....	15
Amir Nakib , From Static to Dynamic Metaheuristics: Design and Applications.....	16
CONTRIBUTED PRESENTATIONS - Wednesday, September 24th, 2014.....	17
Session A1 – OR Theory and Application	
Moshe Sniedovich , Decision-Making Under Non-Probabilistic Uncertainty.....	18
Marcin Anholcer , Algorithm for The Nonlinear Generalized Transportation Problem.....	19
Mustafa Tahir Akkoyunlu, Mehmet Cabir Akkoyunlu, Şaban Pusat, Coskun Özkan , Using Artificial Neural Networks in the Prediction of Incorrect Values of Coal Drying Experiments	19
Emil Tustanovski, Mirjana Pejić Bach, Ilko Vrankić , Testing the Sustainability of Croatian Military Forces: System Dynamics Approach	21
Session B1 – Mathematical Programming	
Marek Kvet, Jaroslav Janáček , Min-Max Optimal Public Service System Design	22
Ninoslav Čerkez, Rebeka Čordaš, Mateja Đumić, Domagoj Matijević , Finding an Optimal Seating Arrangement for Employees Traveling to an Event.....	23
Ilker Murat Ar , Evaluating The Innovation Efficiency of European Countries by DEA and Malmquist-TFP Index	24
Ivo Beroš, Joško Meter , An Integer Programming Model for Assigning Students to Elective Courses.....	25
Jaroslav Janáček, Marek Kvet , Min-Max Optimization with Radial Approach to the Public Service System Design with Generalized Utility	26
Session C1 - Multicriteria Decision Making	
Nassim Dehouche, Daniel Vanderpooten , Accounting for Asymmetry between Strengths, Weaknesses, Opportunities and Threats in Decision Making: The SPADE Outranking Approach	27
Yi Qu, Tolga Bektas, Julia Bennell , A Computational Study of Labelling Algorithms for Multi-Objective Shortest Path Problems With or Without Resource Constraints.....	28

Vladimir Korotkov, Kirill Kuzmin, Yury Nikulin , Stability Analysis in Multi-Criteria Discrete Optimization Models: Quantitative and Qualitative Approaches	29
Marija Rukav, Nenad Šuvak, Zoran Tomljanović , Application of Markov Decision Processes in Minimization of the Expected Costs	30
Marko Mladineo, Nenad Mladineo, Nikša Jajac , Project Management in Mine actions Using Multi-Criteria-Analysis-based Decision Support System	31
Session LN1 - Special Section in Honour of Luka Neralić	
Vincent Charles , Satisficing DEA: Bayesian Predictive Analytics for Peer Mining	32
Mohammad Khodabakhshi, Saba Rashidi, Masoud Asgharian, Luka Neralić , Sensitivity Analysis of Input Relaxation Super Efficiency Measure in Data Envelopment Analysis	33
Valter Boljunčić , Improving Efficiency of Efficient Decision Making Unit	34
Yongjun Li, Hengxuan Gao, Liang Liang, Wei Lu , Efficiency Evaluation of Stock Portfolios based on Multiple Risk Measures: a DEA-like Envelopment Approach	35
Lidija Zadnik Stirn , DEA for Performance Evaluation and Benchmarking: Two Case Studies for Optimal Ecosystem Management	36
Session A2 – OR Theory and Application	
Mehmet Cabir Akkoyunlu, Orhan Engin , Harmony Search Algorithm for Solving Hybrid Flow Shop Scheduling Problems	37
Marko Mladineo, Ivica Veza, Nikola Gjeldum , Single-Objective and Multi-Objective Optimization using HUMANT algorithm	38
Vedran Kojić , Solving the Utility Maximization Problem with the Cobb-Douglas and CES Utility Function without the Use of Calculus	39
Darija Marković, Luka Borožan , On The Existence of the Nonlinear Weighted Least Squares Estimate for Some Special Exponential Type Models	40
Session B2 - Mathematical Programming	
Michael Khachay, Ekaterina Neznakhina , Approximation of k-Minimum Hamiltonian Cover Problem	41
Tomislav Marošević, Rudolf Scitovski , Multiple Ellipse Fitting by Center-Based Clustering	42
Heuristic Methods for The Solution of The Tariff Zones Design	43
Engin Pekel, Selin Soner Kara , A Comparison of Tabu Search Algorithm and Mathematical Model in a Pipeline Network	44
Péter Tar, József Smidla, István Maros , Run-time Parameter Tuning of Optimization Systems.	45
Session C2 - Multicriteria Decision Making	
Petra Grošelj, Lidija Zadnik Stirn , Fuzzy Group Decision Support System Based on AHP and SWOT for Solving Natural Resource Management Problem in Slovenia	46
Ivona Gudac, Ivan Marović, Diana Car-Pušić , Performance Concept in Cost-Effective Construction Management of Educational Facilities	47
Tea Poklepović, Zoran Babić , Stock Selection using A Hybrid MCDM Approach	48
Marko Hell, Ivica Zupanović, Dino Pavlić , Cost Effectiveness of ATM's Automatic Deposit Service.....	49
CONTRIBUTED PRESENTATIONS - Thursday, September 25th, 2014.....	
Session A3 - OR Theory and Application	
Debashis Dutta, Pavan Kumar , A Partial Backlogging Inventory Model for Deteriorating Items with Time-Varying Demand and Holding Cost: An Interval Number Approach	52

Raúl Roldán, Rosa Basagoiti, Enrique Onieva , A Framework in the Formulation and Solution of Inventory Routing Problems	53
Erkan Celik, Alev Taskin Gumus , A Mathematical Model for Centralization of Humanitarian Relief Logistics Networks	54
Amany Mohamed Mamdouh, Mohamed M. Saleh, Abd El-Hadi N.Ahmed, Nedaa Mohamed Ezzat Agami , Hybrid Dynamic Cross Impact Analysis with Markov Chain and Trend Impact Analysis.....	55
Andrija Raguž, Kristina Šorić, Ivan Šutalo , Inventory Sharing with Speculations	56
Session B3 - Quantitative Methods in Banking and Finance	
Robert Zenzerović, Martin Valić Vale , From Diagnosis to Prognosis of Financial (In)stability – Auditors’ Opinion Approach.....	57
Tihana Škrinjarić , Testing for Regime-Switching CAPM on Zagreb Stock Exchange	58
Margareta Gardijan, Tihana Škrinjarić , Estimating Investors Preferences towards Portfolio Return Distribution Moments: Empirical Evidence from Croatian Investment Funds.....	59
Jovan Njegić, Nataša Papić Blagojević, Marijana Ćurak , The Application of Portfolio Optimization Methods in Investment Risk Management – Evidence from Zagreb Stock Exchange	60
Boris Radovanov, Aleksandra Marcikić , A Comparison of Four Different Block Bootstrap Methods.....	61
Session C3 – Multicriteria Decision Making	
Nikša Jajac, Ivan Marović, Marko Mladineo , Planning Support Concept to Implementation of Sustainable Parking Development Projects in Ancient Mediterranean Cities	62
Ufuk Bolukbas, Ali Fuat Guneri , Technology Competency Evaluation of the Manufacturing Companies via Multi-Criteria Approaches	63
Danijela Rabar , The Setting of Key Performance Targets for Croatian Shipyards	64
Ivan Marović, Ivica Završki, Nikša Jajac , Ranking Zones Model – A Multicriterial Approach for Spatial Management of Urban Areas	65
Filipe Alvelos, Xenia Klimentova, Ana Viana, Abdur Rais , Maximizing the Number of Effective 2-Cycles in Kidney Exchange Programs.....	66
Session LN2 - Special Section in Honour of Luka Neralić	
Janez Žerovnik , On Local Search Based Heuristics for Optimization Problems.....	67
Renata Sotirov , On Solving Hard Optimization Problems Using SDP	68
Goran Lešaja , Improved Full-Newton-Step Interior-Point Methods for LO and LCP	68
Tunjo Perić, Zoran Babić, Sead Rešić , Analysis of the Applicability of Goal Programming Procedure for Solving Fuzzy Multiobjective Linear Fractional Programming Problems.....	69
Luka Neralić, Richard E. Wendell , Tolerance Sensitivity in DEA	70
Session A4 - OR Theory and Application	
Aleksandra Marcikić, Boris Radovanov , Linear Programming Model for Rostering Ambulance Crew	71
Muhammet Gul, Ali Fuat Guneri , Modeling Emergency Department Patient Surge in Disaster Conditions by Simulation.....	72
Rui Cunha Marques, Pedro Simões , Performance Evaluation and Regulation Influence on the Portuguese Water Sector	73
Pedro Carvalho, Pedro Simões, Rui Cunha Marques , A Market Structure Analysis of the Brazilian Water Sector	74

Sándor F. Tóth, Kai Ross, Weikko Jaross , Integrated Forest Road Maintenance and Harvest Scheduling With Endogenous Costs	75
Session B4 - Quantitative Methods in Banking and Finance	
Mario Pečarić, Snježana Pivac, Josip Visković , Multivariate Approach to Determination of Intermediate Target of Monetary Policy Strategy in CEE Countries.....	76
Audrius Kabašinskas, Kristina Štutienė, Eimutis Valakevičius , Stochastic Programming Framework for Lithuanian Pension Payout Modelling	77
Vlasta Bahovec, Dajana Cvrlje, Irena Palić , Testing the Effects of Financial Literacy on Debt Behavior of Croatian Financial Consumers Using Multivariate Analysis Methods	78
Petar Taleski, Vasko Bogdanovski , Statistical Analyses of Investment and Pension Funds' Performances from South-Eastern Europe.....	79
Alen Stojanović, Branka Jurčević , Measurement of European Banking Industry Cost Efficiency	80
Session C4 - Statistics and Econometrics	
Samo Drobne, Mitja Lakner , Which Distance-Decay Function for Migration and Which One for Commuting? The Case Study of Slovenia	81
Josip Arnerić, Anita Čeh Časni, Marko Čular , Adjusting for a Calendar Effects of Real Retail Trade Turnover Time Series in Croatia.....	82
Ana Perišić , Development Index: Do Weights Matter? An Application of Data-Driven Weights and Restrictions in the Construction of Composite Indicators	83
Ljiljana Miletić , Research and Evaluation of the Effectiveness of E-learning: A Linear Programming Case Study.....	84
CONTRIBUTED PRESENTATIONS - Friday, September 26th, 2014	85
Session A5 - OR Theory and Application	
Helena Gasparis-Wieloch , Modifications of the Omega Ratio for Decision Making Under Uncertainty.....	87
Ksenija Dumičić, Berislav Žmuk, Anita Čeh Časni , Impacts on Internet Booking for Travel and Holiday Accommodation in European Countries: Multivariate Analysis Approach.....	88
Gregory Koronakos, Dimitris Sotiros, Athanasios Zigomitros, Dimitris Apostolou, Dimitris Despotis , A Group Decision Support System for Evaluating the Efficiency of Academic Units ...	89
Mario Jadrić, Maja Čukušić, Antonia Bralić , Comparison of Discrete Event Simulation Tools in An Academic Environment.....	91
Session B5 - Machine Learning, Data Mining and Analytics	
Ivan Vidović, Dražen Bajer, Rudolf Scitovski , A New Fusion Algorithm for Fuzzy Clustering .	92
Petar Taler, Kristian Sabo , Colour Image Segmentation Based on Intensity and Hue Clustering - Least Square and Least Absolute Deviation Approaches Comparison	93
Dajana Ćorić , Customer Segmentation Using Neural Networks	94
Ozren Kubelka, Nikola Ljubešić , Aligning Classification Schemas of the Croatian Encyclopedia and Wikipedia through Supervised Machine Learning.....	95
Martina Briš Alić, Alen Alić, Rudolf Scitovski , Business Clusters in Croatian Furniture Industry	96
Session C5 - Statistics and Econometrics	
Marina Jeger, Zoran Sušanj, Josipa Mijoč , Entrepreneurial Intention Modeling Using Hierarchical Multiple Regression	97
Mirjana Čizmešija, Nataša Kurnoga, Vlasta Bahovec , Liquidity Indicator for The Croatian Economy – Factor Analysis Approach.....	98

Elza Jurun, Nada Ratković, Frano Moro , Baltic Dry Index and Performance Excellence in the Crisis Environment	99
Ivona Milić Beran , System Dynamics Modelling and Simulation of the Intellectual Capital Influence on the Economy Growth in the Republic Of Croatia	100
Nataša Erjavec, Ivana Lolić, Petar Sorić , How (I)Rrational Are We? Case of Croatian Inflation	101
Session LN3 - Special Section in Honour of Luka Neralić	
Violeta Cvetkoska, Elena Naumovska , Measuring the Efficiency of Macedonian Banks: A Non-Parametric Approach.....	102
Majda Bastič, Igor Vrečko , The Model of Firm's Innovation Orientation - Case of Slovenia.....	103
Petr Fiala, Josef Jablonsky , Performance Evaluation of Central European Firms.....	104
Karlo Kotarac, Zrinka Lukač , Assessing the Quality of Academic Staff Using Multiple-Criteria Decision Making	105
Margareta Gardijan, Tihana Škrinjarić , Equity Portfolio Optimization: A DEA Based Methodology Applied on Zagreb Stock Exchange	106
Session A6 - OR Theory and Application	
Kiyoshi Sawada , An Optimal Pair of Members of Forming Relations to a Liaison with Long Communication Lengths in the Same Level of an Organization Structure.....	107
Ilko Vrankić, Mira Krpan, Zrinka Lukač , Approximating the Solution of the Two-Part Tariff Problem	108
Tadej Kanduč, Blaž Rodič , Optimisation of Workshop Layout in a Furniture Development Company	109
Antoaneta Klobučar, Ivona Puljić , Roman Domination Number on Cardinal Product of Paths and Cycles.....	110
Goran Martinović, Domagoj Matijević, Domagoj Ševerdija , An Efficient Parallel Implementations of Approximation Algorithms for Guarding 1.5D Terrains	111
Session B6 - Machine Learning, Data Mining and Analytics	
Ljubica Milanović Glavan, Vesna Bosilj Vukšić, Nikola Vlahović , Decision Tree Learning for Turning Points Detection in Business Process Orientation: Case of Croatia.....	112
Ivana Đurđević Babić , Predicting Students' Course Satisfaction from Log Data in Virtual Learning Environment – Neural Networks and Classification Tree Model	113
Ivan Bekavac, Daniela Garbin Praničević , Web Analytics Tools and Web Metrics Tools: An Overview and the Tool Comparative Analysis	114
Sanja Scitovski, Nataša Šarlija , Cluster Analysis in Retail Segmentation for Credit Scoring	115
Marijana Zekić-Sušac, Adela Has , Discovering Patterns in Market Basket by Hierarchical Association Rules.....	116
Session C6 - Statistics and Econometrics	
Maciej Nowak, Tadeusz Trzaskalik , An Application of Interactive Multiobjective Dynamic Programming in Project Portfolio Selection	117
Irena Palić, Ksenija Dumičić, Petra Šprajcaček , Measuring Real Exchange Rate Misalignment in Croatia: Cointegration Approach	118
Snježana Pivac, Ivana Tadić, Branka Marasović , Application and Development of Human Resource Information System and Electronic Recruitment in Croatian Companies	119
Saša Žiković, Ivana Tomas Žiković, Maja Grdinić , A VECM Approach to Detangling Growth, Export, Import and FDI Knot in Selected CEE Countries	120

Josip Arnerić, Tea Poklepović, Zdravka Aljinović, GARCH Based Artificial Neural Networks in Forecasting Conditional Variance of Stock Returns	121
AUTHORS	123
AUTHOR INDEX.....	137
Publication Ethics and Malpractice Statement	140
About International Conference on Operational Research KOI	142
About Croatian Operational Research Society.....	144

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Education

- 1997 Doctor of Philosophy (Primary Area - Statistics; Support Areas - Operations Research & Mathematics)
- 1986 Master of Business Administration Degree (Concentration: Management Science), Wright State University
- 1984 Master of Science Degree (Social and Applied Economics), Wright State University
- 1982 Bachelor of Science Degree in Business Administration (dual major in Economics and Marketing), Wright State University

Professional Experience

- August 2014 - present Alabama University, Department of Information Systems, Statistics, and Management Science, Culverhouse College of Commerce and Business Administration, Professor of Applied Statistics and the Rogers-Spivey Faculty Fellow
- 2006-2014 Louisiana Tech University, USA, Professor of Quantitative Analysis and Computational Modeling

Additional Info

James J. Cochran has been a faculty member at Wright State University, University of Cincinnati, Drexel University, and Louisiana Tech University. In August 2014 he became a Professor of applied statistics and the Rogers-Spivey faculty fellow at Alabama University. He served as a visiting scholar at a number of universities such as Pole Universitaire Leonard de Vinci, Universidad de Talca, University of South Africa, Stanford University, and Miami University. His research interests include Statistical methods, statistical learning/data mining, computational statistics, sample based and Bayesian optimization, and applications of statistics and operations research to problems from a wide variety of areas including medicine, social & economic development, politics/elections, sports, finance, economics, engineering, marketing, accounting, and education. He has published a number of papers in journals such as *Management Science*, *Journal of Combinatorial Optimization*, *Statistics and Probability Letters*, *Annals of Operations Research*, *European Journal of Operational Research*, *Communications in Statistics - Theory and Methods*, *Interfaces*, and *The American Statistician*. Professor Cochran is also a co-author of 5 books in the area of OR including *Essentials of Business Analytics* (2013). He is the Founding editor of the editor-in-chief of the *Encyclopedia of Operations Research and Management Science*, which received the award "Outstanding Business Reference by the Reference and User Services Association." He has received a number of honors and awards, such as the American Statistical Association Founders Award (2014), Fellow of the American Statistical Association (2011), Mu Sigma Rho Statistical Education Award (2010), INFORMS Prize for the Teaching of OR/MS Practice (2008) and others. Professor Cochran has served as a consultant for many companies, government agencies, and NPOs, and he has chaired the Teaching Effectiveness Colloquium (TEC) workshop in a number of countries including Uruguay, South Africa, Colombia, India, Argentina, Kenya, and Cameroon.

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Education

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Professional Experience

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Goran Lešaja is a Professor at the Department of Mathematical Sciences at Georgia Southern University, Statesboro, USA where he teaches a variety of mathematical and operations research courses. He was also a visiting scholar at several universities such as Technical University of Delft (Netherlands), Georgia Institute of Technology (USA), Yasar University (Turkey). He received Georgia Southern University Award for Excellence in Instruction (2009) and award for Excellence in Service (2011). He is an Associate Editor of the *Asia-Pacific Journal of Operational Research*, and *Croatian Operational Research Review* and has served as a guest editor of the journal *Optimization Methods and Software*. He is also a member of the Editorial Board of several other journals. He served as a session organizer and a member of the Program and/or Organizing Committee of several conferences. His research interests include design and analysis of optimization methods, especially interior-point methods for linear and nonlinear optimization problems, as well as linear and nonlinear complementarity problems, and their generalizations to optimization and complementarity problems over symmetric cones. He has published a number of papers in journals such as *SIAM Journal on Optimization*, *Mathematical Programming*, *Optimization Methods and Software*, *Journal of Optimization Theory and Application*, *Advances in Difference Equations*, and others.

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Education

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Professional Experience

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- 1994-1988 Operational Research and System Group, Warwick Business School, Warwick University, UK, Doctoral researcher
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Ali Emrouznejad is the Business Analytics Team leader at Aston Business School, Aston University, UK. His areas of research interest include performance measurement and management, efficiency and productivity analysis as well as data mining. He has published 4 books, a number of book chapters, and more than 80 papers in scientific journals.

Dr Emrouznejad is Editor of *Annals of Operations Research*, Associate Editor of *Socio-Economic Planning Sciences*, Associate Editor of *IMA journal of Management Mathematics*, Senior Editor of *Data Envelopment Analysis* journal, and member of editorial boards or guest editor in number other scientific journals including *Journal of Operational Research Society*, *EURO Journal on Decision Processes*, *Journal of Medical Systems*, *International Journal of Society Systems Science*, *International Journal of Applied decision Sciences*, *International Journal of Productivity Management*, and *International Journal of Energy Management Sector*.

He is author of the book on “Applied Operational Research with SAS”, editor of the books on “Performance Measurement with Fuzzy Data Envelopment Analysis” and the book on “Managing Service Productivity”. He is also co-founder of Performance Improvement Management Software (PIM-DEA) [see <http://www.DEAsoftware.co.uk>] and the author of the DEA website (<http://www.DEAzone.com>), which is the richest resource of DEA methodology, courses, tutorials, software, and DEA community.

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Education

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Additional Info

Janez Povh is an Associate professor and the dean of the Faculty of Information Studies in Novo mesto, Slovenia where he teaches several mathematical and statistical courses. He is also a visiting professor at Faculty of Mathematics and Physics, University of Ljubljana (Slovenia), Faculty of Economics, University of Vienna (Austria), Eötvös Loránd University (Hungary). His research interests include application of semi definite programming in combinatorial optimization and real algebraic geometry. His main interest in last years is study of positivity of commutative and non-commutative polynomials and optimization of these polynomials using hierarchies based on sum-of-squares. He is coauthor of software package NCsostools for factorizing and optimization of non-commutative polynomials. He also participates in various projects such as Metric and topological graph theory - ARRS, The algorithms for the analysis of the allocation of sites - ARRS, Graph's minors, plots graphs and networks - ARRS, Algorithmic Discrete Optimization Network - Adonet - EU (Alpen Adria University Klagenfurt, Austria), and others. He received a special Krka's prize for his doctoral dissertation in 2007. His publication activity includes two scientific monographies, two books, more than 50 scientific papers with many of them published in high quality journals like *Mathematical programming*, *Siam journal on optimization*, *Journal of global optimization*, *Optimization letters*, *Computational optimization and applications*, *Journal of optimization theory and applications* and other publications. He also serves as a guest editor of the *Central European Journal of Operations Research*, and the editor of several conference proceedings.

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Education

- 2004-2007 PhD in Computer Science, Université Paris 12 (France).
 Dissertation: Developing of new metaheuristics for images segmentation.
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- 2003-2004 Masters in Research. in Electronics, major: signals, systems and images,
 Université Paris6 (France).
- 2001-2003 Master Degree in Industrial Control, Diplôme de Magistère Contrôle
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Professional Experience

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Additional Info

Amir Nakib is an Associate professor at Université Paris Est where he teaches Image and signal processing, Optimization, Industrial networks, and C/C++ programming courses. His research interests include dynamic optimization, optimization, metaheuristics, image processing, signal processing, medical imaging, and indoor location. He is a co-author of the book "Metaheuristics for Dynamic Optimization" published by Springer Verlag in 2013. He also published four chapters in books and a number of papers in journals and conference proceedings. Some of his papers are published in *Applied Mathematical Sciences*, *Journal of Heuristics*, *Computer Networks*, *International Journal of Applied Metaheuristic Computing*, *Pattern Recognition Letters*, *Signal Processing*, and other journals. He supervised a number of master and doctoral theses. He also served as a reviewer and a chair at a number of conferences. Some of the projects that Dr. Amir Nakib is/was leading are: CIFRE with BULL, "Optimal resource allocation under energy constraints", ESME School and Rothschild Foundation, "Study of the MAV", CIFRE with BULL, "Optimal scheduling for hybrid parallel computation", and others.

SPECIAL SECTION IN HONOR OF LUKA NERALIĆ

Section Editor: Zrinka Lukač

Born on October 16, 1943, Luka Neralić is one of the founders of the Croatian Operational Research Society and was its first president (from 1992 to 1996). For his special contribution to the development of the society and the area of operational research in Croatia and abroad, he received a CRORS Distinguished Service Award in 2013. The special section is organized on occasion of professor Neralić's 70th birthday and is dedicated to the areas of his research interest, such as Data Envelopment Analysis (DEA) and related areas.

Luka Neralić



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Education

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Professional Experience

- 2002-present Ful Professor (permanent position), Faculty of Economics and Business, University of Zagreb, Croatia
- 1998-2002 Ful Professor, Faculty of Economics and Business, University of Zagreb, Croatia
- 1991-1998 Associate Professor, Faculty of Economics, University of Zagreb, Croatia
- 1980-1991 Assistant Professor, Faculty of Economics, University of Zagreb, Croatia
- 1967-1980 Teaching Assistant, Faculty of Economics, University of Zagreb, Croatia
- 1966-1967 Teaching Assistant, Department of Mathematics, University of Zagreb, Croatia

Additional Info

Professor Luka Neralić was the initiator and a founder of the Croatian Operational Research Society, the first CRORS president in two mandates, and is a member of the CRORS Executive Committee. He put long-term enthusiastic efforts in promoting the area of operational research at Croatian academic community by developing courses, seminars, conferences and postgraduate programs in the area of operational research. He also contributed to the inclusion and reputation of the CRORS in international professional organizations EURO, IFORS and INFORMS. Luka Neralić received the Charter of recognition for CRORS from Elise A. Del Rosario (IFORS President) in Sandton, South Africa, 2008. He also established a close collaboration of CRORS with Slovenian Society of Informatics, Section of Operations Research (SOR). His areas of research interest include Data Envelopment Analysis (DEA),

linear programming, parametric programming, multi-objective programming, sensitivity and stability analysis. He has published 3 books, 4 chapters in books, a number of papers in journals and conference proceedings, professional papers, and other publications. His papers are published in Journal of the Operational Research Society, International Journal of Statistics and Management Systems, Mathematical Communications, Mathematical Methods of Operations Research, Optimization, European Journal of Operational Research, and other journals. In his scientific work, he closely collaborated with distinguished researchers in the area of OR, such as R. E. Wendell, Th. Jongen, O. Stein, S. Zlobec, A. Charnes, and others. He was a visiting professor at University of Texas, chaired many conferences in OR, and received a number of research grants. He is a co-editor of the Central European Journal of Operations Research, and an associate editor of the Data Envelopment Analysis Journal. He is also a member of INFORMS, CROORS and Croatian Mathematical Society.

The Special Section in Honor of Luka Neralić consists of 15 papers that are presented at the KOI 2014 conference:

Vincent Charles, Satisficing DEA: Bayesian Predictive Analytics for Peer Mining

Mohammad Khodabakhshi, Saba Rashidi, Masoud Asgharian, Luka Neralić, Sensitivity Analysis of Input Relaxation Super Efficiency Measure in Data Envelopment Analysis

Valter Boljunčić, Improving Efficiency of Efficient Decision Making Unit

Yongjun Li, Hengxuan Gao, Liang Liang, Wei Lu, Efficiency Evaluation of Stock Portfolios based on Multiple Risk Measures: a DEA-like Envelopment Approach

Lidija Zadnik Stirn, DEA for Performance Evaluation and Benchmarking: Two Case Studies for Optimal Ecosystem Management

Janez Žerovnik, On Local Search Based Heuristics for Optimization Problems

Renata Sotirov, On Solving Hard Optimization Problems Using SDP

Goran Lešaja, Improved Full-Newton-Step Interior-Point Methods for LO and LCP

Tunjo Perić, Zoran Babić, Sead Rešić, Analysis of The Applicability of Goal Programming Procedure for Solving Fuzzy Multiobjective Linear Fractional Programming Problems

Luka Neralić, Richard E. Wendell, Tolerance Sensitivity in DEA

Violeta Cvetkoska, Elena Naumovska, Measuring The Efficiency of Macedonian Banks: A Non-Parametric Approach

Majda Bastič, Igor Vrečko, The Model of Firm's Innovation Orientation - Case of Slovenia

Petr Fiala, Josef Jablonsky, Performance Evaluation of Central European Firms

Karlo Kotarac, Zrinka Lukač, Assessing the Quality of Academic Staff Using Multiple-Criteria Decision Making

Margareta Gardijan, Tihana Škrinjarić, Equity Portfolio Optimization: A DEA Based Methodology Applied on Zagreb Stock Exchange

TEACHING EFFECTIVENESS COLLOQUIUM (TEC) Croatia 2014 Workshop

The Teaching Effectiveness Colloquium (TEC) workshop is organized in conjunction with the KOI 2014 conference with the aim to enhance the quality of teaching OR courses at universities.

The following lectures will be given at the TEC Workshop 2014 in Croatia:

1. **Modeling for Insights**
Instructor: prof. Jeffrey D. Camm, University of Cincinnati, USA
2. **Excel-Based Tools for Teaching Analytics**
Instructor: prof. Michael J. Fry, University of Cincinnati, USA
3. **Engaging and Re-Engaging Students with Active Learning**
Instructor: prof. James J. Cochran, University of Alabama, USA

Jeffrey D. Camm

Jeffrey D. Camm is the Head of the Department of Operations, Business Analytics, and Information Systems at University of Cincinnati, and Director of the Center for Business Analytics at the same university. He was a visiting professor at Dartmouth College and Stanford University. He earned his BS from Xavier University, Cincinnati, in Mathematics, Summa Cum Laude, 1980, and PhD in Management from Clemson University, Clemson, South Carolina 1984. He coauthored six books, and a number of research papers in relevant journals such as Journal of Combinatorial Optimization, Interfaces, Management Science and others. He received a number of awards, such as INFORMS Prize for the Teaching of OR/MS Practice, 2006 and others.

Michael J. Fry

Michael J. Fry is an Associate Professor with Tenure at Department of Operations, Business Analytics & Information Systems, University of Cincinnati, as well as the Assistant Director of the Center for Business Analytics, University of Cincinnati. He earned M.S.E. in Industrial and Operations Engineering, University of Michigan in 1998, and a PhD degree in Industrial and Operations Engineering, University of Michigan in 2002. He is the author of four books, several book chapters, and has published a number of papers in relevant journals such as European Journal of Operational Research, Operations Research, Manufacturing & Service Operations Management, and others.

James J. Cochran

James J. Cochran received M.B.A. in 1985 from Wright State University. He then earned a Ph.D. in Quantitative Analysis from the University of Cincinnati in 1997. Currently an Associate Professor at Louisiana Tech University, he has previously been on the faculty at Wright State University, Drexel University, Miami University, and Stanford University. He has published a number of papers in journals, 5 books, and other publications in the area of OR. He received a number of awards, such as INFORMS Prize for the Teaching of OR/MS Practice, 2008 and others.

15th International Conference on Operational Research KOI 2014

PLENARY LECTURES

September 24 – 26, 2014
Osijek, Croatia

Wednesday September 24th, 2014
Plenary Lecture 1, Room 1 (10:15-11:00)

How are Analytics and Operations Research Related?

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Abstract

For a variety of interesting reasons, the concept of analytics has begun to resonate with businesses and governments, which has led to its emergence in academia and growing interest by students. But what does analytics mean and what are the ramifications of these developments for operations research? Is Operations Research = Analytics? Is Operations Research \subset Analytics? Is Analytics \subset Operations Research? Is $|\text{Operations Research} \cap \text{Analytics}| = \emptyset$?

In this talk we consider various ways to define the term analytics, discuss the immediate and short term implications for operations research, and demonstrate of how some of the speaker's various research efforts fit into analytics. We also consider the future of analytics and what its continued growth and evolution may mean for operations research.

Keywords: *analytics, operations research, business analytics, implications, future*

Wednesday September 24th, 2014
Plenary Lecture 2, Room 1 (14:00-14:45)

**Interior-Point Methods for Linear Complementarity Problems and
Generalizations**

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Abstract:

A class of Linear Complementarity Problems (LCP) is an important class of problems closely related to many important and frequently used optimization problems. Thus, efficient algorithms for solving LCP are of the interest for theoretical and practical purposes.

In the first part of the talk Feasible Interior-Point Methods (IPM) based on the class of eligible kernel functions will be presented. This class of kernel functions is fairly general and includes the classical logarithmic function, the prototype self-regular function, and non-self-regular kernel functions as special cases. It will be shown that the methods globally converge and iteration bounds to obtain epsilon-approximate solution match best known iteration bounds for these types of methods. In particular, one of the main achievements of the kernel-based IPMs is the improved complexity of long-step methods leading to the significant reduction of the theoretical complexity gap between long-step and short-step algorithms.

In the second part of the talk generalizations of these methods to Linear Complementarity Problems over symmetric cones will be considered. A remarkable and surprising result has been shown recently: The algebraic structure of Euclidean Jordan Algebras and associated symmetric cones are connected to important optimization problems and can serve as a unifying frame to analyze IPMs for semi definite optimization problems, second order cone optimization problems, and classical optimization problems over nonnegative orthant. Using carefully tools of EJA and symmetric cones it is shown that generalizations of the kernel based IPMs for LCP over symmetric cones still possess the best known complexity achieved for the LCPs over nonnegative orthant.

Keywords: *Linear Complementarity Problems, Interior-Point Methods, Kernel functions, Euclidean Jordan algebras and symmetric cones, polynomial complexity*

Thursday September 25th, 2014
Plenary Lecture 3, Room 1 (8:30-9:15)

**A Systematic Process for Measuring Efficiency of Decision Making
Units using Data Envelopment Analysis**

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Abstract

In large and complicated organizations, a standard process could facilitate performance assessment and help 1) to translate the aim of the performance measurement to a series of small tasks 2) to select homogeneous DMUs and suggest an appropriate input/output selection 3) to detect a suitable model 4) to provide means for evaluating the effectiveness of the results, and 5) to suggest a proper solution to improve the efficiency and productivity of entities.

This paper proposes a systematic process for measuring efficiency of DMUs. The proposed framework helps to link different tools and different people with diverse skills and backgrounds, in order to work on an efficient and effective project.

Keywords: *Data Envelopment Analysis, performance measurement, COOPER framework*

Friday September 26th, 2014
Plenary Lecture 4, Room 1 (8:30-9:15)

**From Combinatorial Optimization to Real Algebraic
Geometry and Back**

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Abstract

The combinatorial optimization problems date back to the famous Four colouring theorem in 1850s and now consist of all optimization problems where the feasible set is a large discrete combinatorial set. Classical combinatorial optimization problems are e.g. Linear and Quadratic assignment problem, Max cut problem, Travelling salesman problem,...

There are several approaches how to solve them. Good solutions can be obtained by applying appropriate heuristics, like tabu search, simulated annealing etc. Optimal solutions are reachable in practice only for special instances of the problems (e.g. Max cut problem for planar graphs) or for small instances. If the instance is not small enough we typically run branch and bound or branch and cut algorithms, which both rely on linear or semidefinite programming relaxations.

Real algebraic geometry deals with a question if a given real polynomial f in n variables belongs to set $P = \{f | f(x) \geq 0 \text{ for all } x \in S\}$,

where

$$S = \{x \in R^n | g_1(x) \geq 0, \dots, g_k(x) \geq 0\}$$

and g_i are real polynomials in n variables. The motivation for this type of problems goes back to Hilbert and its famous 17th problem, announced in 1900. Several results, known under the name Positivstellensatz, provide algebraic certificates for non-negativity, based on polynomials with non-negative coefficients or sum of squares. Searching for such certificates with fixed degree can be done by linear or semidefinite programming. By increasing the degree of certificates we obtain a natural hierarchy of tractable inner approximations of the set P .

In the lecture we will present the development of results in combinatorial optimization and real algebraic geometry and demonstrate how each of these two areas influenced the other area and what is current situation on both areas.

Keywords: *combinatorial optimization, real algebraic geometry, linear and semidefinite programming*

Friday September 26th, 2014
Plenary Lecture 5, Room 1 (14:00-14:45)

From Static to Dynamic Metaheuristics: Design and Applications

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Abstract

Dynamic metaheuristics of optimization (DMO), or the study of applying metaheuristics algorithms to dynamic optimization problems (DOPs), is an active research topic and has increasingly attracted interest from the metaheuristic community. The field is relatively young as most of the studies have been made in the last 20 years with the exception of a few early works. Due to its relatively young age, the field still has a lot of open areas with open research questions, of which perhaps one of the most important questions is about how well academic DMO research reflects the common characteristics of DOPs and if there are any types of DOPs that have not been covered by current academic research. The main purpose of this work is to investigate this important issue and to propose solutions.

Indeed, our interest is focused on dynamic optimization problems (DOPs), which are solved online by an optimization algorithm. In other terms, time-dependent problems that are solved in a dynamic way, i. e. new solutions are produced to react to changes over the time are considered. The other cases where the future changes can be completely integrated into a static objective function, or a single robust-to-changes solution can be provided, or only the current static instance of the time-dependent problem is taken into account, then the problem can be solved using static optimization techniques and hence is no longer of interest to MDO.

The performance of dynamic optimization algorithms in the literature is improving, and many research directions can be further investigated in order to obtain even more efficient algorithms. In our work, a new approach for design algorithms for dynamic continuous optimization was proposed. The approach is based on cooperative search strategies. It makes use of a population of coordinated local searches to explore the search space.

Keywords: *local search, metaheuristics, dynamic optimization, multi-agent, optimization*

**CONTRIBUTED PRESENTATIONS -
Wednesday, September 24th, 2014**

Wednesday September 24th, 2014
Session A1 – OR Theory and Application, Room 12 (11:30-13:00)

Decision-Making Under Non-Probabilistic Uncertainty

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Abstract

Decision makers, engineers, military commanders, entertainers, managers, politicians, indeed people in all walks of life, regularly need to deal with a non-probabilistic uncertainty, that is, an uncertainty that, for whatever reasons, is not quantified probabilistically. In fact, even if the uncertainty is, or can be, quantified probabilistically, it is often desirable, indeed required, sometimes mandatory, to conduct a non-probabilistic analysis of the problem considered, for instance a non-probabilistic worst-case analysis.

Unsurprisingly, therefore, methodologies designed to handle a non-probabilistic uncertainty, often prescribing a worst-case analysis of some sort, have long been used routinely to model, analyze and design economic, management, and engineering systems. In many disciplines, the predominant worst-case oriented methodology employed to tackle decision/design under a non-probabilistic uncertainty has been, and remains, Wald's maximin paradigm (circa 1940).

It is against this background that, I review in this presentation the use, and misuse, of worst-case analysis models in the treatment of non-probabilistic uncertainty, in fields such as operations research, robust optimization, control theory, economics, finance, mechanical engineering, ecology, and biosecurity.

It seems that the culprit that is often implicated in the misguided handling of non-probabilistic uncertainty is the lack of appreciation of the ostensibly self-evident difference between a local and a global analysis, specifically the difference between a local and a global robustness analysis. To expound this claim we examine here the role and place of radius of stability models (1960) in the treatment of non-probabilistic uncertainty. We illustrate that due to their inherently local orientation, models of this type are unsuitable for tackling non-probabilistic problems that are characterized by a vast uncertainty space and a likelihood-free quantification of uncertainty.

Our main conclusion is that verbal narratives, namely rhetoric, about the paradigms proposed for dealing with a non-probabilistic uncertainty, ought to reflect accurately the mathematical models employed to quantify the uncertainty. For one thing, this rhetoric must not employ terminology and concepts that are associated with probabilistic models of uncertainty, but which are ill-defined, in the context of non-probabilistic models of uncertainty and might therefore be open to misinterpretation.

Keywords: *uncertainty, decision-making, robustness, Worst-Case Analysis, Maximin*

Wednesday September 24th, 2014
Session A1 – OR Theory and Application, Room 12 (11:30-13:00)

Algorithm for The Nonlinear Generalized Transportation Problem

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Abstract

The Generalized Transportation Problem is a well-known generalization of the ordinary Transportation Problem, where the amounts of goods change during the delivery process. We consider a version of this problem, where the transportation costs and costs associated with the destination points are nonlinear. We present a general model of such a problem, and then provide an effective solution method.

Keywords: *nonlinear generalized transportation problem, stochastic generalized transportation problem, Equalization method*

Wednesday September 24th, 2014
Session A1 – OR Theory and Application, Room 12 (11:30-13:00)

**Using Artificial Neural Networks in the Prediction of Incorrect Values
of Coal Drying Experiments**

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Abstract

Coal drying is quite important from both theoretical and practical perspective. Therefore, coal drying experiments is one of the most important issues to work on academics. Also be made of those experiments because of the expensive laboratory equipment and necessity of considerable time are quite costly. Even if economic costs of experiments would be acceptable, sometimes long period of experiments can cause certain serious problems for academics.

During experimental studies, researchers observe the results which are converting it into graphical form. However when creating charts, some of the results are diverging from the others is observed abnormally. In order to eliminate these abnormalities, certain experiments should be repeated. Due to the high cost and time constraints, repetition of these experiments is not suitable for researchers. Estimation of these deviations is possible using Artificial Neural Networks which is one of the scientific methods. With using this technique the researchers can obtain quite successful scientific results with acceptable deviations.

Keywords: *coal drying, Artificial Neural Network*

Wednesday September 24th, 2014
Session A1 – OR Theory and Application, Room 12 (11:30-13:00)

Testing the Sustainability of Croatian Military Forces: System Dynamics Approach

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Abstract

The events of 9/11 and the subsequent wars in Afghanistan and Iraq brought attention to the requirements of asymmetric and urban warfare, in addition to highlighting international terrorism as a growing threat to global security. The rapid technological advancement in the fields of electronics and communication opened new challenges to defense doctrines by introducing robotics and ‘intelligent’ weaponry to the battlefield. Introduction of sterner budgetary constraints brought the cost-effectiveness of military programs back in the eye of the public. Due to changes in the geopolitical environment, as well as the economic challenges set by the global financial crisis, there have been priority shifts in the national security strategies. In most cases, it meant reductions in manpower and additional spending, while maintaining or even improving national security through optimization of the use of available resources. In line with the global trends, Croatian military is also going through the transformation, but one that is currently being stifled by a long recession and negative demographic trends. The purpose of this article is to outline the possibilities for the usage of system dynamics models in testing the sustainability of Croatian military forces according to the size and composition. The main focus of the article is on the demographic trends and their implications on the Croatian military forces. After a brief exposition of the research done in this field so far, two models are developed in the article – a demographic model and a recruitment model of military forces. Two models were carefully tested using validation tests suitable for system dynamics modelling. After the validation, the models were merged into one integral system dynamics model of Croatian military forces. Three experiments were conducting based on the different values of fertility, and impact of demographic trends, which emerge from the different fertility level, was tested. The results of the simulation based on the use of the demographic data from the Census of 2011, as well as estimates for the data which was not accessible at the time, suggest that the Croatian military could have trouble meeting its demands for recruits in the next 20-30 years. Additional implications of the current demographic trends on the sustainability of the Croatian military forces are discussed in the end. Since the basic inputs for any organization (civilian and military alike) are labor and capital, the problem is addressed from two complementary perspectives: a demographic perspective and a financial one.

Keywords: *system dynamics, military forces, demography, fertility*

Wednesday September 24th, 2014
Session B1 - Mathematical Programming, Room 13 (11:30-13:00)

Min-Max Optimal Public Service System Design

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Abstract

A public service system structure is usually formed by location of limited number of service centers and the associated objective is to minimize total disutility like social costs, which are proportional to the distances travelled by all users to the nearest service center. In such case, the weighted p-median problem with min-sum criterion is solved. In many cases such criterion leads to the situation, when the average disutility is minimal, but the disutility of the worst situated user is extremely high, what is considered unfair design. To avoid this unfair situation various schemes of fairness are applied. The strongest fairness criterion in the public service system design consists in the process, when the disutility of the worst situated users is minimized first and then disutility of better located users is optimized under the condition that the disutility of the worst situated users does not worsen, what is called lexicographical minimization. The first step of the process is called min-max optimal public service system design. In this contribution we focus on a solving method for the first step, which seems to be the most time consuming part of the lexicographical optimal public service system design according to our preliminary experiments. The keystone of the studied solving method consists in radial formulation of the weighted p-median problem, which outperforms approaches using the location-allocation formulation. Attempts at solving real instances, characterized by hundreds or thousands of possible service center locations, often fail due to enormous computational time or huge memory demands, when using a location-allocation model. Radial formulation of the problem enables its implementation in a frame of commercial optimization software to obtain near-optimal solution in a short term. The main goal of this study is to show how suitable chose of the solving method for min-max optimal public service system design can save computational time.

Keywords: *Min-Max approach, radial formulation, public service system*

Wednesday September 24th, 2014
Session B1 - Mathematical Programming, Room 13 (11:30-13:00)

**Finding an Optimal Seating Arrangement for Employees Traveling to
an Event**

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Abstract

Let A denote the set of n employees working in some company and let $B \subseteq A$ denote the employees with assigned company vehicle. The problem is to find the “cheapest” way of organizing a visit of employees to an event satisfying the following requirements:

- a) Employees with assigned company vehicles will ‘prefer’ to use their vehicles for traveling to an event
- b) Company owns additional vehicles that can be put on a disposal to their employees
- c) Employees may use their personal vehicles if no company vehicles are available at the desired time
- d) Each vehicle has its own capacity
- e) Employees may use the public transport such as train, bus or airplane, if no other options are available
- f) Each employee is free to choose the time for traveling to, and time for traveling back from an event depending on her/his selfish reasons.

Our task is to assign each employee to a certain vehicle on the way to an event and back (note that this need not be the same vehicle), satisfying the above set of constraints, and such that the overall cost of such an assignment is minimal (“cheapest”) in terms of overall number of vehicles needed.

By our knowledge, Croatian software company IN2 was the first one to raise importance of this practical problem.

We formulate the problem as a non-trivial integer linear program, managing to avoid the use of vehicle-employee assignment variables, which dramatically reduced the dimension of the problem. As a result, we demonstrate that the problem can be efficiently solved in practice on different testbeds despite the fact that theoretically it is not clear that the problem in general is polynomially solvable, with the use of standard methods, such as cutting plane and branch and bound methods. For empirical test, we used the state-of-the art integer-programming solver GUROBI. We also tested our algorithm on a real-world instance, provided by courtesy of IN2 d.o.o.

Keywords: *scheduling problem, integer linear program, GUROBI*

Wednesday September 24th, 2014
Session B1 - Mathematical Programming, Room 13 (11:30-13:00)

**Evaluating The Innovation Efficiency of European Countries by DEA
and Malmquist-TFP Index**

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Abstract

While withstanding a highly competitive environment, an increasing number of countries have recognized that innovation is an important issue to achieving competitive advantages. Although the importance of innovation in ensuring superior competitive advantages is well accepted, exactly how it is developed with national policy. So, determination or selection of right national innovation policy has become a critical issue for the European countries. Accordingly, this study analyses the relative innovation efficiency of European countries from 2006 to 2011 by using the DEA and Malmquist-TFP Index. It uses four inputs as SMEs innovating in-house, innovative SMEs co-operating with others, innovation expenditures, SMEs using organisational innovation. However, it used two different outputs as applications (sales of new-to-market products, sales of new-to-firm products, and exports of high technology products) and intellectual property (EPO patents, USPTO patents, triadic patent families, new community trademarks, and new community designs). So, this study analyses the two different models, one of them considers the output as applications other is intellectual property. The results of these analyses provide some policy implications for countries. Moreover, the results of this study provide a valuable reference for future studies in alternative contexts.

Keywords: *innovation, European countries, DEA, Malmquist-TFP Index*

Wednesday September 24th, 2014
Session B1 - Mathematical Programming, Room 13 (11:30-13:00)

An Integer Programming Model for Assigning Students to Elective Courses

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Abstract

This paper deals with the problem of assigning students to elective courses according to their preferences. In the process of assigning students to the elective courses according to their preferences, academic institutions commonly deal with many obstacles, the most typical being a limited number of students who can be assigned to any particular class. Also, due to financial or technical reasons, it is possible that the maximum number of the elective courses is determined in advance, so that the institution has to make the decision which courses to carry out. Therefore, it is not realistic to expect that all the students will be assigned to the courses which are their first choices (perfect satisfaction).

This paper presents an integer programming model which maximizes total student satisfaction subject to the number of different constraints. The measure of the student satisfaction is based on students' order of preference according to the principle: *the higher choice met – the higher satisfaction obtained*. Following the basic model, several versions of the models are generated for covering possible real-life situations, taking into consideration the way the student satisfaction is measured, as well as the academic institution's preferences within the possible technical and financial constraints.

Keywords: *integer programming, multi-unit assignment, elective courses*

Wednesday September 24th, 2014
Session B1 - Mathematical Programming, Room 13 (11:30-13:00)

**Min-Max Optimization with Radial Approach to the Public Service
System Design with Generalized Utility**

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Abstract

The paper deals with the public service system design, where the generalized utility is considered. On the contrary to the former formulations, the generalized utility defined for a public service system assumes that the user's utility comes generally from more than one located service center and the individual contributions from relevant centers are weighted by reduction coefficients depending on a center order. Real instances of the public service system design problem are characterized by a big number of possible facility locations. The classical approaches to the related problems make use of location-allocation model. Complexity of location-allocation problems considerably grows with the number of possible locations and so commercial IP-solvers often fail due to enormous computational time or extreme memory demands. A public service system structure is usually formed by location of limited number of service centers and the associated objective is to maximize the total utility. In many cases such criterion leads to the situation, when the average utility is maximal, but the utility of the worst situated user is extremely small, what is considered unfair design. To avoid this unfair situation various schemes of fairness are applied. The strongest fairness criterion in the public service system design consists in the process, when the utility of the worst situated users is maximized first and then utility of better located users is optimized under the condition that the utility of the worst situated users does not worsen, what is called lexicographical maximization. The first step of the process is called max-min optimal public service system design. In this contribution we focus on a solving method for the first step, which seems to be the most time consuming part of the fair optimal public service system design according to our preliminary experiments. The main goal of this study is to develop an effective max-min approach for the public service system design with the generalized utility, which originates from more than one service center.

Keywords: *public service system, generalized utility, Max-Min approach, radial formulation*

Wednesday September 24th, 2014
Session C1 - Multicriteria Decision Making, Room 14 (11:30-13:00)

**Accounting for Asymmetry between Strengths, Weaknesses,
Opportunities and Threats in Decision Making: The SPADE Outranking
Approach**

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Abstract

Numerous organizations use SWOT analysis as part of their strategic planning process. The simplicity of this framework is one of the reasons for its popularity, but it is also a downfall. The framework itself being only a knowledge capture exercise, it naturally leads managers to the question of "what to do with the results of a SWOT Analysis".

In this paper, we propose a new multicriteria outranking method that aims at answering the post-SWOT question by consolidating SWOT analysis with sound decision-theoretic techniques, and making use of its results to support decision-making.

From a preference modelling point of view, the main contribution of this paper consists in discussing and modelling the asymmetrical nature of evaluation criteria notably relevant in strategic planning, project portfolio management and complex systems management. We also guarantee the theoretic validity of our approach, by showing that it possesses desirable properties such as monotonicity. This allows for a reduced implementation time and thus a real-time use of the system. In practice, we illustrate its application through a comparative study with two popular multicriteria decision aid methods, on a set of real data regarding a power plant siting problem.

Keywords: *decision support systems, Multi-Criteria Decision Analysis, outranking approaches, strategic planning, project portfolio management*

Wednesday September 24th, 2014
Session C1 - Multicriteria Decision Making, Room 14 (11:30-13:00)

A Computational Study of Labelling Algorithms for Multi-Objective Shortest Path Problems With or Without Resource Constraints

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Abstract

The multi-objective shortest path problems (MSPP) and the constrained multi-objective shortest path problem (CMSPP) are extensions of the classical SPP, both of which find a wide range of practical applications. This paper describes and presents a numerical comparison of a number of labeling algorithms for the MSPP and the CMSPP. The algorithms include label correcting and setting.

Extensive computational comparison results are presented on three types of networks, namely full, acyclic and random, which show the superiority of label correcting algorithms for both the MSPP and the CMSPP.

Keywords: *Multi-Objective Shortest Path Problem, label setting algorithms, label correcting algorithms, Constrained Shortest Path Problems*

Wednesday September 24th, 2014
Session C1 - Multicriteria Decision Making, Room 14 (11:30-13:00)

**Stability Analysis in Multi-Criteria Discrete Optimization Models:
Quantitative and Qualitative Approaches**

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Abstract

We concentrate on studying the behavior of Pareto optimal solutions under small perturbation of original problem data in some multi-criteria models of discrete optimization. Two approaches are highlighted and scrutinized. Computational tractability of both approaches is discussed.

The first (qualitative) approach consists in finding necessary and sufficient conditions which preserve solutions optimality in a class of predetermined perturbed problems for a generic multi-criteria combinatorial (trajectory) optimization problem. We describe the regularity properties which have to be required from the multiple criteria (objectives) in order to guarantee the property of stability (no new optima appear) and quasi-stability (all original optima are preserved).

The second (quantitative) approach deals with finding some bounds on numerical stability measures. This approach is illustrated using a vector discrete portfolio optimization model. We specify attainable lower and upper bounds on the supreme level of independent perturbations which do not eliminate Pareto optimality of one given efficient solution (investment portfolio). Various metrics in the space of perturbed parameters (risks, market states etc.) are analyzed. Numerical examples illustrate the difference.

Keywords: *Multi-Criteria Analysis, Pareto optimality, stability measures, stability conditions, Qualitative and Quantitative approaches, trajectory problem, Boolean investment*

Wednesday September 24th, 2014
Session C1 - Multicriteria Decision Making, Room 14 (11:30-13:00)

**Application of Markov Decision Processes in Minimization of the
Expected Costs**

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Abstract

Basics of Markov decision processes will be introduced in order to obtain the optimization goal function for minimizing the long-term expected costs of some system. The system that we consider is based on farmer's costs caused by optimal replacement policy of milk cows using their lactation status.

The transition probability matrix of the Markov process will be estimated from the data simulated from the lactation model that is often used in practice. We want to choose the optimal actions for the respective lactation states when considering the farmer's costs. Originally this problem can be solved by exhaustive enumeration of all possible cases in order to obtain optimal policy that minimizes the long-term expected costs. This is feasible for small number of states, but generally this problem can be approached in the linear programming setting which yields the efficient solution. In order to demonstrate and compare these two approaches we also present an example based on the simulated lactation data.

Keywords: *Markov Decision Processes, expected costs, linear programming*

Wednesday September 24th, 2014
Session C1 - Multicriteria Decision Making, Room 14 (11:30-13:00)

Project Management in Mine Actions Using Multi-Criteria-Analysis-Based Decision Support System

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Abstract

In this paper Web-based Decision Support System (Web DSS), that supports humanitarian demining operations and restoration of mine-contaminated areas, is presented. The financial shortage usually triggers a need for priority setting in Project Management in Mine actions. As a part of FP7 Project TIRAMISU, a specialized Web DSS has been developed to achieve fully transparent priority setting process. It allows stakeholders and donors to actively join decision making process using user-friendly and intuitive Web application. The main advantages of this Web DSS are its unique way of managing mine action project using Multi-Criteria Analysis (MCA) in order to select priorities for demining actions. First of all, most of the MCA data (i.e. most of the criteria evaluations) are generated directly from Geographic Information System (GIS). Second, MCA is performed using PROMETHEE method, so criteria evaluations do not need to be "converted" (i.e. one criterion can have unit: square meters of area, other criterion can have unit: number of victims). Third, many different type of stakeholders can be included in assessment of criteria weights needed for PROMETHEE method, so the results of MCA will be acceptable to everyone. All these advantages make this DSS very economical and efficient. Using this DSS suspected minefields with highest priority will be demined first. That will decrease number of new potential victims, and that will demine areas with highest potential of economic or social usage. Demining actions which are only "demining of the landscape" will have lowest priority. So, enormous potential economic growth and social welfare can be achieved using this DSS. Furthermore, DSS seems to be very efficient for both functional connection between hierarchic decision levels and determination of the objective priorities. For each problem level, a specific evaluation procedure for criteria and action (solution) is developed. At each decision level a separate set of actions (projects for humanitarian demining of socio-political entities, such as counties, municipalities, villages, mine fields, homogenous areas, etc.) could be created by GIS, and evaluated with multicriteria analysis. The hierarchic approach is very useful because, at each level, it makes distribution of money for the humanitarian demining of mine-affected counties easier by simulating results attained from multicriteria analysis. Developed Web DSS allows decision makers to use several predefined scenarios (different criteria weights) or to develop their own, so it allows project managers to compare different demining possibilities with ease.

Keywords: *Decision Support System, project management, Multi-Criteria Analysis, PROMETHEE method, Geographic Information System*

Wednesday September 24th, 2014
Session LN1 - Special section in honour of Luka Neralić, Room 1
(11:30-13:00)

Satisficing DEA: Bayesian Predictive Analytics for Peer Mining

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Abstract

Everything that happens in the world is uncertain and everyone is aware of the same. Experiencing uncertainty in day-to-day life is extremely certain. Tiding over uncertainty has been the quest of every industrial endeavor ever since the formation of the industries. For more than last two decades, the banking sectors of many Latin American countries including Peru have undergone rapid structural changes so as to improve the efficiency and resilience of their financial systems. Unfortunately, hardly any attention has been made to know the performance of the Peruvian banks. Therefore, the primary objective of this research was to measure the stochastic efficiency of Peruvian banks as well as provide appropriate strategies based on Bayes` peer classification, which eventually laid a pavement to help the stochastically inefficient banks to excel. Also, the present work provides insights based on the bias-corrected and accelerated confidence interval for potential improvement.

Keywords: *Data Envelopment Analysis, efficiency, stochastic programming, Bayes classification, Peruvian banks*

Wednesday September 24th, 2014
Session LN1 - Special section in honour of Luka Neralić, Room 1
(11:30-13:00)

**Sensitivity Analysis of Input Relaxation Super Efficiency Measure in
Data Envelopment Analysis**

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Abstract:

Sensitivity analysis is an essential part of studying efficiency in Data Envelopment Analysis (DEA). One appealing approach to sensitivity analysis allows simultaneous data perturbation in all DMUs. We present this type of sensitivity analysis for super-efficiency measures when some input relaxation is permissible. We also study sensitivity analysis in the worst-case scenario where the efficiency, based on the relaxed inputs, of an evaluating unit is worsening while the efficiencies of the other DMUs are improving. Necessary and sufficient conditions for preserving a DMU's efficiency classification are developed when various data changes are applied to all DMUs.

Keywords: *DEA, linear programming, super-efficiency, input relaxation, sensitivity analysis*

Wednesday September 24th, 2014
Session LN1 - Special section in honour of Luka Neralić, Room 1
(11:30-13:00)

Improving Efficiency of Efficient Decision Making Unit

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Abstract

Applying DEA model each DMU is classified as efficient or inefficient. If the DMU is inefficient, then projection point on efficient frontier is used as reference point. Thus we obtain sources of inefficiency. If, on the other hand, DMU is efficient, we do not obtain much other information how to improve efficiency. In this paper we explore efficient DMU and how to improve its efficiency, i.e. how to increase outputs or decrease inputs such that the newly obtained DMU dominates the original one, but in the same time that also some other tasks are fullfield. For example, we would like to move as possible away from the other DMU, or in a certain direction, or in a way that the measure of efficiency is maximized. Using extended DEA model, with parametric programming different scenarios how to improve efficiency of the efficient DMU can be obtained.

Keywords: *efficiency, parametric programming, efficient frontier*

Wednesday September 24th, 2014
Session LN1 - Special section in honour of Luka Neralić, Room 1
(11:30-13:00)

Efficiency Evaluation of Stock Portfolios based on Multiple Risk Measures: a DEA-like Envelopment Approach

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Abstract

In this paper, we present a new approach for stock efficiency evaluation based on multiple risk measures. It learns from the envelopment form of DEA and constructs a derived programming model subject to quadratic constraints. The derived model functions as an input-oriented DEA model through minimizing multiple risk measures as inputs and remaining return as output fixed. In addition, it introduces the Russell input measure and evaluates the corresponding efficiency results. The findings show that stock efficiency evaluation under the new framework is also effective. Efficiency values indicate the portfolio frontier under the new framework is more externally enveloped than the DEA efficient surface under a standard DEA framework.

Keywords: *Data Envelopment Analysis (DEA), stock portfolio, risk measures, efficient frontier*

Wednesday September 24th, 2014
Session LN1 - Special section in honour of Luka Neralič, Room 1
(11:30-13:00)

**DEA for Performance Evaluation and Benchmarking: Two Case Studies
for Optimal Ecosystem Management**

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Abstract

As a multi-criteria performance measuring technique, data envelopment analysis (DEA) is used for evaluation of decision-making units' (DMUs') efficiency by the ratio of the sum of DMU's weighted outputs to the sum of its weighted inputs. In this sense, the DMUs are considered as alternatives, outputs as criteria to be maximized and inputs as criteria to be minimized (Huguenin, 2013). DEA has been widely applied to management as well as to social problems. DEA's results namely show if a DMU is completely efficient, i.e., it reaches the score 1 (100%), lies at the efficiency frontier and is taken as a benchmark for the DMUs which are beneath the efficiency frontier and can improve the performance. The aim of this paper is to present two specific problems from the environmental sector in which adapted versions of DEA have been used.

In the introduction we briefly present DEA models, including preference models used to examine the improvement of individual inputs and outputs regarding the benchmarks.

Section 2 introduces the problem of forest ownership in Slovenia. The private forests in Slovenia, owned by about 490.000 owners and co-owners, demonstrate insufficient management, above all low exploitation and bad support of forests' social and ecological functions. In order to achieve better results in forest management in Slovenia Forest Owner Associations (FOAs) have been established. The efficiency of FOAs has been evaluated from the technical, economic, social and educational point of view by using DEA models (Leban et al., 2014).

Section 3 deals with group AHP which is applied to management of Panovec (Slovenia) regarding tourism, forestry, agriculture, and nature protection. The main problem of group AHP is to derive the group priority vector from comparison matrices of individual decision makers (Wang and Chin, 2009). Several aggregation group AHP methods based on DEA have been developed, one of them also by a group of Slovenian researchers (Grošelj et al., 2011). In the management problem of Panovec (SLO) four decision makers (experts) revealed their preferences for future development of Panovec. In the evaluation of the alternatives for management of Panovec, different group AHP methods, all based on DEA have been used.

In conclusions a discussion on the legitimate use of DEA in two presented case studies is given. Also some ideas for future work are conferred, like sensitivity analysis (Neralič, 1999) in the sense of data perturbations.

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Keywords: *DEA, CCR and BCC model, associations of forest owners, group AHP, stakeholders, ecosystem, management of natural resources*

Wednesday September 24th, 2014
Session A2 – OR Theory and Application, Room 12 (17:00-18:30)

Harmony Search Algorithm for Solving Hybrid Flow Shop Scheduling Problems

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Abstract

Hybrid Flow Shop (HFS) scheduling problems are known as NP-Hard problems (Non-deterministic Polynomial-time hard). In order to obtain satisfactory results in acceptable CPU time, metaheuristic algorithms are used. Harmony Search Algorithm (HSA) is one of the metaheuristic methods which are used for solving optimization problems. One of the most important advantages of HSA is the simplicity of its search structure.

In this study, some small sized HFS problems are solved by using HSA and successes of the algorithm are investigated on such scheduling problems. Findings are compared with some former studies. The results have shown that HSA can be an alternative and competitive method for solving HFS scheduling problems. In future researches, HSA can be tested on larger problems and also can be applied on real world problems.

Keywords: *Hybrid Flow Shop, Harmony Search Algorithm, scheduling*

Wednesday September 24th, 2014
Session A2 – OR Theory and Application, Room 12 (17:00-18:30)

**Single-Objective and Multi-Objective Optimization using HUMANT
algorithm**

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Abstract

Nowadays there are many metaheuristic algorithms like Ant Colony Optimization (ACO), Genetic Algorithm (GA), Particle Swarm Optimization (PSO) or Simulated Annealing (SA) that are successfully solving many optimization problems, even if they are NP-hard problems. However, these optimization problems are mainly Single-Objective i.e. they have only one criterion of excellence. And there are many Single-Objective optimization algorithms and techniques that can solve them. When facing a real world, optimization problems mainly become Multi-Objective i.e. they have several criteria of excellence. And when talking about multi-criteria problems things become complicated, because multi-criteria problem submitted to a multi-criteria evaluation is a complex problem. Usually there is no optimal solution; no alternative is the best one on each criterion. Furthermore, there is no known Multi-Objective optimization algorithm to be universal i.e. that can be applied on many different Single-Objective and Multi-Objective optimization problems.

On the other hand, there are many Multi-Criteria Decision Making (MCDM) methods like AHP, ELECTRE, MACBETH, MAUT, PROMETHEE, or TOPSIS that are very successful in solving multi-criteria problems with limited number of alternatives. All these methods are using some *a priori* knowledge about decision maker preferences, like for instance criteria weights. Using these *a priori* defined decision maker preferences they compare and rank alternatives i.e. they are solving complex multi-criteria problem with limited number of alternatives. However, if this limited number of alternatives becomes unlimited or very large (10^{20} alternatives or more), then practically it is not possible to apply any of these methods, because computational time becomes too long. It means that these methods cannot be applied to complex Multi-Objective optimization problems because number of possible solutions (alternatives) is too large, and sometimes there can even be infinite number of possible solutions.

However, if a metaheuristic algorithm could be combined with Multi-Criteria Decision Making method then only near-optimal solutions could be submitted to multi-criteria evaluation i.e. compared

and ranked using these *a priori* defined decision maker preferences. In this paper, this kind of approach is presented using specially designed HUMANT (HUMANoid ANT) algorithm derived from Ant Colony Optimization and PROMETHEE method. Preliminary results of this new optimization algorithm are presented for Single-Objective Traveling Salesman Problem (TSP) Shortest Path Problem (SPP), and Multi-Objective Partner Selection Problem (PSP). Additionally, HUMANT algorithm's Multi-Objective approach to Single-Objective optimization problems is presented on Shortest Path Problem (SPP).

Keywords: *Single-Objective Optimization, Multi-Objective Optimization, HUMANT algorithm, PROMETHEE method, Ant Colony Optimization*

Wednesday September 24th, 2014
Session A2 – OR Theory and Application, Room 12 (17:00-18:30)

Solving the Utility Maximization Problem with the Cobb-Douglas and CES Utility Function without the Use of Calculus

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Abstract

In this paper, a new original method to solve the utility maximization problem with Cobb-Douglas and CES utility function by using the weighted arithmetic-geometric-mean inequality (weighted AM-GM inequality) and the Jensen's inequality is proposed. Instead of using calculus and the Lagrange multiplier method, the maximum utility and global maximizer in the case of the Cobb-Douglas and CES utility function are derived in the direct way.

Keywords: *constrained optimization, Cobb-Douglas utility function, CES utility function, without derivatives, mathematical inequalities*

Wednesday September 24th, 2014
Session A2 – OR Theory and Application, Room 12 (17:00-18:30)

**On The Existence of the Nonlinear Weighted Least Squares Estimate
for Some Special Exponential Type Models**

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Abstract

In various applied research such as finance, statistic, biology and medicine there are lots of different applications of two-parameter models of exponential type

$$f(t;a,b)=g(t) \exp(a+bh(t)),$$

where a and b are unknown parameters and g strictly positive and h strictly monotone are some known functions. Exponential regression, power regression, Schumacher equation and Fox surplus-yield model are some of the important models of this type. The unknown parameters must be estimated from the data (w_i, t_i, y_i) , $i = 1, \dots, n$, where t_i denote the values of the independent variable, y_i are respective estimates of regression function f and $w_i > 0$ are some data weights. A very popular method for parameter estimation is the method of least squares. In practice, to avoid using nonlinear regression, these kinds of problems are commonly transformed to linear, which is not statistically justified. In this paper we consider original nonlinear least squares problem and the problem of the existence of the best nonlinear least squares estimate (LSE) for this type of models. It is shown that the best nonlinear LSE exists. Generalization in the l_p norm ($1 \leq p < \infty$) and some illustrative examples are also given.

Keywords: *two-parameter models, least squares, parameter estimation, existence problem, data fitting*

Wednesday September 24th, 2014
Session B2 - Mathematical Programming, Room 13 (17:00-18:30)

Approximation of k-Minimum Hamiltonian Cover Problem

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Abstract

We consider the following simple generalization of the well-known Traveling Salesman Problem, which we call k-Minimum Hamiltonian Cover (k-MHC) Problem. Let k be some fixed natural number. For a given complete weighted graph $G=(V,E)$, it is required to construct a minimum-cost vertex-disjoint cover (of the set V) by closed routes (or cycles). Such a family of routes is called *Hamiltonian cover*.

We prove that k-MHC (like TSP) is strongly NP-hard and inapproximable in the general case (unless $P=NP$). The problem remains intractable even in the metric and Euclidean cases. In the metric case weights of the edges are supposed to satisfy the triangle inequality, and in Euclidean case nodes of the given graph are points in d -dimensional Euclidean space for some $d>1$, and weights of edges are distances between the incident nodes.

For any fixed $k>1$ we propose 2-approximation polynomial-time algorithm for Metric 2-MHC. For Euclidean 2-MHC in the plane we propose polynomial-time approximation scheme (extending the well-known PTAS for TSP, obtained by S.Arora), which finds $(1+1/c)OPT$ solution within $O(n^3(\log n)^{O(c)})$ operations.

The research is supported by Russian Scientific Foundation, grant no. 14-11-00109.

Keywords: *NP-hard problem, generalized Traveling Salesman Problem, approximation algorithm, polynomial-time approximation scheme*

Wednesday September 24th, 2014
Session B2 - Mathematical Programming, Room 13 (17:00-18:30)

Multiple Ellipse Fitting by Center-Based Clustering

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Abstract

The multiple ellipse fitting problem based on the given data point set in a plane is considered. It has been supposed that all data points come from k ellipses that should be fitted. The problem is solved by the application of center-based clustering of the data set, where clusters are determined by corresponding ellipses. Thereby, an adaptation of the well-known k -means algorithm has been constructed.

The algebraic fitting criterion can be used in this problem. Another approach is to use the Mahalanobis distance-like function, where a positive definite symmetric matrix determines the major and the minor axes lengths as well as the orientation of the ellipse. In such a way, the ellipse is determined by its five parameters. The proposed algorithm is illustrated on several numerical examples.

Keywords: *multiple ellipse fitting, center-based clustering, algebraic criterion, Mahalanobis distance*

Wednesday September 24th, 2014
Session B2 - Mathematical Programming, Room 13 (17:00-18:30)

Heuristic Methods for The Solution of The Tariff Zones Design

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Abstract

Zone tariff is one of various approaches how to design the tariff in city and regional public transport. In the zone tariff system the whole area is divided in smaller sub-regions – tariff zones and the price of travelling depends on the number of travelled zones. The zone tariff systems can be divided into two groups. In the zone tariff with arbitrary prices, prices are given for all pairs of zones separately and arbitrary. In the counting zone tariff system, the price of trip is calculated according to the number of travelled zones and the price for all trips passing the same number of zones must be the same. When we want to design zone tariff system, we have to decide about optimal price for travelling for passengers and optimal zone partitioning of the region. The zone partitioning problem can be described with the mathematical model which is similar to the p -median problem. The main drawbacks of this model are the nonlinear objective function and the solution time of the linearized model using the exact methods rapidly grows with the size of the problem. This paper deals with the various heuristic approaches to the zone partitioning in the counting zone tariff system design. In the literature there can be found heuristic methods based on the clustering theory, greedy algorithm and the spanning tree approach. Selected heuristic approaches will be implemented and improved using new criteria. These heuristic approaches will be compared with the solution of exact method. We will make a computational study on test data sets from selected region and compare the results of obtained by heuristic methods with the solution of exact method.

Keywords: *tariff zones design, zone partitioning, p -median problem, heuristic method*

Wednesday September 24th, 2014
Session B2 - Mathematical Programming, Room 13 (17:00-18:30)

A Comparison of Tabu Search Algorithm and Mathematical Model in a Pipeline Network

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Abstract

In this study the determination of an optimal situated pipeline network has been proposed by means of the implementation of both a metaheuristic algorithm called Tabu Search coded in VB and a mathematical model solved in GAMS so as to reach the optimal pipeline network design. At the same time, both Tabu Search and mathematical model have been compared to each other with regard to CPU times for different number of nodes. In order to reach an optimal pipeline network or route, it has been aimed to minimize the total length of the network with the aid of both Tabu search and mathematical model. Previous studies executed by other researchers did not focus the comparison of the two different methods so it is aimed with this study to fill this gap.

Keywords: *Tabu search, mathematical model, pipeline networks, spanning tree*

Wednesday September 24th, 2014
Session B2 - Mathematical Programming, Room 13 (17:00-18:30)

Run-time Parameter Tuning of Optimization Systems

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Abstract

The most recent mathematical programming solvers incorporate many different optimization algorithms. These algorithms are usually built up from modules with dedicated tasks. The roles of these tasks are unique but each can be usually performed using different implementation approaches and the sequence of these steps leads the algorithm to an optimal solution. These algorithmic choices can be controlled using compilation time or run time logic. Compilation time choices are independent of the user, but run time tuning of the algorithm can speed up the solution algorithm and reduce the computational effort needed. Mathematical optimization problems can be classified as linear, integer or non-linear problems. Linear optimization is usually the hidden engine behind other optimization algorithms, thus its performance affects other areas as well. Linear optimization systems can use different solution methods and algorithmic techniques during the solution process, which can be controlled using run-time parameterization. These parameters have default values, but they are not necessarily the best for all problem classes. The dimension of the parameter space of linear optimization systems can be around a hundred. Finding a good combination of parameters is not a trivial task; the solution of a set of problems using one parameterization can take considerable time, thus testing a set of parameterizations needs enormous computational power. One possible solution can be achieved using parallel architecture. Parallel computing infrastructures can be provided by supercomputers, clouds or desktop grids. The advantage of using grids is that its investment cost is low, since any unused capacity of a computer network can provide a grid or even volunteer resources can be used for this purpose. Our method for the parameter tuning of optimization systems provides a simple interface to specify parameter sweeping tasks and evaluate the performance of parameterizations in a transparent and unified manner. This way the parameter tuning of linear programming solvers can be done in reasonable time in order to provide guidelines for their parameterization. In our work the parameterization of open source linear optimization systems are investigated and evaluated on different linear programming problem classes.

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Keywords: *parameter tuning, mathematical programming software, linear programming*

Wednesday September 24th, 2014
Session C2 - Multicriteria Decision Making, Room 14 (17:00-18:30)

Fuzzy Group Decision Support System Based on AHP and SWOT for Solving Natural Resource Management Problem in Slovenia

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Abstract

Natural resource management systems are often complex and unpredictable. As such, they require systematic framework which enables inclusion of various qualitative and quantitative information, subjective judgments, experts' opinions and technical data as well as several stakeholders. Multi-criteria decision making offers a formal paradigm for structuring and solving such problems. Combined with fuzzy set theory it can be effectively used to deal with imprecise information in natural systems.

In the paper we propose a group approach based on analysis of strengths, weaknesses, opportunities and threats (SWOT) and fuzzy analytic hierarchy process (FAHP). The proposed approach is applied on a management problem of Pohorje (Lešnik Štuhec, 2010; NATREG, 2011). The aim of the study is selection of optimal strategy for Pohorje management regarding the hierarchy of SWOT factors and SWOT groups. Four alternatives were pairwise compared by a group of stakeholders. Their judgments were aggregated by geometric mean. The group judgments were translated into triangular fuzzy numbers since a crisp number can hardly express the variety of stakeholders' opinions. The points that estimated importance of SWOT factors were converted to five linguistic variables from unimportant to very important on the basis of fuzzy logic. Local priorities derived from fuzzy matrices were hierarchically synthesized into global priorities of alternatives. The alternative "Sustainable development" was identified as the most appropriate for development of Pohorje.

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Keywords: *group decision making, fuzzy analytic hierarchy process, SWOT analysis, stakeholders, natural resources*

Wednesday September 24th, 2014
Session C2 - Multicriteria Decision Making, Room 14 (17:00-18:30)

Performance Concept in Cost-Effective Construction Management of Educational Facilities

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Abstract

Performance concept or approach in building is not new and can be traced back thousands of years. The concept is widely acclaimed and is applicable to both building procurement (design and construction) and to regulation (control), but has not been widely applied, especially in Croatia. In this approach the focus of all decisions is on the required performance-in-use, and on the evaluations and testing of building asset. The use of performance-based approach in the building industry allows more open competition, promotes transparent procurement, and supports cost-effective building. Particular application in building consists of translating human needs to user requirements, transforming them into technical performance requirements and quantitative criteria that do not dictate a prescribed solution, but rather compose a means for the investigation of various alternatives, and responding to these requirements during the various stages of conceptual, preliminary and detailed design to enable cost-effective construction of buildings that provide long-term satisfactory performance. Pluralism of private and public interests and goals in public management of urban areas is making decision making more complex. In such complex situation capital forms public interest, therefore in conditions of limited financial funds there is a need for partial interventions into public space. Defining, developing and implementing performance concept in construction management of education facilities will give the decision makers a right tool for making quality and consistent decisions which will be based on adequate data. Concept is based on multicriteria analysis taking into account various quantitative and qualitative building indicators. Current construction codes and standards determine minimal infrastructure, financial and human resource indicators for realization and development of education buildings. Disproportion that appears in construction practice directs to the need for establishing upper, maximum values indicators. Beside the quantitative indicators, it is necessary to define certain qualitative indicators (in term of various technical solutions, materials and other) that would lead to more rational solutions and improved management of government budget. This paper will provide a recent research and preliminary findings in development of performance concept in construction management of education facilities. Intention is to give a platform for decision makers in order to help them making fast, quality and appropriate decision upon value of each building element, and how will it reflect on total value of whole building.

Keywords: *performance concept, educational facilities, decision making, value indicators, cost-effective construction management*

Wednesday September 24th, 2014
Session C2 - Multicriteria Decision Making, Room 14 (17:00-18:30)

Stock Selection using A Hybrid MCDM Approach

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Abstract

The problem of selecting the right stocks to invest in is of immense interest for investors on both emerging and developed capital markets. Moreover, an investor should take into account all available data regarding stocks on the particular market. This includes fundamental and stock market indicators, which means that the decision making process includes several stocks to invest in and more than one criterion. Therefore, the task of selecting the stocks to invest in can be viewed as multiple criteria decision making (MCDM) problem. There are also several MCDM methods which often lead to divergent rankings of stocks. The goal of this paper is to resolve these possible divergent results obtained from five MCDM methods using a hybrid MCDM approach based on Spearman's rank correlation coefficient. MCDM methods include AHP, SAW, PROMETHEE, LINEAR ASSIGNATION and TOPSIS method. Data for this study is obtained from REUTERS database and includes information on stock returns and traded volumes averaged over sample period for 12 stocks which are constituents of stock indices on Croatian capital market. Data consists of around 500 daily observations in period from the March 2012 to the March 2014. It also includes the most important fundamental and stock market indicators for selected stocks in that period.

Keywords: *MCDM approach, Spearman rank coefficient, stock selection*

Wednesday September 24th, 2014
Session C2 - Multicriteria Decision Making, Room 14 (17:00-18:30)

Cost Effectiveness of ATM's Automatic Deposit Service

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Abstract

Bankers and other financial experts have analyzed the value of ATMs in relation to the growing demands of consumers, rising costs of technology development, decreasing profitability and market share. One of the areas of specific interest is present as well as future status of various financial services used within automated teller machines (ATM). Automatic deposit service is one of such services.

This paper presents a step by step process of performing cost effectiveness analysis of ATM's automatic deposit service implementation. The first step was to determine the users' attitude towards using automatic deposit service of ATMs by using Technology Acceptance Model (TAM). The second step was to determine the optimal network positioning of ATMs with automatic deposit service by using Analytic Hierarchy Process (AHP) model for the selection of optimal locations. Results of the previous steps enabled a highly-efficient application of the cost-benefit analysis in order to evaluate cost-effectiveness of automatic deposit service implementation. In order to fully understand the proposed procedure outside the theoretical terms, an initial case study was conducted that was based on its real-world application.

Keywords: *Automatic deposit service, ATM, Technology Acceptance Model, Analytic Hierarchy Process, Cost-benefit analysis, Cost-effectiveness*

**CONTRIBUTED PRESENTATIONS -
Thursday, September 25th, 2014**

Thursday, September 25th, 2014
Session A3 - OR Theory and Application, Room 12 (9:20-10:50)

**A Partial Backlogging Inventory Model for Deteriorating Items with
Time-Varying Demand and Holding Cost: An Interval Number
Approach**

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Abstract

In this paper, we propose a deteriorating inventory model with time proportional holding cost and demand rate. Deterioration rate is assumed to be constant. The demand varies with time until the shortage occurs; during shortages, demand rate becomes constant. Shortages are allowed and assumed to be partially backlogged. We formulate an expression for the total cost function in crisp case as well as in interval-valued case. In crisp case, the Taylor's series expansion is used, and mathematically it is shown that the cost function is convex. While, in case of intervals, the interval arithmetic is used, and then the problem is changed into multi objective non-linear optimization problem with interval objective function. To solve this problem, the weighted-sum method (WSM) is used. The proposed procedure is validated with the help of a numerical example. Sensitivity analysis on various parameters also has been carried out and conclusions are drawn accordingly. A brief discussion on Interval valued numbers has been given in the APPENDIX.

Keywords: *inventory model, interval valued number, Weighted-Sum Method*

Thursday, September 25th, 2014
Session A3 - OR Theory and application, Room 12 (9:20-10:50)

A Framework in the Formulation and Solution of Inventory Routing Problems

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Abstract

Researchers who investigate in fields relate with optimization problems in Supply Chain (SC), in special those that involve the process of inventory and its distribution, find difficulties to relate the knowledge areas such as operation research and computer science, organizing the procedure and evaluating the solutions obtained. After analyzed this problem, a simple framework has been developed to use in the searching of near-optimal solutions in the field of Inventory Routing Problems (IRP). In this paper this framework is described in detail, and all the phases to follow are introduced step by step. Although some of these phases can be extended for other type of optimization problem in the SC, the literature of this study is focused in IRP. This field has been chosen due to its importance in the real world, and its great relevance in the literature. The use of benchmark instances for evaluating of results is highlighted and these instances are organized according the concrete problem where are used. Also, it is presented some key elements to face the problem such as the information management, relationship of inventory policies with the demand information, demand and lead time modeling and optimization methods. These elements are organized and classified for ease of use.

Keywords: *Inventory Routing Problems, optimization problems, Supply Chain, optimization methods*

Thursday, September 25th, 2014
Session A3 - OR Theory and application, Room 12 (9:20-10:50)

**A Mathematical Model for Centralization of Humanitarian Relief
Logistics Networks**

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Abstract

In recent years, natural disasters have been affecting an increasing numbers of people all over the world. According to the records of the Centre for Research on the Epidemiology of Disasters (CRED-EMDAT), 4,183 natural disasters have been registered in the last decade. The CRED estimates 1,481.5 billions of dollars in economic damage from these events, 1,027,296 casualties, and 1,734 millions of affected people. Hence, governmental and non-governmental humanitarian relief organizations have paid attention to its importance to response for providing quick aid to the affected areas in order to save lives and minimize the death rate. Before implementing humanitarian logistics, an effective and efficient humanitarian relief logistic network must be established considering both governmental and non-governmental relief organizations.

The location of governmental and non-governmental organizations' facilities is an important aspect of a humanitarian relief logistics system for determining centralized warehouses of relief items. The decisions of the number and locations of the facilities, and the amount of relief supply inventory directly affect the response time and costs of humanitarian relief operations' performance. In this paper, a mathematical model is proposed for centralization of governmental and non-governmental humanitarian relief logistics networks in order to achieve more effective and efficient response. The proposed model aims to identify the locations of open facilities, their respective supplies and amount of supplies allocated to demand point.

Keywords: *humanitarian relief logistics, centralization, mathematical model*

Thursday, September 25th, 2014
Session A3 - OR Theory and application, Room 12 (9:20-10:50)

Hybrid Dynamic Cross Impact Analysis with Markov Chain and Trend Impact Analysis

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Abstract

Our decisions shape the future and dependent on the future's shape. Faster pace and complexity of change today increases the value of early warning, because it increases time-space for analysis to create more intelligent decisions. Forecasting techniques don't consider the unprecedented events (wildcards) might emerge in the future; depend on the history shape only and generate one image of the future. The Futures Methodologies overcome constrains of the Forecasting techniques. The purpose of Futures Methodologies is to explore, create, and test both possible and desirable futures to improve decision making process; it is also combining quantitative and qualitative techniques. Cross Impact Analysis (CIA) and Trend Impact Analysis (TIA) each one of them is a hybrid quantitative and qualitative futures methodology and very prominent in the Futures Studies literature. The Cross Impact Analysis method generates the occurrence probabilities of wildcards taking into account the interdependencies between their occurrences at specific point of the future. The Trend Impact Analysis method incorporates the changes caused by wildcards occurrences on the forecasted trend (surprise free forecast) and generates fan of futures scenarios, but it assumes that wildcards occurrences are not dependent. This paper introduces two contributions to the Futures Studies literature. The first contribution is an enhancement to the traditional Cross Impact Analysis by adding the dynamic behavior –time dimension- using Markov Chain Transition Probability Matrix, to generate dependent wildcards occurrence probabilities for a number of future years not only at one future year, this proposed method is called Dynamic CIA (DCIA) The second contribution is an enhancement to the Trend Impact Analysis by relaxing the assumption of considering independent wildcards occurrences to consider the interdependency between them. This is done by hybridizing the DCIA with TIA. This hybrid approach leads to generate fan of futures scenarios based on the trend of any studied variable. The results will be more realistic and rational for better anticipation of the future and better decision making.

Keywords: *forecasting, futures studies, Trend Impact Analysis, Cross Impact Analysis, Markov chain, transition probability matrix*

Thursday, September 25th, 2014
Session A3 - OR Theory and application, Room 12
(9:20-10:50)

Inventory Sharing with Speculations

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Abstract

In order to create more efficient supply chains the members involved are trying to introduce the concept of inventory sharing. In this paper we consider a version of supply chain consisting of one manufacturer and one retailer playing the game of inventory sharing with speculations. Namely, the inventory is determined as the difference between supply and demand depending on price, inflation rate and inflation rate change resulting in the possible speculations. The manufacturer's and retailer's objective is to minimize their corresponding inventory costs. The problem is formulated as a game using the concept of Stackelberg model where retailer is the leader and the manufacturer is the follower. The optimization problems that have to be solved are optimal control theory problems with the objective functions in the form of integral functional with the integrand depending on the state function and its first and second derivative. The necessary conditions for an optimal solution existence are derived and interpreted.

Keywords: *supply chain, inventory sharing, speculations, optimal control theory problem*

Thursday, September 25th, 2014
Session B3 - Quantitative Methods in Banking and Finance, Room 13
(9:20-10:50)

**From Diagnosis to Prognosis of Financial (In)stability – Auditors’
Opinion Approach**

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Abstract

Approach used in this paper differs from other researches that focus on deriving the financial (in)stability prediction models as a diagnosis and prognosis tool. It uses auditors’ reports on companies financial statements that emphasize the companies’ ability to continue as a going concern as a main criterion that discriminate financially unstable from stable companies. Two related hypothesis were tested in this paper: H_1 – Auditor’s report with explanatory paragraph that points out the problems with going concern assumption is appropriate criterion for classify the company as financially unstable; and H_2 – Combination of financial ratios represent good analytical tool for distinguishing financially stable from unstable companies. Research results conducted among 191 companies that have securities listed on Zagreb stock exchange confirmed both hypothesis and LRA model – diagnosis and prognosis tool for estimating the state of financial stability was derived. Combination of five financial ratios that best discriminate unstable and stable companies includes two solvency ratios, two profitability ratios and one cash flow ratio. Model was derived by logistic regression analysis application. Its’ statistical adequacy and quality was tested using appropriate measures like Nagelkerke R^2 , type 1 and type 2 errors that appear when model’s classification ability was calculated as well as area under ROC curve. All measures indicate that model is statistically adequate and that it could be used as diagnosis and prognosis tool in estimating as well as forecasting degree of company financial stability.

Despite the model’s wide area of application analysts should make attention on type 1 error i.e. incorrect classification of financially unstable companies in the group of stable ones. Authors assume that this is the consequence of criterion used for distinguishing unstable from stable companies. Namely, emphasize on company’s ability to proceed as a going concern sometimes could be noted in auditor report as a consequence of some qualitative variable that does not have immediate influence on quantitative or financial variable. As a result the LRA model classifies the company in the group of financially stable companies, although it is in fact unstable according to fact that the auditor add explanatory paragraph in his report. This opens some new questions that should be scientifically investigated like what qualitative variables/measures influence companies’ ability to continue as a going concern and what is direction and degree of their influence; or could we calculate not only two degrees of financial stability (unstable and stable), but more financial stability levels.

Keywords: *financial instability diagnosis and prognosis, auditor report, Logistic Regression Analysis*

Thursday, September 25th, 2014
Session B3 - Quantitative Methods in Banking and Finance, Room 13
(9:20-10:50)

Testing for Regime-Switching CAPM on Zagreb Stock Exchange

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Abstract

The standard Capital Asset Pricing Model (CAPM) is well-known in the finance literature. It assumes that a linear relationship between the risk (beta) and the expected excess return of a stock exists. However, over the years empirical findings have shown that this relationship varies over time. Stock markets undergo phases of greater and smaller volatility, in which beta varies accordingly. The research area of investing has provided evidence that beta undergoes different regimes, as the whole market does. Moreover, the regime-switching models are proven to be quite good for describing the regime changes on stock markets. Given that the Croatian capital market is still insufficiently investigated, the aim of this paper will be to explore the possibility of a non-linear relationship between the stock risk and return. Linear and Markov-switching models (Hamilton 1994) will be examined on the Zagreb Stock Exchange, based on monthly data on 21 stocks, ranging from January 2005 to December 2013. In that way, investors can use the results based on the best model when making decisions about buying stocks. Since this is one of the first papers on regime-switching on Croatian capital market, it will, hopefully, contribute to the existing works on investing.

Keywords: *regime-switching, Zagreb Stock Exchange, CAPM, time-varying beta*

Thursday, September 25th, 2014
Session B3 - Quantitative Methods in Banking and Finance, Room 13
(9:20-10:50)

**Estimating Investors Preferences towards Portfolio Return
Distribution Moments: Empirical Evidence from Croatian Investment
Funds**

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Abstract

Recent researches in the field of investor's preferences emphasize the need to go beyond the simplification of analyzing just the first two moments of the portfolio return distribution used in MV paradigm. It is strongly suggested to observe the investor's utility function as an n^{th} order Taylor approximation. In such a framework, it is assumed that the signs of the derivatives in Taylor series for expected utility alternate in sign (given the negative second derivative) which implies that investors are risk averters, prefer a positive third, a negative fourth moment of a distribution, etc. Given that higher moments should be considered when observing investors utility, it is assumed that investors pay attention and manage higher moments of their portfolio return distribution according to their preferences. In order to investigate the preferences of Croatian investment funds, we shall undertake the analysis of the moments of their return distribution. Furthermore, we estimate whether they manage higher moments of their return distributions consistently. Using the theoretical utility functions (DARA, CARA, CRRA), we compare the changes of their preferences when higher moments are included. Moreover, we investigate whether funds' returns reflect the preferences towards higher moments according to the expected utility theory.

Keywords: *higher distribution moments, investor preferences, expected utility, Croatian investment funds*

Thursday, September 25th, 2014
Session B3 - Quantitative Methods in Banking and Finance, Room 13
(9:20-10:50)

The Application of Portfolio Optimization Methods in Investment Risk Management – Evidence from Zagreb Stock Exchange

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Abstract

The paper aims to examine the possibilities of risk minimization by applying various methods of portfolio optimization on securities listed on Zagreb Stock Exchange. In the research, besides equally weighted portfolio which is used as a basic benchmark, authors optimized and examined portfolios based on global minimum variance (GMV), conditional value-at-risk (CVaR) and conditional drawdown-at-risk (CDaR). Also, authors investigated the possibilities of modelling individual series of returns with adequate ARMA and GARCH models, in order to conduct portfolio optimization based on predictions of applied models. In the case of series correlation, optimal ARMA model is selected based on Schwarz information criterion, while the presence of heteroscedasticity is solved by application of GARCH, EGARCH, TGARCH and GARCH in mean models with Gaussian, Student or GED distribution.

Keywords: *portfolio optimization, Zagreb Stock Exchange, GARCH, time series modeling*

Thursday, September 25th, 2014
Session B3 - Quantitative Methods in Banking and Finance, Room 13
(9:20-10:50)

A Comparison of Four Different Block Bootstrap Methods

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Abstract

The paper contains a description of four different block bootstrap methods: non-overlapping block bootstrap, overlapping block bootstrap (moving block bootstrap), stationary block bootstrap and subsampling. Furthermore, basic goal of this paper is to quantify relative efficiency of each mentioned block bootstrap procedures and then to compare those methods. To achieve the goal, we measure mean square errors of estimation variance returns. The returns are calculated from 1250 daily observations of Serbian stock market index values BELEX15 since April 2009 until April 2014. Thereby, considering the effects of potential changes in decision according to variations in the sample length and purposes of the use, this paper introduces the stability analysis which contains robustness testing of different sample size and different block length. The testing results indicate some changes in bootstrap method efficiencies when altering the sample size or block length.

Keywords: *block bootstrap, returns, stability analysis*

Thursday, September 25th, 2014
Session C3 - Multicriteria Decision Making, Room 14 (9:20-10:50)

Planning Support Concept to Implementation of Sustainable Parking Development Projects in Ancient Mediterranean Cities

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Abstract

This paper proposes planning support concept to planning processes related to implementation of sustainable parking development (PSC-ISPDP) in the area of ancient Mediterranean cities by the sea. The specificity of these cities stems from their origin of development from the historic centers of ancient cities which are jointly with their contact area often under the protection of international institutions for the protection of cultural heritage, such as UNESCO. This implies the existence of spatial and dynamic constraints to the realization of such projects. In fact, there is a deficit of available spaces around the traffic attraction points for construction of parking places or garages, and also, there are great variations in the number of city residents during and after the tourist season. Both greatly influence the dynamics of project implementation. Presented PSC-ISPDP is conceptualized by the logic of decision support systems and multicriteria analysis approach with a purpose to support setting of implementation priorities for construction of new and/or improvement of existing parking places or garages within a sustainable parking development project. Analyzing available information on existing and planned state of parking spaces within the city, the main goal (sustainable parking development in the city) and its supporting objectives are generated. These goal and objectives are structured in a hierarchy form of a goal tree. In accordance with it, alternative solutions are defined (possible locations for future parking spaces and possible improvement of existing ones). Objectives from the last hierarchy level within goal tree are used as criteria for assessment of defined alternative solutions. Using the AHP method, preliminary importance of each criterion in defined criteria set is determined based on stakeholder opinions (traffic experts, local-government, and citizen representatives). Final values of criteria importance are gained by SAW where different stakeholder groups have different influence on criteria weighting according to their financial, social and/or political responsibility relating project decisions. PROMETHEE I and PROMETHEE II were used for priority ranking, while implementation of linear programming by virtue of PROMETHEE V ensured definition of project's implementation phases i.e. project subset definitions which represent the first phase of the whole project. The result of presented model is the implementation plan for sustainable parking development projects in ancient Mediterranean cities. The model is tested on planning sustainable parking development project in the city of Trogir, Croatia.

Keywords: *project management, sustainable development, parking, ancient Mediterranean city, multicriteria, PROMETHEE, AHP, SAW*

Thursday, September 25th, 2014
Session C3 - Multicriteria Decision Making, Room 14 (9:20-10:50)

**Technology Competency Evaluation of the Manufacturing Companies
via Multi-Criteria Approaches**

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Abstract

This study presents a hybrid fuzzy multi criteria decision making approach to evaluate technology competency of Turkish manufacturing sector. Financial and non-financial performance criteria of companies have basically been used to evaluate the company's financial situation and performance. This study evaluates technology competency level of Turkish manufacturing companies with respect to current and past data by using multi criteria decision making approaches. Fuzzy analytic hierarchy process is utilized for determining the importance weights of the technology competency evaluation criteria. Then the ranking of the manufacturing companies is evaluated by Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) approaches. The proposed approaches are used as a benchmarking for the heavy manufacturing companies related to technology competency level.

Keywords: *technology competency, Decision Support Systems, Turkish manufacturing sector, Multi-Criteria Decision Making Approach*

Thursday, September 25th, 2014
Session C3 - Multicriteria Decision Making, Room 14 (9:20-10:50)

The Setting of Key Performance Targets for Croatian Shipyards

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Abstract

Ship is the most complex product that Croatia produced and exported to the international market. Also, the shipbuilding is the driving force behind the development of various supporting manufacturing and service activities, which makes it vitally important industry representing a powerful generator of employment and of local, regional and national development of Croatia.

The aim of this paper is to apply Data Envelopment Analysis (DEA) method in measuring and analysing different types of relative efficiency of five Croatian shipyards. The indicators for this measurement are chosen in order to capture different important aspects of the shipbuilding performance in Croatia.

To determine the efficiency of shipyards and to observe the possibility of changes in the shipyard efficiency over time, window analysis is used. As a result, the subset of efficient "best practice" shipyards is identified, while for the others the magnitude of their inefficiency is derived and the efficient input and output targets are specified. The special significance of window analysis is the fact that its results can serve as an early warning to all inefficient shipyards. By identifying the sources of inefficiencies and formulating proposals for improving the performances of the observed shipyards over the six-year period (2007-2012), the results presented in this paper can be used to enhance and alter decisions.

Keywords: *shipbuilding, Data Envelopment Analysis, Croatian shipyards, window analysis, scale efficiency*

Thursday, September 25th, 2014
Session C3 - Multicriteria Decision Making, Room 14 (9:20-10:50)

Ranking Zones Model – A Multicriterial Approach for Spatial Management of Urban Areas

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Abstract

Urban areas are constantly changing as they expand into new territory or existing areas are re-developed due to both private and public investments. The planning and analysis of such investments can be characterized as highly complex, where there may be different views among stakeholders and experts as to the scope, scale and potential solutions. The evaluation of these investments requires explicit consideration of multiple, conflicting and incommensurate criteria as they have important social, economic, and environmental effects that impact various stakeholders differently. It generally involves evaluation of options or alternatives that have both qualitative and quantitative dimensions. To take into account all dimensions, the Ranking Zones Model (RZM) is proposed that is based on PROMETHEE methods. RZM consists of several steps such as: identifying zones in observed urban area, creating hierarchy structure of goals and criteria, criteria weighting, and ranking zones according to defined criteria. The model result is a rank-list of all observed zones. The rank-list helps decision-makers come up with consistent decisions in which zones to invest, and, at the same time, knowing that the decision is based upon mutual comparison of all observed zones in that urban area. The advantage of such approach to decision-making lies in the fact that even if it comes to a change in the structure of decision-makers, the decision-making procedure itself remains consistent. The development of presented model has been motivated by a real world urban case study of the city of Split, Croatia.

Keywords: *multicriteria, decision support, spatial management, prioritization, urban development*

Thursday, September 25th, 2014
Session C3 - Multicriteria Decision Making, Room 14 (9:20-10:50)

Maximizing the Number of Effective 2-Cycles in Kidney Exchange Programs

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Abstract

In recent years, kidney exchange programs (KEPs) have been designed and implemented in some countries. In the core of a KEP is a set of pairs, each made of a person who is willing to donate a kidney, the donor, to a specific patient, the recipient. The purpose of a KEP is to allow transplants to recipients associated with incompatible donors (e.g. because of their blood types) through the exchange of donors between recipients.

The simplest exchange consists in an exchange of the donor between two pairs: if a pair with a donor A and recipient 1 is incompatible and a pair with a donor B and recipient 2 is also incompatible but A is compatible with 2 and B is compatible with 1, then the two recipients can receive a kidney.

The exchange idea can be extended for more than two transplants, although limited to a value conditioned by practical and logistics issues (e.g., ideally, the transplants in an exchange should be simultaneous). For example, in the United Kingdom KEP the maximum number of exchanges is three.

A KEP optimization problem is usually modeled by defining a graph where vertices correspond to incompatible pairs and arcs correspond to the donor of the origin vertex being compatible with the recipient of the destination vertex. An exchange corresponds to a cycle in this graph. The above mentioned exchange between A1 and B2 is a 2-cycle (a cycle of length 2).

In this work, we consider effective 2-cycles which are, by definition, 2-cycles or 3-cycles with at least one back-arc. A back-arc is an arc that does not belong to the cycle but, in case of failure of the cycle

(e.g. after the transplants are decided, additional tests reveal some incompatibility – an arc is removed – or someone resigns – a vertex is removed), may allow that two transplants are made.

We discuss two formulations for maximizing the number of effective 2-cycles which is the first criterion in the UK KEP. The first one is an integer programming formulation with a polynomial number of decision variables and constraints and the second one has an exponential number of decisions variables but is addressable by branch-and-price, not requiring the enumeration of all the effective 2-cycles of the graph. We present preliminary computational results.

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Keywords: *Kidney Exchange Problem, integer programming, branch-and-price*

Thursday, September 25th, 2014
Session LN2 - Special Section in Honour of Luka Neralić, Room 1
(9:20-10:50)

On Local Search Based Heuristics for Optimization Problems

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Abstract

Even the most simply stated problems such as the traveling salesman problem are known to be NP-hard, which roughly speaking means that there is no practical optimization algorithm provided the famous $P \neq NP$ conjecture is correct. The question is among the most challenging theoretical problems that were included into a list of seven millennium problems. From practical point of view, knowing that the problem is computationally intractable implies that we may use heuristics approaches and that we also should aim to find a nearly optimal solutions for which sometimes but not always approximation bounds can be given. It is well known that best results are obtained when a special heuristics is designed and tuned for each particular problem. This means that the heuristics should be based on considerations of the particular problem and perhaps also on the properties of the most likely instances. On the other hand, it is useful to work within a framework of some (one or more) metaheuristics which can be seen as a general strategies to attack an optimization problem. When comparing various metaheuristics, even asking a fair and formally consistent question is often difficult. Having this in mind, we provide some further evidence that simple local search heuristics may be at least very competitive choice.

Keywords: *optimization, heuristics, local search*

Thursday, September 25th, 2014
Session LN2 - Special Section in Honour of Luka Neralić, Room 1
(9:20-10:50)

On Solving Hard Optimization Problems Using SDP

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Abstract

Semidefinite Programming (SDP) is an extension of linear programming where the nonnegative vector variables are replaced by positive semidefinite matrix variables. Recently, SDP has turned out to be a very powerful tool for approximating NP-hard problems, and finds diverse applications in engineering etc.

In this talk we provide a brief background on SDP and an overview of the recent developments on solving several optimization problems by using SDP.

Keywords: *semidefinite programming, combinatorial optimization*

Thursday, September 25th, 2014
Session LN2 - Special Section in Honour of Luka Neralić, Room 1
(9:20-10:50)

Improved Full-Newton-Step Interior-Point Methods for LO and LCP

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Abstract

An improved version of an infeasible full Newton-step interior-point method for linear optimization is considered. In the earlier version, each iteration consisted of one infeasibility step and a few centering steps while in this version each iteration consists of only an infeasibility step. This improvement has been achieved by a much tighter estimate of the proximity measure after an infeasibility step. However, the best iteration bounds known for these types of methods are still achieved. Next, generalizations of the improved method to linear complementarity problems are considered.

Keywords: *linear optimization, linear complementarity problems, Interior-Point Methods, full Newton-step, polynomial complexity*

Thursday, September 25th, 2014
Session LN2 - Special Section in Honour of Luka Neralić, Room 1
(9:20-10:50)

Analysis of the Applicability of Goal Programming Procedure for Solving Fuzzy Multiobjective Linear Fractional Programming Problems

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Abstract

In the paper B. B. Pal et al, A goal programming procedure for fuzzy multiobjective linear fractional programming problem, *Fuzzy Sets and Systems* 139 (2003) 395-405, a new goal programming procedure for solving multiple objective fractional linear programming problems with fuzzy objectives has been proposed. In the proposed approach for achievement the highest membership value of each of the fuzzy goals defined for the fractional objectives, a goal programming model is formulated. In this method the decision makers should determine the lower and upper achievement limits of the objectives. This method for expressing the relative importance of objective functions uses an approach in which the weight for each objective function is calculated as the reciprocal value of the difference of the upper and lower achievement limits of the objective function. This method has not been tested on the practical problems. The first aim of this paper is to analyse the applicability of the method using (1) a company production plan optimization example, with 3 fractional objective functions, 24 variables and 26 constraints, and (2) a company financial structure optimization example with 4 fractional linear objective functions, 6 variables and 8 constraints. The proposed analysis will be done using the decision makers' and analysts' chosen criteria. The main drawback of this method is recognized in the fact that it requires information about the values of the lower and upper limits of the objective function achievements. Decision makers provide stated information, which is not always easy to provide. Additionally, studies have shown that the objective function weights incorporated into the method do not always reflect the decision makers' aspirations. Problems of a technical nature relating to the application of the method are also present. Therefore, the additional aim of this paper is to propose a modification of this approach. Information on the lower and upper achievement limits of the objective functions from the decision makers will not be required anymore. These will be replaced by the minimum and maximum value of the objective function. Also, the paper proposes introduction of the objective function weights determined by the method or obtained by the decision makers. On proposed, this paper will research whether the weights reflect the decision makers' preferences. The final aim of this paper is the comparison of the obtained results.

Keywords: *fuzzy linear programming, multiobjective fractional programming, goal programming*

Thursday, September 25th, 2014
Session LN2 - Special Section in Honour of Luka Neralić, Room 1
(9:20-10:50)

Tolerance Sensitivity in DEA

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Abstract

Data Envelopment Analysis (DEA) is a methodology for performing a relative efficiency evaluation of entities called Decision Making Units (DMUs) which use the same inputs and produce the same outputs. Since the first seminal paper of Charnes et al. [1978] DEA has become a fast growing area in both the theory and applications. Indeed, according to the bibliography of Emrouznejad [2011] there are more than four thousand references of works on DEA.

The importance of variations in the data, or what we will call sensitivity analysis, was apparent in the early days beginning with Charnes et al [1985] considering sensitivity with respect to a single output. This was followed by Charnes and Neralic [1990] and others. For a further discussion see, for example, Cooper et al [2001] as well as Cooper et al [2006] and Cook and Seiford [2009].

One of the approaches to DEA sensitivity, proposed by Charnes et al [1992, 1996], was to apply metric concepts in a way to make it possible to determine allowable variations in all inputs and outputs for one DMU in a DEA model. In particular, using an l_p norm to characterize distance, these papers propose optimization models to determine a maximum radius, called a “radius of stability”, within which variations of the inputs and outputs in a selected DMU would remain efficient, if the selected DMU was originally efficient, and would remain inefficient, if it was originally inefficient. As noted by Charnes et al [1996], “computations seem to be tractable only for the l_1 and the Chebychev (l_∞) norms” in which case the optimization models that they proposed correspond to linear programming formulations. Since then, research on these models has primarily focused on the Chebychef norm.

Independent from the above stream of work, a Tolerance Approach to sensitivity analysis in optimization problems was proposed by Wendell [1982, 1984, 1985]. This work originally focused on the Chebychev norm and showed how to find a maximum tolerance, typically interpreted as the maximum percentage within which selected coefficients or terms could vary while maintaining the same optimal basis. As noted by Wendell and Chen [2010], a number of subsequent papers proposed various theoretical extensions as well as applications including sensitivity of matrix coefficients, facility location problems, and multiple objective problems.

Both streams of research have remarkable similarities, but interesting differences. Herein, we explore these similarities and differences, as well as potential insights that might be gained from applying results obtained in one stream to the other.

Keywords: *Data Envelopment Analysis, sensitivity analysis, tolerance approach*

Thursday, September 25th, 2014
Session A4 - OR Theory and Application, Room 12 (11:05-12:35)

Linear Programming Model for Rostering Ambulance Crew

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Abstract

To provide the best health care given the limited resources that are available, managers need effective methods for decision making, as well as effective methods for management and improvement of health care systems. The main goal of this paper is development and application of linear programming model to aid decision making in health care sector, especially addressing workforce allocation in health care organizations with stochastic demand. In order to improve economic efficiency of ambulance service, optimal monthly schedule has been obtained. The current schedules in health care organizations in Serbia are static and made ad hoc, that leads to inefficient resources allocation. Rostering ambulance services is a very complex task, due to numerous constraints dealing with various legal and organizational regulations. In order to minimize costs, presented as the sum of required number of ambulance crews per month, the linear programming model has been developed and implemented. In this paper we analyze the data provided by ambulance service in city of Subotica. The proposed model is easily applicable to various aspects of human resources planning process in organizations with stochastic demand.

Keywords: *linear programming, health care management, scheduling, rostering*

Thursday, September 25th, 2014
Session A4 - OR Theory and application, Room 12 (11:05-12:35)

**Modeling Emergency Department Patient Surge in Disaster Conditions
by Simulation**

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Abstract

Emergency departments (EDs) are considered as heart of hospitals since they are the sole admission points to get first care anytime. Especially, the importance of these departments is appeared clearly in meeting the patient surge during disaster times with the available resources. Many EDs require additional resources to struggle with the bottlenecks in their systems. Maybe, EDs think about staff dispatching among other EDs temporarily in order to respond to the increased demand or hiring of doctors and nurses outside the hospital for a while. In this study, a computer simulation model is developed to investigate both normal time analysis of the ED and disaster time scenario considering increased disaster-victim patient arrivals. By doing this, early preparedness of departments in terms of physical and human resources will be performed. The studied ED is located in an earthquake zone in Istanbul and according to the report presented by Japan International Cooperation Agency (JICA) and Istanbul Metropolitan Municipality (IMM) on disaster preparedness of Istanbul, the district where the ED is located is estimated to have the highest injured rate. Based on this reality the study is aimed to present a good picture on pre-planning of the ED resources against the disasters.

Keywords: *emergency departments, patient surge, disaster time, simulation*

Thursday, September 25th, 2014
Session A4 - OR Theory and application, Room 12 (11:05-12:35)

Performance Evaluation and Regulation Influence on the Portuguese Water Sector

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Abstract

Measuring the performance of water services usually uncovers very high potential for gains in efficiency and productivity. This circumstance occurs, naturally, due to the fact that these services are outside the market and because they are subjected to various market failures in their organizational framework. The aim of this study was to examine the Portuguese regulatory model and to measure the performance of the Portuguese water services in order to identify the major reforms carried out and their outcomes. As a first objective, the sunshine regulatory approach adopted in Portugal, in which performance comparison and its public discussion are the main tools, was investigated. The second objective was to compute the efficiency of the Portuguese water services by means of the non-parametric robust techniques, evaluating the Portuguese regulatory model and the existing market structure, as well as the influence of the operational environment on efficiency. The benchmarking frontier technique of DEA is particularly useful in the efficiency measurement of public utilities, in which knowledge of the production function is relatively scarce. Several DEA models were used and they all depicted significant inefficiency.

Keywords: *benchmarking, Data Envelopment Analysis (DEA), efficiency; Portugal, regulation; water sector*

Thursday, September 25th, 2014
Session A4 - OR Theory and application, Room 12 (11:05-12:35)

A Market Structure Analysis of the Brazilian Water Sector

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Abstract

Water services in Brazil have historically been provided together with other services, such as the waste services. Despite the lack of discussion on this subject in the literature, some questions have been raised about the gains, in terms of efficiency, of this policy. Following a recent and robust partial nonparametric frontier model, based on order- α , we intend to evaluate the presence of economies of scope in the Brazilian water companies. Furthermore, we also estimate the economies of scale using the traditional data envelopment analysis. These outcomes might be useful for policy and decision makers in further reforms.

Keywords: *Data Envelopment Analysis (DEA), economies of scale, economies of scope, efficiency, Order- α , water sector*

Thursday, September 25th, 2014
Session A4 - OR Theory and application, Room 12 (11:05-12:35)

**Integrated Forest Road Maintenance and Harvest Scheduling With
Endogenous Costs**

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Abstract

Forest harvest scheduling models optimize the spatiotemporal layout of silvicultural actions to maximize timber revenues subject to environmental, logistical and sustainability constraints. Logistics, such as road construction and maintenance account for some of largest financial and environmental costs of forest management. Integrating decision support for harvest and road scheduling can minimize both of these types of expenses. We propose an integer programming model that not only coordinates road maintenance with harvest scheduling decisions, but it also accounts for costs that increase endogenously the longer a road segment is in disuse since its last haul. We will illustrate the mechanics and the benefits of the model in the Upper Clearwater watershed on the Olympic Peninsula, United States. This research was sponsored by the Washington State Department of Natural Resources.

Keywords: *integer programming, harvest scheduling, fix-charge problem, road networks*

Thursday, September 25th, 2014
Session B4 - Quantitative Methods in Banking and Finance, Room 13
(11:05-12:35)

**Multivariate Approach to Determination of Intermediate Target of
Monetary Policy Strategy in CEE Countries**

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Abstract

The main aim of this paper is to investigate the characteristics which determine the choice of intermediate target of monetary policy strategy in Central and East European (CEE) countries. Theoretical choice of intermediate target of monetary policy strategy refers to inflation targeting, exchange rate targeting and monetary targeting. Practical choice in these countries refers to inflation targeting and exchange rate targeting. This research tends to find out whether the choice of these regimes is adequate to theoretical presumptions.

Eleven characteristics will be classified for 16 chosen CEE countries, using the multivariate and multicriteria approaches, to determine whether there is a relationship between these characteristics and the choice of intermediate target. The 11 characteristics considering the theoretical insights and previous empirical research are: GDP level, inflation, external debt, loans in foreign currency or loans denominated in foreign currency, central bank independence, level of banking sector loans, international reserves, interest rates, trade openness, government budget deficit and trilemma index. The research will be done for four years (2005, 2007, 2009 and 2011). Therefore, the analyses will emphasize whether there is difference in characteristics in period before and during financial crisis. Moreover, the results will be compared with previous empirical research.

Keywords: *multivariate and multicriteria approaches, the choice of intermediate target, characteristics of CEE countries*

Thursday, September 25th, 2014
Session B4 - Quantitative Methods in Banking and Finance, Room 13
(11:05-12:35)

Stochastic Programming Framework for Lithuanian Pension Payout Modelling

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Abstract

The pension accumulation system in Lithuanian Republic (LR) was changed in 2014. The demographic situation is worsening and is expected not to be improved in the near future. Therefore, there are many uncertainties for the citizens of Lithuania, which pension accumulation system to choose. We provide a scientific approach to this problem. The decision making model, which can be used to plan long-term Lithuanian Republic (LR) citizen's pension accrual in optimal way is presented. This model focuses on factors that influence the sustainability of the pension system selection under macroeconomic, social and demographic uncertainty. The model is formalized as a stochastic programming (optimization) problem, where the long-term optimal strategy can be obtained based on the possible scenarios generated for a particular person. Stochastic programming methods allow including the pension fund rebalancing moment and direction of investment, and taking into account possible changes in personal income, changes in society and in the global financial market. The collection of methods used to generate scenario trees is useful in science to solve strategic planning tasks and can be adapted in other countries.

Keywords: *pension modelling, scenario tree, long-term strategy, rebalancing moment*

Thursday, September 25th, 2014
Session B4 - Quantitative Methods in Banking and Finance, Room 13
(11:05-12:35)

**Testing the Effects of Financial Literacy on Debt Behavior of Croatian
Financial Consumers Using Multivariate Analysis Methods**

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Abstract

The problems related to financial illiteracy are increasingly becoming a topical issue. More than ever before, individuals are in charge of their own financial security, especially after retirement. The shift from defined benefit to defined contribution pension plans that has occurred over the past twenty years made individuals in charge of making their own financial decisions. Making necessary financial decisions are even more difficult due to increased complexity of financial products and services, financial instruments and financial institutions. Moreover, the later economic crisis highlighted the importance of understanding financial products and services and the risks of engaging in financial activities without the necessary level of financial knowledge and skills. There is mounting evidence that people are in terms of financial literacy undereducated and thus unfamiliar with even the most basic financial concepts. Consequently, in the developed countries there is a growing body of literature investigating the concept of financial literacy, its determinants as well as its possible effects on households' wellbeing. However, the literature measuring financial literacy in small transition economies like Croatia is rather limited.

Financial literacy reflects individuals' ability to understand financial concepts, financial products and services and enables them to control their personal financial resources. Financial literacy should increase individuals' ability to independently manage and plan their personal finances.

The aim of this paper is threefold. Firstly, the aim is to detect and categorize the levels of financial literacy of Croatian financial consumers and to analyze whether the levels of financial literacy will be statistically significantly different with respect to socio-demographic characteristics. Second objective is to determine the factors underlying the debt behavior of financial consumers; and the third objective is to investigate whether the debt behavior of the respondents will differ with respect to financial literacy levels.

In order to analyze the effects of financial literacy on debt behavior of Croatian financial consumers, a financial literacy questionnaire was administered to a sample of 101 respondents living in Croatia. The sampling method used is snowball sample. After conducting the survey, multivariate statistical methods are used. To categorize the level of financial literacy of the respondents in the survey, multivariate cluster analysis is used. With the purpose of determining whether respondents' financial

literacy levels differ with respect to demographic characteristics, nonparametric chi-square test is applied. We investigated the effects of financial literacy on the debt behavior by principal component factor analysis. We also examined whether the debt behavior of the respondents differs with respect to financial literacy levels and socio-demographic variables using rank-based nonparametric test Kruskal–Wallis H-test. To examine the source of the difference in the debt behavior with respect to different financial literacy levels of the respondents we conducted a post hoc analysis using Dunnett's test. Post-hoc analysis examines the combination of groups and reveals which groups are responsible for the difference. Dunnett's test is one of a number of post hoc tests run after a significant one-way analysis of variance (ANOVA), used to determine which differences are significant. It differs from other post hoc tests in that its use is restricted to comparing a number of experimental groups against a single control group.

Keywords: *cluster analysis, factor analysis, post hoc analysis, financial literacy, financial illiteracy, debt behavior*

Thursday, September 25th, 2014

Session B4 - Quantitative Methods in Banking and Finance, Room 13

(11:05-12:35)

Statistical Analyses of Investment and Pension Funds' Performances from South-Eastern Europe

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Abstract

The foundation of the post-modern portfolio theory is creating a portfolio based on the desired target return. This specifically applies on the operations of the investment and pension funds in order to provide a rate of return that meets the payment requirements from the funds' investors. The preferred targeted return is a return necessary for achieving the desired goal of the investment or pension fund. It is the primary benchmark used to measure performances, dynamic monitoring and evaluation of the risk – return ratio on investment of funds.

The analysis applied in this paper is conducted based on monthly returns of the investment and pension funds from the South – Eastern Europe region. It uses the basic, but still highly informative statistical characteristic moments like Skewness, Kurtosis, Jarque – Bera, and Chebyishev's Inequality. The objective of this study is trough analyses that use the above and other specific statistical techniques (Sharpe, Sortino, Omega, Upside Potential, Calmar, Sterling) to draw relevant conclusions regarding the risks and the characteristic moments in the performances of the investment and pension funds from the region.

Keywords: *desired target return, downside deviation, risk management, investments*

Thursday, September 25th, 2014
Session B4 - Quantitative Methods in Banking and Finance, Room 13
(11:05-12:35)

Measurement of European Banking Industry Cost Efficiency

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Abstract

The main goal of the paper is to measure and to analyse efficiency results of chosen European banking systems by using mathematical linear programming non-parametric method. In that sense, Data Envelopment Analysis (DEA) can be effective mathematical tool for measuring overall technical inefficiency, among others in banking industry as well. DEA efficiency measurement approach includes defining relatively efficient Decision Making Units (DMUs), which define the efficiency frontier and evaluate the inefficiency of other, relatively inefficient DMUs. Efficiency measurement for the purpose of this research is made by using DEA CCR and BCC, as well as window analysis model.

More concrete, impact of long-term funding sources on the European banking industry cost efficiency is tested for the period after the onset of the last global financial and economic crisis (2008–2012). In this case, DMUs are banking systems of the European Union member countries. Input data include interest expenses and total operating expenses as a sum of two positions: fee and commission expenses and other operating expenses (labour-related and capital-related administrative expenses and other expenses from bank's business activity). Output data include interest income and total operating income as a sum of two positions: fee and commission income and other operating income.

The results of efficiency measurement suggest that costly more efficient are banking systems of post-transition countries which still have dominant deposit long-term financing base, while other sources of fund for the purpose of long-term lending activities such as housing loans finance (i.e. issuing of mortgage securities) have relatively low significance, up to 10 percent. Such results can be explained by the fact that last global financial and economic crisis had significantly higher impact on banking systems exposed to mortgage securities instruments as relatively significant sources of funds for the purpose of long-term lending activities.

The results of DEA efficiency measurement approach are compared with chosen accounting cost efficiency ratios as well. The main goal of such comparison is to see if there exists correlation between results of those two different cost efficiency measurement methodologies. This comparison can help in bringing to more precise conclusion about banking industry efficiency.

Keywords: *bank, long-term financing, efficiency, Data Envelopment Analysis, accounting ratios*

Thursday, September 25th, 2014
Session C4 - Statistics and Econometrics, Room 14 (11:05-12:35)

**Which Distance-Decay Function for Migration and Which One for
Commuting? The Case Study of Slovenia**

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Abstract

According to Evers and Van der Veen (1985), commuting can be considered as a substitute to migration if work and residence are geographically separated, but that they can be also considered as a complement if a person chooses to move away from their workplace locality, and then commutes to work. If there are conditions that allow for commuting, people often choose to commute instead of moving closer to their work. And vice versa: poor commuting conditions can be perceived as a prerequisite for migration. Many researches of spatial interaction systems, e.g. Ravenstein (1885), Stewart (1941), Taylor (1975), Haynes and Fotheringham (1984), Fotheringham and O'Kelly (1989), proved that the volume of the interactions between two locations depends significantly on the distance between them. In this paper we determine the effect of the distance on migration and commuting flows. The question is how the intensities of migration and commuting decrease with distance, since this decrease is usually not linear. To answer this question we analysed the shape and parameters of several distance-decay functions for migration and separately for commuting flows between municipalities in Slovenia for a period of two years (2010–2011). Those functions were: power, exponential, normal, square-root exponential, hyperbolic, power-exponential, and normalized power-exponential distance-decay function. Distance was considered in three ways: as the shortest road distance, as the fastest road distance, and as Euclidean distance between municipal centres under consideration. The analysis was performed for the whole set of interactions in the state, as well as for interactions to specific regional centres in the state. The results show that the S-shape of the power-exponential distance-decay function fits best for all analysed cases. The determination coefficients are low ($R^2 \approx 0.2$) when analysing all data together, but they increase significantly when distance-decay functions are modelled for specific centres ($0.65 < R^2 < 0.95$).

Keywords: *distance-decay function, spatial interaction, intensity of interaction, commuting, migration, Slovenia*

Thursday, September 25th, 2014
Session C4 - Statistics and Econometrics, Room 14 (11:05-12:35)

Adjusting for a Calendar Effects of Real Retail Trade Turnover Time Series in Croatia

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Abstract

Economic activity fluctuations are often influenced by various factors related to the calendar. These factors include non-working (non-trading) days, leap years, public holidays etc. In analysis of many economic variables in which time series are seasonally adjusted it is necessary to identify and correct calendar effects using suitable method, but there is no general or unique procedure for correcting these effects in pre-adjustment process. If these effects are not well adjusted, the identification of the ARIMA model may not be correct, and the quality of the seasonal adjustment is poor. Therefore, in this paper different methods of correction of the calendar effects are compared and applied to time series of real retail trade turnover (RRTT) in Croatia (monthly data observed from January 2008 to December 2013). The most common used method is regression model with different types of explanatory variables which take into account calendar effects. The contribution of this paper is to define new explanatory variables (regressors that include not only different number of working and non-working days of the month but also country specific calendar effects) which will give most accurate correction of RRTT time series with appropriate goodness of fit and prediction power. Also, the significance of different calendar effects will be tested. Even particular methods are similar; for example method that uses U.S. Census Bureau compared to the Eurostat method, it is not clear which method is better. The choice of method usually depends on experience and the policy of entire organization such as Croatian Bureau of Statistics. Calendar adjustment as well as seasonal adjustment is a source of constant debate, due to the different methods that can be used, and the different tools and computer programs that exist.

Keywords: *calendar effects, time series, adjustment process, country specific regressors*

Thursday, September 25th, 2014
Session C4 - Statistics and Econometrics, Room 14 (11:05-12:35)

Development Index: Do Weights Matter?
An Application of Data-Driven Weights and Restrictions in the
Construction of Composite Indicators

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Abstract

Composite indicators are increasingly recognized as a useful tool in policy analysis and public communication. However, if they are poorly constructed they can send misleading policy messages. One of the most difficult aspects of constructing composite indicators is choosing weights for the components.

The categorization of Croatian territorial units for development policy is based on the value of development index. This index is a composite indicator which is calculated as the weighted average of five basic normalized socio-economic indicators: income *per capita*, budget revenue *per capita*, unemployment rate, change in population number, and educational attainment rate, relative to the national average. The indicators and their corresponding weights are determined by a government decree. This paper provides a brief overview of the government methodology, and proposes a new method, based on empirical approach for weight selection.

This approach appeared worthwhile pursuing, as it uses non-subjective weights, and thus generates less biased results. The main goal of this paper is to propose an empirical approach for weight selection. In order to generate the set of non-subjective weights, principal component analysis and linear programming methods have been applied. An application of data envelopment analysis to the field of composite indicators, known as the Benefit Of the Doubt (BOD) approach, has been demonstrated. This method allows weights to vary across units and determines weights which maximize the value of territorial unit's composite indicator subject to the given restrictions. Instead of setting absolute restrictions to the values of weights, proportional sub-indicator share restrictions were imposed. Additionally, assuming the weight setting as the only source of uncertainty, Monte Carlo simulation of weights was conducted. This allowed for estimating confidence intervals for the values of the development index instead of unique point estimation. Methods used in this paper can contribute in the construction of an index designed to represent the complex phenomenon of socio-economic development.'

Keywords: *composite indicator, development index, weighting, principal component analysis, Benefit Of the Doubt*

Thursday, September 25th, 2014
Session C4 - Statistics and Econometrics, Room 14 (11:05-12:35)

**Research and Evaluation of the Effectiveness of E-learning:
A Linear Programming Case Study**

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Abstract

In this talk we consider an implementation of the e-learning for the case of Linear Programming (LP) module of lectures. Furthermore, an action research methodology was used to examine the effectiveness of e-learning approach versus classical learning techniques.

At the first stage of the research, an e-learning module of LP lectures has been created using Loomen Moodle software and other interactive software used within such Geogebra. In addition to classical material, such as Simplex Method (SM), the module contains a section on new methods in LP, called Interior-Point Methods (IPM).

At the second stage of the research, a study of the effectiveness of e-learning was conducted. The LP module was taught as a short course to two groups of students with statistically insignificant differences in background knowledge, previous academic performance and other academic indicators. In one group the module was taught using classical in class teaching methods while in the other group the module was taught using e-learning approach.

The teaching process was monitored using Action Research Methodology (ARM). Detailed ARM plan was created and followed which included writing a diary, collection of comments from students and “critical friends”, and collection of statistical data measuring progress and success in the course.

At the last stage of the research, after the delivery of the course, the collected data was analyzed and validated and statistical analysis was performed showing that the group of students that was taking the course using e-learning approach performed better than the group that used classical teaching approach. Hence, the initial thesis that can be formulated as follows: The e-learning methodology if implemented correctly, which requires significant preparation and planning, leads to the improved understanding, acquisition and retention of the material being taught; has been validated.

Keywords: *linear programming, e-learning, action research, statistical analysis*

**CONTRIBUTED PRESENTATIONS -
Friday, September 26th, 2014**

Friday, September 26th, 2014
Session A5 - OR Theory and Application, Room 12 (9:20-10:50)

**Modifications of the Omega Ratio for Decision Making Under
Uncertainty**

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Abstract

The Omega ratio was proposed by Shadwick and Keating in 2002 as a performance measure applied when making rankings of assets, portfolios or funds. It involves partitioning returns into loss and gain below and above a given point of reference. The original version of the Omega ratio was designed for decision making under risk (probabilities totally known), but recent research has shown that it was possible to adjust this measure to decision making under partial information (likelihoods not known completely). In this contribution we examine the possibility of using the concept of the Omega ratio in decision making under uncertainty (DMUU) which occurs when the decision maker (DM) has to choose the appropriate alternative (decision, act, project, strategy) on the basis of some scenarios which probabilities are not known at all. The goal of this article is to adjust the Omega ratio to DMUU so that the modified measure takes into consideration DM's preferences (i.e. his or her attitude towards risk understood as the possibility that some bad circumstances will happen: losses or low outcomes) and the distribution of all payoffs connected with particular decisions. The original Omega ratio is combined with the H+B rule (a hybrid of Hurwicz and Bayes rules proposed by the author in another paper). The Omega(H+B) measure enables to select an appropriate pure strategy under uncertainty.

Keywords: *Omega ratio, hybrid of Hurwicz's and Bayes' decision rules, decision making under uncertainty, optimal pure strategy, reference point, Omega(H+B)*

Friday, September 26th, 2014
Session A5 - OR Theory and application, Room 12 (9:20-10:50)

**Impacts on Internet Booking for Travel and Holiday Accommodation
in European Countries: Multivariate Analysis Approach**

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Abstract

An increase of Internet penetration and of percentage of Gross National Product (GDP) for public expenditure on education, as well as increased Internet skills make people better prepared to adopt Internet when purchasing services. For many European economies tourism became a major source of wealth influencing an increase of GDP per capita, taxes, employment, exports, etc., but there is a hypothesis that the opposite also holds, because the higher GDP per capita positively influence the raise of demand for tourism services purchased on-line. Since the Internet purchases are in recent years in many European countries close to prevail in tourism services retail, the authors have found challenging enough to investigate what are the most important variables that impact the Internet booking of travel and holiday accommodation in these countries. According to the latest Eurostat surveys about attitudes of Europeans towards tourism Internet remains for them the most common way to arrange holidays. E.g. in 2012 Internet is more likely to be mentioned for holiday arranging by respondents 15+ living in EU15 countries compared to those in new member states. The Internet was the most used method to arrange holidays in all but four countries: the FYR Macedonia, Serbia, Croatia and Turkey. This paper investigates impacts of economic individuals' ICT skills related variables on Percentage of individuals who booked travel and holiday accommodation over the Internet in the last 12 months, as the main variable under study. Recent official data for 31 European countries are explored. Not only data for European Union (EU) countries, but three EU candidate countries data, for Turkey, the FYR of Macedonia and Serbia are analysed, too. The research focuses the position of the above mentioned EU candidate countries considered to be part the Western Balkans, and also the position of Croatia, the youngest EU member, compared to older member states, considering trends of Internet booking. The main variable under study and four variables that make a statistically significant impact on it are explored. After exclusion of outliers, the correlation analysis, regression modelling and cluster analysis follow. The four-cluster solution by k-means method gave somewhat different country classifications compared to hierarchical clustering. The four-cluster solution included the following clusters: Scandinavian countries; developed North and Central European countries; EU developing countries; and cluster of Western Balkan countries. The newest EU member Croatia falls into the cluster of EU developing countries.

Keywords: *internet booking, European Union countries; k-means clustering, hierarchical clustering, regression modeling*

Friday, September 26th, 2014
Session A5 - OR Theory and application, Room 12 (9:20-10:50)

A Group Decision Support System for Evaluating the Efficiency of Academic Units

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Abstract

In this paper we develop a Data Envelopment Analysis (DEA) assessment framework to evaluate the research activity of academic staff in comparable university departments. The selected factors (inputs and outputs) have a meaningful interpretation in the analysis and provide us with the ability to perform the assessments by taking into account both the extent as well as the quality of the research records. We take as inputs the duration of the research activity and the salary received. We consider as outputs the number of publications in journals ranked as A+ or A, the number of publications in journals ranked as B or C, the publications in unranked journals, publications in conferences and the number of citations (excluding self-citations). We draw the journal rankings from the Excellence in Research for Australia (ERA) 2010 journal classification system. The data are drawn from Scopus, Google Scholar, university personal records and CVs.

In DEA, each DMU is free to select the weight variables that maximize its relative efficiency. However, the arbitrary trade off among the factors may not be in line with the decision maker. To facilitate the incorporation of a quality aspect in our assessments, i.e. to reward the quality research outcome while diminishing the contribution of extensive publications in low quality journals in the overall research performance, we restrict the weight space by imposing assurance region constraints. In particular, we utilize the Analytical Hierarchy Process (AHP) for enabling a group of experts to express their individual preferences with respect to the relative importance of the factors, and to

aggregate them into group preferences that denote not only the ranking of the factors, but also the intensity of the group preference over the factors. By translating this information into assurance region constraints, we incorporate into the DEA assessments the preferences of decision makers over the relative importance of the factors.

To meet the above requirements, we developed a web-based group DSS which integrates AHP and DEA and enables the asynchronous cooperation of the experts. Particularly, the core of the system integrates AHP with an algorithm which encapsulates the CCR, the BCC and the additive DEA models and supports the incorporation of weight restrictions. In addition, the software provides cross efficiency as a post-analysis tool as well as it provides reports with efficiency scores, slacks and projections on the efficient frontier. Thus, we develop a robust framework to evaluate the research activity of academic staff. We illustrate both the proposed hybrid approach and the system with the aforementioned academic data set.

Keywords: *Data Envelopment Analysis (DEA), Analytic Hierarchy Process (AHP), research activity, higher education, academic evaluation*

Acknowledgment: This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: THALES. Investing in knowledge society through the European Social Fund.

Friday, September 26th, 2014
Session A5 - OR Theory and Application, Room 12 (9:20-10:50)

**Comparison of Discrete Event Simulation Tools
in An Academic Environment**

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Abstract

Computer-based simulation is a valuable and appreciated tool that enables organizations to explore and evaluate different organizational policies and strategies, having in mind all the economic and business aspects of the observed business processes. In the paper two discrete event simulation tools are evaluated in detail using task-centered walkthrough evaluation methods. Both tools were used for teaching discrete event simulation in preceding academic years. With the aim to inspect their effectiveness and to help us determine which tool is more suitable for students' i.e. academic purposes we used a simple simulation model of entities competing for limited resources. The main goal was to measure subjective (primarily attitude) and objective indicators while using the two tools - Arena and ExtendSim when the same simulation scenario is given. The subjects were first year students of master studies in Information Management at Faculty of Economics in Split taking the course in Business Process Simulations. In the controlled environment in a computer lab two groups of students were given detailed, step-by-step instructions for building the model using both tools - first using ExtendSim then Arena or vice versa. The subjective indicators (students' attitudes) were collected using an online survey that the students completed upon building the model in each tool. Subjective indicators include primarily students' personal estimation of the possibilities of Arena and ExtendSim (for model building, model simulation and result analysis). Some other information with regards to students' perceptions was collected as well. Objective indicators were measured using software that logs information on user's behavior while performing a particular task on their computer such as distance crossed by the mouse during building the model, number of mouse clicks, usage of mouse wheel and speed achieved. The results indicate that ExtendSim is preferred comparing to Arena when it comes to subjective indicators while the objective indicators are better for Arena. Objectively students completed the given scenario faster and with fewer movements in Arena, but they still prefer ExtendSim and perceive it as the better tool, considering the defined characteristics and functionalities. The research gives a new dimension to comparing simulation tools in academic surrounding and is therefore only a beginning of a broader exploration of the usage and acceptance, as well as the role of this important technique for solving and optimizing problems.

Keywords: *discrete event simulation, tool evaluation, ExtendSim, Arena*

Friday, September 26th, 2014
Session B5 - Machine Learning, Data Mining and Analytics, Room 13
(9:20-10:50)

A New Fusion Algorithm for Fuzzy Clustering

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Abstract

In this paper we have considered the merging problem of two ellipsoidal clusters in order to construct a new fusion algorithm for fuzzy clustering. We have proposed a criterion for merging of two ellipsoidal clusters π_1, π_2 with associated main Mahalanobis circles $E_j(c_j, \sigma_j)$, where c_j is the centroid and σ_j^2 is the Mahalanobis variance of cluster π_j . Based on the well-known Davies-Bouldin index we have constructed a new fusion algorithm. The criterion has been tested on several data sets, and the performance of the fusion algorithm has been demonstrated on an illustrative example.

Keywords: *fusion algorithm, fuzzy clustering, Mahalanobis clustering, cluster merging, Davies-Bouldin index*

Friday, September 26th, 2014
Session B5 - Machine Learning, Data Mining and Analytics, Room 13
(9:20-10:50)

**Colour Image Segmentation Based on Intensity and Hue Clustering -
Least Square and Least Absolute Deviation Approaches Comparison**

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Abstract

This paper addresses the color image segmentation problem. Motivated by the method for color image segmentation based on intensity and hue clustering, proposed in the paper Zhang and Wang (2000), we give some theoretical explanations for this method that directly follows from the natural connection between Maximum Likelihood approach and Least Square or Least Absolute Deviation clustering optimality criteria. The method is tested and illustrated on a few typical situations, such as the presence of outliers among the data.

Keywords: *data clustering, colour image segmentation, least square, least absolute deviation*

References:

[1] Zhang, C. and Wang, P. A new method for color image segmentation based on intensity and hue clustering, In Proceedings of the 15th ICPR, Barcelona, **3** (2000), 717—620.

Friday, September 26th, 2014
Session B5 - Machine Learning, Data Mining and Analytics, Room 13
(9:20-10:50)

Customer Segmentation Using Neural Networks

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Abstract

This paper shows how neural networks can be useful in process of predicting customer segments. An important factor of customer relation is their segmentation and an adequate relation according to their belonging to particular segment. Not all customers are cost effective for the company, and customer segmentation gives an insight which of them are worth for the company and which are not. Activities related to the company's most profitable customers are focused on efforts to retain them, and for those less profitable attempts to move them into more profitable segment. The aim of this paper is to determine how neural networks are able to predict belonging of each customer to specific segment based on data from transactional database of loyalty cards which brought together companies that are engaged in trade and services in different specialties. This paper presents research on analyzing data set of loyalty card users classified by customer status (active, inactive and new) and loyalty classification (high, medium and low). A result of the research indicates three groups of customers. In first group are customers on which is necessary to act more aggressively in marketing field in order to keep them. Second group identifies customers which need to be stimulated to transfer them in the group of profitable customers, and third group contains of customers that need to be stimulated with appropriate marketing activities to get out of zone of unprofitability or ultimately reject them. Customer activity in first quarter will be used to predict segment in which customer belongs at the end of the year. This will show predictive ability of neural networks and how reliable they are in process of customer segmentation using incomplete data.

Keywords: *customer segmentation, neural networks, loyalty cards*

Friday, September 26th, 2014
Session B5 - Machine Learning, Data Mining and Analytics, Room 13
(9:20-10:50)

**Aligning Classification Schemas of the Croatian Encyclopedia and
Wikipedia through Supervised Machine Learning**

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Abstract

This article paper has emerged as a result of research on the effectiveness of methods of supervised learning in text mining. The research objective was to find an effective method of encyclopaedic articles categorization. As a labelled data (training set) we used a complete content of Croatian Encyclopaedia published by Miroslav Krleža Institute of Lexicography with over a 70.000 articles and categorization was conducted over 140.000 articles of Croatian issue of Wikipedia. Research was conducted in preparation of encyclopaedic content for further quality comparison and for this purpose we tested methods for supervised learning (Bayes, Support Vector Machine, J48) and rate their effectiveness. In addition to testing individual methods, the research included the impact of certain parameters of pre-processing (word frequency, stop words, etc.) and numerical statistic (TF-IDF algorithm).

This research provided us with: (1) data insight on the impact of pre-processing settings when preparing data for each method used, (2) comparative data on the effectiveness of the application of text mining methods, and (3) the results of the classification: the representation of certain content categories according to the number of articles published in Croatia Encyclopaedia and Wikipedia

Keywords: *text mining, supervised learning, automated text categorization*

Friday, September 26th, 2014
Session B5 - Machine Learning, Data Mining and Analytics, Room 13
(9:20-10:50)

Business Clusters in Croatian Furniture Industry

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Abstract

Cluster-based economic development has received much attention in the literature as a development strategy in the era of globalization. The present paper is devoted to the issue of furniture industry clusters in Croatia. Furniture manufacturing has always been a very important segment of the Croatian economy. In this research paper, theoretical and empirical research methods are used. This study will examine spatial autocorrelation among furniture manufacturers in Croatia to identify areas with high concentrations of these manufacturers because such areas might constitute business clusters and be suitable for targeted cluster-based economic development. The literature review suggests that most clusters have emerged with the purpose to increase export volume and competitiveness of the constituent companies. High manufacturer density indicates that these areas offer advantageous conditions that might have resulted from the abundance of input resources, positive business environment, suitable infrastructure or historical presence of the industry. The identified areas might benefit from cluster-based economic development by capitalizing on existing infrastructure and business linkages.

Keywords: *furniture manufacturers, data clustering, clustering, location, spatial analysis*

Friday, September 26th, 2014
Session C5 - Statistics and Econometrics, Room 14 (9:20-10:50)

Entrepreneurial Intention Modeling Using Hierarchical Multiple Regression

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Abstract

The aim of the study is to incorporate elements of effectuation, as prospective predictors of entrepreneurial intention, into entrepreneurial behavior prediction model. Effectuation and entrepreneurial intention prediction models represent research fields that have rarely crossed their paths. The goal of this study is to identify the contribution of effectuation dimensions to the predictive power of the entrepreneurial intention prediction model over and above that which can be accounted for by other predictors previously selected and confirmed by researchers in the field. To do this, the authors apply theory of planned behavior and effectuation as theoretical framework, and hierarchical multiple regression as primary data analytic procedure behind the model development.

Intention to undertake a certain behavior is considered to be the best predictor of the actual behavior. Based on the theory of planned behavior, the intention is under direct influence of three main antecedents – personal attitude, subjective norms and perceived behavioral control – to which the authors add six new ones, defined as dimensions of effectuation. Effectuation represents a logic that can be applied in business decision making and is typical for expert entrepreneurs. Therefore, it is a valid assumption that people, who are more inclined to use effectual logic, will have higher propensity to pursue entrepreneurial career.

As is often the case with data analysis in social and behavioral studies, some variables are likely to be highly correlated with each other. Therefore, the relative amount of variance in the criterion variable explained by each of the predictors depends on several factors such as the order of variable entry and sample specifics. Hence, application of hierarchical regression analysis requires from the researcher to provide a clear and logical rationale for selection of predictor variables and specific order of entry. The results show quite modest predictive power of two dimensions of effectuation prior to introduction of the theory of planned behavior elements. Once included in the model, personal attitude and perceived behavioral control significantly increase the predictive power of the model and render effectuation variables irrelevant. Overall, the article highlights the main advantages of applying hierarchical regression in social sciences in general as well as in specific context of entrepreneurial intention formation, and addresses some of the drawback that this type of analysis entails.

Keywords: *hierarchical multiple regression, entrepreneurial intention, effectuation*

Friday, September 26th, 2014
Session C5 - Statistics and Econometrics, Room 14 (9:20-10:50)

Liquidity Indicator for The Croatian Economy
- Factor Analysis Approach

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Abstract

The aim of this paper was to continue the research process started in 2012 in developing new business survey liquidity indicator for Croatian economy. Simple business survey liquidity measure (calculated only) in manufacturing industry was defined as the balance between the weighted percentages of the positive (1) and negative (3) managers' responses to the question: "*Liquidity of your firm is: (1) good, (2) with temporary problems, (3) bad*". Forecasting properties of this indicator was confirmed. It can be a proxy of widely used Industrial confidence indicator (ICI). So, the changes in the liquidity measure can predict the direction of changes in industrial production with one or two quarters lead.

However, since the Croatia's business survey are conducted in manufacturing industry, retail trade and construction sector, the aim of this research was to form a new liquidity indicator by including business survey liquidity measures from all three covered economic sectors in Croatia's economy, mentioned above. In calculating new leading indicator, factor analysis approach was used. This approach is usually used in calculating Business survey indicators according to harmonized EU Business survey methodology. However, this kind of indicator does not exist in Croatia, or in any other European economy. Furthermore, the issue of Croatian companies' illiquidity is highly neglected in the literature.

The empirical analysis consists of two parts. In the first part the new liquidity indicator was formed using factor analysis. Three liquidity variables (in manufacturing industry, construction and in retail trade) were extracted in one factor. This factor represents the new liquidity indicator (LI) for the Croatian economy. In the second part, some econometric models were applied in order to investigate the forecasting properties of new business survey liquidity indicator, when predicting the direction of changes in Croatian macroeconomic aggregates. Based on the econometric analysis, it can be conclude that the new liquidity indicator can be a proxy of widely used business survey composite indicator like Economic Sentiment Indicator (ESI). The quarterly data covered the period from 2000/I to 2013/IV. The data sources were *Privredni vjesnik* and the *Croatian Bureau of Statistics*.

Keywords: *leading indicator, liquidity measure, factor analysis*

Friday, September 26th, 2014
Session C5 - Statistics and Econometrics, Room 14 (9:20-10:50)

Baltic Dry Index and Performance Excellence in the Crisis Environment

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Abstract

This paper deals with an approach of analysing the relationship between Baltic Dry Index as the main indicator of the cyclical nature of the maritime market and the performance excellence of the representative shipping companies. The performance excellence will be measured by one traditional indicator of business performance - Z score as well as the one recent performance indicator Bex Index. Bex Index has been so far only applicable to the assessment of production enterprises. In this article Bex Index will be applied to the same data of the same shipping companies as the Z score indicator testing the hypothesis that Bex Index is the valuable indicator for performance excellence of the companies that operate on the maritime market. As the world stock market oscillates in an ever tightening trading range, investors around the world are trying to read the tea leaves to determine what will happen next. Baltic Dry Index as the most comprehensive indicator of the global demand for commodities and raw materials will be analysed as a signal for the supply and demand at the stock market. It is known that Baltic Dry Index is such a signal in no crisis period and this paper aims to test the hypothesis that Baltic Dry Index as a signal also promptly responds on the crisis effects. Specifically, in the case of high correlation between short-term (quarterly) average Baltic Dry Index values and the company business excellence results, Baltic Dry Index values come to the possibility to be buying or selling signal for the certain shares. This signal is even more valuable because it occurs before the quarterly accounting maritime companies reports. The whole methodological procedure is conducted using the real date base related to the shipping companies chosen for the case study. Namely, chosen companies should have a similar structure of the fleet and further more similar all of the fleet structure dimensions. Case study companies set contains of the companies whose headquarters are on different continents. In addition, chosen European, Asian and American shipping companies have at least seventy fleet percent ships for transporting bulk cargo called bulk carriers. According to the research results in the time horizon from 1985 to 2013 year the maritime companies that have used the similar strategy of the Baltic Dry Index volatility hedging have the similar performance excellence indicators.

Keywords: *Baltic Dry Index, performance excellence, Bex Index, Altman adjusted Z-Score, maritime market, shipping companies excellence*

Friday, September 26th, 2014
Session C5 - Statistics and Econometrics, Room 14 (9:20-10:50)

**System Dynamics Modelling and Simulation of the Intellectual Capital
Influence on the Economy Growth in the Republic Of Croatia**

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Abstract

System dynamics simulation modelling is one of the most appropriate and successful scientific methods of complex, nonlinear natural, economic and technical system dynamics modelling as it enables both monitoring and the assessment of the intellectual capital influence on economy growth. Intellectual capital is defined as "the ability to transform knowledge and intangible assets in the resources to create wealth for the company and for the country". The transformation of knowledge is crucial. Knowledge will increase the wealth of the country only if its importance is recognized and applied in a manner different from the existing working practices. The aim of this paper is to show the efficiency of the system dynamics simulation modelling of the intellectual capital influence on economy growth. Computer simulation provided a mathematical model, which enables practical insight into the dynamic behavior of the observed system, i.e. the analysis of economy growth and observation of mutual correlation between individual parameters. The results of the simulation are presented in a graphic form. The dynamic model of the intellectual capital influence on the economy growth in the Republic of Croatia has been verified through the comparison of the simulation results with the existing economy growth data.

Keywords: *intellectual capital, economy growth, system dynamics, structural model, development diagram*

Friday, September 26th, 2014
Session C5 - Statistics and Econometrics, Room 14 (9:20-10:50)

How (I)Rrational Are We? Case of Croatian Inflation

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Abstract

The rational expectations hypothesis (REH) today presents the workhorse model of modern macroeconomics. It is widely accepted that economic agents are utterly rational and fully informed, taking into account all the relevant information when making economic decisions. However, the fact that most macro models employ the rationality assumption does not mean it is indeed true. This paper aims to add to the literature by analysing whether the REH holds in the case of Croatian consumers and their inflation expectations (measured by consumer surveys). Previous studies on this issue focus entirely on examining the relationship between actual and expected inflation in a purely linear fashion. Adding to the existing literature, this paper investigates whether time-varying econometric models in a state-space framework offer new insights on the matter. The authors estimate eight separate state-space models in order to properly explain the relationship between actual and expected inflation in Croatia. According to the Akaike information criterion, the best model is found to be the one with a time-varying constant term, fixed slope, and fixed seasonal component. While the slope is approximately equal to zero, the estimated constant term (reflecting the expectations bias) varies around 3% throughout the analysed period of 2005-2014. This implies that Croatian consumers heavily overestimate actual inflation dynamics, which is utterly in line with similar international research. Also, this kind of expectations-actual inflation relationship can also be attributed to the anchoring heuristic. Namely, the obtained results reveal that the actual inflation dynamics hardly has any effect on consumers' inflation expectations. The consumers produce inflation estimates independently and re-appraise them only in case of extreme events. Two such occasions were also documented here in the analysed period: i) the constant term reaches its historical maximum in 2009 due to the price boom of food and energy on the world markets; ii) the constant term falls sharply after the Croatian accession to the EU. The latter can be attributed to the record-low inflation figures after mid-2013.

Keywords: *inflation expectations, rational expectations hypothesis, state space model, consumer surveys, time-varying parameters*

Friday, September 26th, 2014
Session LN3 - Special Section in Honour of Luka Neralić, Room 1
(9:20-10:50)

**Measuring the Efficiency of Macedonian Banks:
A Non-Parametric Approach**

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Abstract

The financial development process is usually understood as improvements in the quality of the five key financial functions: savings mobilization, risk diversification, resource allocation, corporate control and ease of trading. The performing of these financial functions can be expressed through four different components of the financial development process: size, activity, efficiency and stability of the financial institution and markets.

The subject of this paper is the way in which efficiency contributes to the financial development process in Central and Eastern European Countries with a typically banking-oriented financial sector. Through assessment of the relative importance of each of the four components of the financial development process we will emphasize the crucial role of the efficiency in the banking sector in these countries, with special focus on the case of Macedonia.

The aim of the paper is to measure the relative efficiency of Macedonian commercial banks in the period between 2007 and 2013, using the non-parametric deterministic methodology data envelopment analysis (DEA). The analysis is carried out using DEA models with both (constant returns-to-scale (CRS) and variable returns-to-scale (VRS)) assumptions. The obtained results are presented, compared and analyzed and it is pointed out what the banks that are identified as relatively inefficient should undertake to achieve successful results.

Keywords: *banking, Macedonian commercial banks, banks efficiency, Data Envelopment Analysis, returns-to-scale*

Friday, September 26th, 2014
Session LN3 - Special section in honour of Luka Neralić, Room 1
(9:20-10:50)

The Model of Firm's Innovation Orientation - Case of Slovenia

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Abstract

Firms have to innovate to maintain or capture markets, to outdistance competitors, and to assure long-term growth and survival. The purpose of this article is to develop and test the model of firm's innovation orientation in order to define the most important factors as well as to measure their impact on a firm's innovation output and its performance. Innovation orientation is defined as the knowledge structure that permits the recognition of market dynamism and then provides a knowledge template to develop the required process and to build a firm's dynamic capabilities (Siguaw et al., 2006).

In our model, the concept of innovation orientation was measured by three inter-related dimensions: an innovation strategy, an organizational culture and a sustainable development strategy. Further, we examined the pathways from an innovation orientation to a firm's competences and then to innovation-related output and its performance. Our research was limited to the competences required in the beginning of innovation process: an idea generation and evaluation. It was hypothesized that the firms with the strong innovation orientation develop and deploy competences to stimulate systematic generation and evaluation of ideas to select those that will continue the development process because they have among all the greatest chance to be successful.

First, a research instrument with 62 items was developed. Then, we used structural equation modelling with exploratory and confirmatory factor analysis and data obtained by 220 managers of Slovenian firms in winter 2012/2013 to test psychometric characteristics of latent variables (model components) as well as the hypothesized relationships between latent variables.

The obtained results confirmed all three hypothesized dimensions of innovation orientation with positive impact of innovation strategy on both the organizational culture and sustainable development strategy. Culture, sustainable development strategy and employee rewards positively influence deployment of competences in both stages of development process. We also confirmed that innovation performance depends on both innovation strategy and idea evaluation while innovation output depends mainly on idea generation.

Keywords: *innovation orientation model, SEM, Slovenia*

Friday, September 26th, 2014
Session LN3 - Special section in honour of Luka Neralić, Room 1
(9:20-10:50)

Performance Evaluation of Central European Firms

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Abstract

The paper presents a modeling approach for performance comparison of Central European firms. Within the process of analysis of performance of countries it is necessary to take into account the performance of production units operating in these countries. As the production units can be taken important firms in different economic branches. Their performance depends on many factors that can be divided into two basic groups - inputs and outputs. Inputs can be characterized as sources used by the firm during the process of producing outputs. Then, the measure of performance of firms can be derived by a comparison of outputs and inputs. The knowledge of performance measures of firms can be used for estimation of performance measures of economic branches. Similarly, the importance of the branches within the selected country together with performance measures of branches can lead to estimation of performance measures of the country. One of the important problems within the above mentioned process is the evaluation of performance of the firms with respect to information about their inputs and outputs substantially influencing the performance. It is clear that the evaluation is based on comparison of multiple inputs and outputs. That is why one of the available methodological tools for this purpose is multiple criteria decision making.

The main aim of the paper is to propose a methodological framework for evaluation of performance and identification of performance gaps between selected Central European countries accessing the European Union and developed industrial Western Europe economies. The paper describes and discusses issues and results of the international project focusing this subject of study. The approach is based on Data Envelopment Analysis and Analytic Network Process. The proposed model consists of two basic parts. The first one estimates the importance of branches within the countries and the second one evaluates the performance of the firms within branches. The results of both the parts are synthesized and the performance of the countries is estimated. The evaluation is based on the data set resulting from a survey among firms of selected industries. Our aim was to compare the performance of Central European firms, branches and countries by different models and to try to identify the sources of inefficiencies of the evaluated units. In order to receive appropriate data sets for the evaluation the questionnaire was prepared and distributed to hundreds of firms in the countries attending the study. Almost one thousand letters with the request on filling out the questionnaire was distributed in each of the attending countries (Czech Republic, Poland, Hungary, East and West Germany) to the firms of selected branches. The most important branches in all of the attending countries (building, meat processing, furniture, freight transport, etc.) were taken into account.

Keywords: *performance evaluation, Data Envelopment Analysis, Analytic Network Process*

Friday, September 26th, 2014
Session LN3 - Special section in honour of Luka Neralić, Room 1
(9:20-10:50)

**Assessing the Quality of Academic Staff Using Multiple-Criteria
Decision Making**

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Abstract

Two major requirements for the researchers at the universities are to publish quality research papers in international journals and to meet high standards in their teaching activities. Although it is difficult to unambiguously quantify the quality of the research of a specific researcher, such quantification would be of great benefit for academic community. When allocating the resources for scientific research, it is important that these resources are well allocated, i.e. that the best get the most funding. When candidates apply for a vacant position at universities it is essential that selection process is transparent. For faculty administration it might be useful to rank the staff with respect to their research and teaching contribution. Researchers could benefit from pointing out the potential shortcomings of their work in order to be able to improve elements of their work. In this paper, we will identify attributes that could be good indicators in assessing quality of researchers and propose a multi-criteria decision making method for ranking researchers using these attributes.

Keywords: *quality assessment, Multi-Criteria Decision Making*

Friday, September 26th, 2014
Session LN3 - Special section in honour of Luka Neralić, Room 1
(9:20-10:50)

**Equity Portfolio Optimization: A DEA Based Methodology Applied on
Zagreb Stock Exchange**

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Abstract

Recent studies show that Data Envelopment Analysis (DEA) models are rising in popularity among models used for equity portfolio selection. The great flexibility in individual choice of inputs and outputs and the number of models within DEA methodology open a great space for modification and improvement of proposed portfolio selection strategies. In this research we apply a two-stage portfolio selection strategy. In first stage we choose efficient stocks based on their DEA super-efficiency scores, and in the second stage we optimize the portfolio weights using modified Markowitz model. In order to observe whether our strategy creates an outperforming portfolio through time, we do a time-dependent DEA Window Analysis using a reference time of one year. Moreover, we compare the portfolio returns to market portfolio in each stage. Previous researches using DEA investment strategies on Croatian capital market observed inputs and outputs which were computed just from market data. In this analysis we include financial data that are found as significant indicators of stock's future performance and use different combinations of inputs and outputs consisted of financial data and market data of chosen publicly listed companies on Croatian capital market. In order to estimate the results of a market portfolio against those of a two-stage DEA portfolio during the given time period, we compare their standardized and cumulative returns as well as returns adjusted for transaction costs. In that way we can assess whether DEA based strategies can outperform the market and to what extent.

Keywords: *portfolio selection, optimization, DEA, Markowitz model, financial ratios*

Friday, September 26th, 2014
Session A6 - OR Theory and Application, Room 12 (11:05-12:35)

**An Optimal Pair of Members of Forming Relations to a Liaison with
Long Communication Lengths in the Same Level of an Organization
Structure**

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Abstract

The pyramid organization structure can be expressed as a rooted tree, if we let nodes and edges in the rooted tree correspond to members and relations between members in the organization respectively. Then the pyramid organization structure is characterized by the number of subordinates of each member, that is, the number of children of each node and the number of levels in the organization, that is, the height of the rooted tree. Moreover, the path between a pair of nodes in the rooted tree is equivalent to the route of communication of information between a pair of members in the organization, and adding edges to the rooted tree is equivalent to forming additional relations other than that between each superior and his direct subordinates. Liaisons which have roles of coordinating different sections are also placed as a means to become effective in communication of information in an organization.

We have proposed some models of placing a liaison which forms relations to members in the same level of a pyramid organization structure which is a complete K -ary ($K = 2, 3, \dots$) tree of height H ($H = 2, 3, \dots$). When a liaison node which gets adjacent to nodes with the same depth is placed, an optimal depth is obtained by minimizing the total distance which is the sum of lengths of shortest paths between every pair of all nodes in the complete K -ary tree. These models are expressed as all edges have the same length. However, we should consider that edges between the liaison and the other members are longer than those between members except the liaison in the organization.

This study proposes a model of placing a liaison which forms relations to two members in the same level of a pyramid organization structure which is a complete K -ary tree of height H when lengths between the liaison and the other members are more than those between members except the liaison in the organization. The lengths of edges between the liaison and the other members are L ($1 < L < 2$) while those of edges between members except the liaison are 1. An optimal pair of two members to which the node of liaison gets adjacent is obtained by minimizing the total distance.

Keywords: *organization structure, liaison, communication length, complete K -ary tree, total distance*

Friday, September 26th, 2014
Session A6 - OR Theory and application, Room 12 (11:05-12:35)

Approximating the Solution of the Two-Part Tariff Problem

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Abstract

The problem of setting the reservation price in context of two-part tariff problem is reduced to the difference between the minimum expenditure at new prices for the starting level of utility and nominal consumer income. It is known that this difference in expenditure can be interpreted as the area below the compensated demand curve. The compensated demand curve is not directly observable, so the reservation price in this article is approximated by the change in the consumer's surplus. In case of heterogeneous consumers there are more reservation prices and in this article we address the error estimation in setting the price of a capital good and the price of a service. The results obtained are illustrated with a numerical example.

Keywords: *two-part tariff problem, reservation price, heterogeneous consumers, error estimation*

Friday, September 26th, 2014
Session A6 - OR Theory and application, Room 12 (11:05-12:35)

**Optimisation of Workshop Layout in a Furniture Development
Company**

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Abstract

In this talk we will present a problem of optimizing positions of machines in workshop of a Slovenian furniture company.

The company employs around 300 workers that work on approximately 140 machines and produces over 30,000 different products. To manufacture a final product, each product has its own working procedures, i.e. a sequence of prescribed tasks. For each product and task there is a list of suitable machines and expected completion times. More complicated products are manufactured by joining smaller semi-finished products. After a task at a machine is finished, the entire series of products is moved by carts to the next prescribed location (machine).

Primary goal of the company is to reduce overall costs. This can be achieved by removing bottlenecks (overloaded machines), reducing transport distances (distances the carts need to do between the machines), reducing overall time to finish a work order or by increasing overall machine utilizations. The goal of this project is try to tackle these problems by finding a more effective layout of existing machines. It is also eligible to buy some additional machines if necessary. There exist several approaches to optimize the layout such as quadratic assignment problem (QAP) algorithms, force-directed graphs approach and widely used metaheuristic methods such as genetic algorithms.

Since the processes in the workshop are complicated we decided to build a discrete event simulation model (DES) in Anylogic software first. The model helped us understand the nature of production processes for existing layout and it simplified our optimization procedures since modifications of the original model were easily applied. Results of existing and optimized layouts will be presented at the end of the talk.

Keywords: *discrete event simulation, optimal layout, heuristic optimisation*

Friday, September 26th, 2014
Session A6 - OR Theory and application, Room 12 (11:05-12:35)

Roman Domination Number on Cardinal Product of Paths and Cycles

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Abstract

In the 4th century AD the Roman Empire suffered from numerous barbaric attacks, so the emperor Constantine had to arrange Roman legions in a way all strategically important places were protected. Not only did this arrangement have to be successful in defending the Empire, it also had to be easy to maintain.

If at least one Roman legion was stationed at a certain location, that location was considered to be secured. Unsecured locations, on the other hand, had no legions stationed at them, but they had to be adjacent to at least one secured location. If an unsecured location was under attack, sending a legion from its secured neighbor would not be effective if doing so makes that location unsecured. Therefore, Constantine decreed that at least two legions must be stationed at a location before one of them is sent to help its attacked neighbor. In order to reduce costs of maintaining an army, Constantine had to use as few legions as possible. Roman domination can be used even today, not only in military situations, but also in protecting some locations against fire or crime etc.

For a graph $G = (V, E)$, a Roman dominating function (RDF) is a function $f: V \rightarrow \{0, 1, 2\}$ satisfying the condition that every vertex u for which $f(u) = 0$ is adjacent to at least one vertex v for which $f(v) = 2$. The weight of an RDF equals $w(f) = \sum_{v \in V} f(v) = |V_1| + 2|V_2|$ where $V_i = \{v \in V : f(v) = i\}$, $i \in \{1, 2\}$. An RDF for which $w(f)$ achieves its minimum is called a γ_R -function and its weight, denoted by $\gamma_R(G)$, is called *the Roman domination number*. In this lecture we determine some bounds and some exact values for the cardinal product of paths and cycles.

Keywords: *Roman dominating function, Roman domination number, cardinal product of paths, cardinal product of cycles*

Friday, September 26th, 2014
Session A6 - OR Theory and application, Room 12 (11:05-12:35)

An Efficient Parallel Implementations of Approximation Algorithms for Guarding 1.5D Terrains

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Abstract

In 1.5D Terrain Guarding Problem we are given an x -monotone polygonal line defined by n vertices and a set G of points from the terrain, i.e. guards, and a set N of points from the terrain which are to be seen (guarded) by guards. We say that two points from the terrain see each other if segment that connects them never goes strictly below the terrain. The goal is to find a minimum number of guards from G such that every point in N has a guard in G that sees it. This kind of guarding problem and its generalizations to 3-dimensions are motivated by optimal placement of antennas for communication networks; for more details see [1] and the references therein. Our work deals with implementations of two generalizations of the original problem: a weighted version of the guarding problem where guards G have weights and the goal is to find a minimum weight subset of G to cover N , and a version of the problem where points from N have demands, and the goal is to find the smallest subset from G such that every point in N is seen by the demanded number of guards. Both problems are known to be NP-hard. The state-of-the-art results for the weighted and version with demands are approximation algorithms of overall factor 5 approximation (see [2]). The fundamental part of these algorithms is the solution to the corresponding linear program (LP), that is later on cleverly used for problem decomposition into optimally solvable smaller subproblems. The solution to the original problem then consists of combined solutions of these subproblems. We extend the work of [2] and show that if $(1 + \epsilon)$ -approximate solution to LP is computer, for any $\epsilon > 0$, an extra $(1 + \epsilon)$ factor will appear in the final approximation factor for the problem. However, this will allow us to replace the general LP solvers with the simple combinatorial approach of [3], incurring an explicit time dependency of $1/\epsilon^2$ in running time. We furthermore exploited the use of the algorithm of [3] in order to provide the parallel implementation of our problem. We use NVIDIA's parallel computing architecture CUDA for the parallel environment. We test and compare our algorithm with the state-of-the-art linear programming tools such as Gurobi to solve 1.5D Terrain Guarding Problem on relatively large and dense inputs. We conclude that our algorithm implementation well behaves on such inputs and outperforms Gurobi solver typically by one order of magnitude.

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Keywords: *1.5D terrain guarding, linear programming, CUDA, approximation algorithm*

Friday, September 26th, 2014
Session B6 - Machine Learning, Data Mining and Analytics, Room 13
(11:05-12:35)

Decision Tree Learning for Turning Points Detection in Business
Process Orientation: Case of Croatia

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Abstract

Companies worldwide are embracing Business Process Orientation (BPO) in order to improve their overall performance. The purpose of this paper is to report on the results of research into the precedence of the maturity factors, or key turning points in BPO maturity implementation efforts. Maturity model consists of a number of stages through which companies evolve as they increase the adoption of process oriented practices. A key turning point can be defined as a component of business process maturity that stabilizes within an organization and leads to the establishment and expansion of other factors that move the organization to the next maturity level. Over the past few years different methodologies for analyzing maturity state of BPO have been developed. In this paper we argue that the research of BPO can also benefit from the introduction of data mining techniques. Data mining is an approach to detecting meaningful new correlations, patterns and trends by applying pattern recognition techniques as well as statistical and mathematical methods to large datasets. Data mining methodology has proven to provide invaluable intrinsic information from datasets in a number of application areas. For this purpose selected data mining technique of classification and regression trees (C&RT) was used to analyze the maturity state of BPO in Croatian companies and to detect their key turning points. Key turning points were detected based on survey results obtained in 2013. Data was then used for building a data mining model that revealed knowledge about conditions of business process organization and management for transition between different stages of the BPO maturity model. These findings present invaluable guidelines for any business that strives to achieve more efficient business processes.

Keywords: *Business Process Orientation maturity, key turning points, data mining, decision trees, Croatia*

Friday, September 26th, 2014
Session B6 - Machine Learning, Data Mining and Analytics, Room 13
(11:05-12:35)

Predicting Students' Course Satisfaction from Log Data in Virtual Learning Environment – Neural Networks and Classification Tree Model

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Abstract

In academic institutions students' course satisfaction has become an important issue over the years and is recognized as a support in ensuring effective and quality education as well as in enhancing students' studying experience. The aim of this paper is to investigate whether there is a connection between students' course log data in virtual learning environment (VLE) such as Moodle and students' course satisfaction. Furthermore, the paper explores whether it is possible to develop a successful classification model in order to predict student's course satisfaction based on their course log data. The research was conducted at the Faculty of Teacher Education in Osijek at Croatian University and included the analysis of log data and course satisfaction on the sample of third and fourth year students. For each study year log data within one VLE course and satisfaction with that course were obtained. Multilayer Perceptron (MLP) with different activation functions and Radial Basis Function (RBF) neural networks as well as classification tree models were developed, trained and tested in order to classify students into one of two categories of course satisfaction. For the purpose of model comparison, classification accuracy, type I and type II errors and input variable importance were used. The results indicate that MLP neural network model provides the highest average classification accuracy, although t-test of the difference in proportions showed that the difference in performance between the compared models is not statistically significant on the level of significance 0.05.

Keywords: *classification, neural networks, classification tree, course satisfaction, log data*

Friday, September 26th, 2014
Session B6 - Machine Learning, Data Mining and Analytics, Room 13
(11:05-12:35)

Web Analytics Tools and Web Metrics Tools: An Overview and the Tool Comparative Analysis

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Abstract

The paper is structured as an overview of web metric and web analytics tools. It will also present the comparative analysis of its characteristics and functionalities, its types and the different data collecting methods.

Accordingly, the research is divided in two parts: in the first (qualitative) part the focus is on the analysis of web analytics and metrics tools in context of exploring its functionalities and business model integration capabilities. It is known that web analytics tools support business analysts to obtain useful and relevant insights in market dynamics. In other words, data collected by one web analytics tool has to be combined with data gathered from other sources to enable better understanding of sophisticated consumer (web sites visitors) behavior. Thus the general approach to web analytics tool selection has to be highly studious, not random. In the second (quantitative) part of the paper the focus is shifted from theoretical elements to empirical ones. It means, that additionally it will be enclosed the output data as results of the study based on the perception of the web analytics tools usefulness. The empirical study is carried out between numerous IT experts as users of previously mentioned web analytics and web metrics tools.

The contribution of the paper is expected in terms of emphasizing the management support that web analytics and web metrics are available to offer, relating to rising needs of global market trends understanding and its predicting. The importance of the proper tool choice and its implementation in particular business model will also be additionally argued.

Keywords: *web analytics and web metrics tools, business models, the behavior of website visitors, web analytics and web metric tools functionalities, comparative analyses*

Friday, September 26th, 2014
Session B6 - Machine Learning, Data Mining and Analytics, Room 13
(11:05-12:35)

Cluster Analysis in Retail Segmentation for Credit Scoring

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Abstract

Cluster analysis is a method that has been widely used in market segmentation. It is usually applied to create customized marketing strategies for selected segments in order to better satisfy clients' needs. In this paper the aim is to make segmentation of retail clients by using the adaptive Mahalanobis clustering in a way that each segment is suitable for separate credit scoring development. In such a way a better risk assessment of retail clients would be accomplished. Data set for this research is consisted of 3165 retail clients from one bank in Croatia. The groups of criteria used for segmentation are: demographic, behavioral, personal, financial and loan characteristics. The grouping of the data point set is implemented by using the adaptive Mahalanobis partitioning algorithm. This is an incremental algorithm, which recognizes ellipsoidal clusters with main axes in the directions of eigenvectors of corresponding covariance matrix. On the basis of given data points set by using the well-known DIRECT algorithm for global optimization it is successively possible to search an optimal partitions with $k = 2, 3, \dots$ clusters. After that, the most appropriate number of clusters in a partition is determined by using various validity indexes (Simplified Silhouette Width Criterion, Davies – Bouldin index, Calinski – Harabasz index, *Hypervolume index*). Results show that each group of criteria is important in retail segmentation. Based on the description of each cluster, banks could decide to develop a separate credit scoring model for each cluster as well as to create a business strategy customized to each cluster.

Keywords: *cluster analysis, credit scoring, segmentation, data mining, adaptive Mahalanobis clustering, most appropriate number of clusters, data classification*

Friday, September 26th, 2014
Session B6 - Machine Learning, Data Mining and Analytics, Room 13
(11:05-12:35)

Discovering Patterns in Market Basket by Hierarchical Association Rules

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Abstract

Association rules is a data mining method for discovering patterns of frequent item sets, such as products in a store that are frequently purchased together by the same customer. They could be used in market basket analysis, but also in other domains. A number of measures of association rules interestingness have been developed so far, but previous research shows that there is no one dominant measure and that the appropriate measure should be selected for each dataset on the basis of properties that suit user needs. Previous authors mostly use objective measures, while subjective measures were rarely investigated. This paper aims to combine objective measures such as support, confidence and lift with a subjective approach based on human expert selection in order to extract interesting rules in a real dataset collected from a large Croatian retail chain. Due to a large number of transactions, hierarchical association rules were used to enhance the efficiency of rule extraction. The results show that the hierarchical method provides more interesting rules than the non-hierarchical one, and that a hybrid approach of combining objective and subjective measure is able to extract some unexpected and actionable rules. The research could be beneficial to retail and marketing managers for planning their marketing strategies, and also to researchers in this area.

Keywords: *association rules, data mining, market basket analysis*

Friday, September 26th, 2014
Session C6 - Statistics and Econometrics, Room 14 (11:05-12:35)

**An Application of Interactive Multiobjective Dynamic Programming in
Project Portfolio Selection**

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Abstract

The perception of the role the projects play in achieving strategic goals of any organization has increased significantly in recent years. It is generally accepted that the project's goal should be defined clearly and unambiguously. The common opinion is that imperfection in specifying the objective is one of the most important reasons for the project's failure. The clarity and explicitness, which is an advantage for a single project, becomes inadequate when the portfolio of projects is analyzed. Both researchers, as well as practitioners agree that multiple criteria should be taken into account in such case.

In this paper a dynamic programming model for project portfolio selection is proposed. We assume that the decision maker's goal is to define a strategy for T periods. In each period the project portfolio is reviewed, to evaluate its consistency with strategic goals, and as a result new projects are included to the portfolio, while some others are terminated. Even if a company has free resources, it's sometimes better to decide not to start a new project and wait for a more profitable proposal.

At the beginning we consider the projects that can be started in period 1. As the available resources are not enough to start all these proposals, the company must select some of them. However, it is possible, that new proposals will appear in next periods. The company must decide whether to assign all free resources to the current proposals, or leave some part of resources unused for some time and wait for better alternatives.

Our goal is to propose a procedure for identifying strategy that should be implemented by the decision maker. Such a strategy defines decisions that should be made in each period. The procedure that we propose combines multiobjective dynamic programming and interactive approach. First, efficient strategies are identified using Bellman's principle of optimality adapted to multiobjective problem. Next interactive procedure is used to find the final solution. In each iteration a candidate strategy is presented to the decision maker. If he/she is satisfied the proposal, the procedure ends, otherwise he/she is asked to express his/her preferences defining values, that the criteria should achieve, or at least indicating the criterion that should be improved.

Keywords: *project portfolio selection, Multiobjective Dynamic Programming, decision making under risk, Interactive Approach*

Friday, September 26th, 2014
Session C6 - Statistics and Econometrics, Room 14 (11:05-12:35)

Measuring Real Exchange Rate Misalignment in Croatia: Cointegration Approach

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Abstract

There has been an extensive debate about the adequacy of the exchange rate level in Croatia since the implementation of Stabilization program in October 1993 by the Croatian government. The question whether Croatian kuna is overvalued is one of the dominant issues related to conducting monetary policy in Croatia. On the one hand, the monetary authorities claim that it is very important to maintain the stability of the exchange rate in Croatia in order to maintain the price stability, which is the primary objective of Croatian monetary policy. However, on the other hand, the overvalued local currency could have a negative effect on the economic activity primarily through its unfavorable effect on the competitiveness of domestic products on the global market. Measuring overvaluation or undervaluation of exchange rate is quite controversial tasks for economic analysts from the methodological point of view. Accordingly, the purpose of this paper is to determine whether the real exchange rate in Croatia is misaligned. In order to define misalignment, an analytical model that could be used for determination of the equilibrium real exchange rate (ERER) is provided in the first place. The ERER is computed using the cointegration approach whereat the real exchange rate and its fundamentals are included in the cointegration analysis. It is assumed that misalignment could arise due to inappropriate macroeconomic policies. Once this concept is defined, in the second step the corresponding misalignment is computed as a deviation of the real exchange rate from its equilibrium level. The econometric methodology used in this paper refers to stationarity and cointegration tests. After testing the stationarity of time series, the test for cointegration between real exchange rate and the underlying macroeconomic fundamentals is conducted. Finally, the long-run parameters are estimated and afterwards used for computing the real exchanger rate and the corresponding misalignment. The determination of RER misalignment could be very useful for economic policymakers as the theoretical and empirical literature suggest that the RER misalignment is one of the key indicators in identifying a country's economic vulnerability. In other words, the persistent RER misalignment can be considered as an indicator of potential crisis with adverse effects on economic activity. According to that, the policy makers should take into account the RER misalignment for future studies of domestic economic developments.

Keywords: *cointegration approach, exchange rate equilibrium, currency misalignment, adjustment speed*

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**Application and Development of Human Resource Information System
and Electronic Recruitment in Croatian Companies**

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Abstract

Performing business according to contemporary requirements influences companies for continues application of modern managerial tools, such as human resource information system (HRIS) and electronic recruitment (ER). Human resources have been recognised as curtail resources and the main source of competitive advantage in creation of successful business performance. In order to attract and select the top employees, companies use quality information software for attracting internal ones, and electronic recruitment for attracting the best possible external candidates.

The main aim of this paper is to research the level of application and development of HRIS and ER within medium and large Croatian companies. Moreover, the additional aim of this paper is to evaluate the relationship among application of these modern managerial tools and overall success of human resource management within these companies.

For the purpose of this paper, primary and secondary researches have been conducted. Primary research included written survey distributed to all Croatian public companies listed on Croatian Stock Exchange Market. This part of the research collected data according to the level of HRIS development as well as development of overall human resource management system. Secondary research included evaluation of companies' official web pages (participated in the first round of the research) in order to collect necessary data for ER implementation. Furthermore, appropriate statistical methods are applied in order to reveal application and development of HRIS and ER as well as overall success of human resource management in Croatian companies.

Keywords: *Human Resource Information System (HRIS), Electronic Recruitment (ER), Human resource management, survey analysis, Multicriteria classification and ranking*

Friday, September 26th, 2014
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**A VECM Approach to Detangling Growth, Export, Import and FDI Knot
in Selected CEE Countries**

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Abstract

There is an ample body of literature trying to determine and explain the interconnectivity between economic growth and various macroeconomic variables. In this paper the authors try to solve the relationship between GDP, international trade activity (import coverage ratio), capital flow (FDI) and gross fixed capital formation (GFCF) for a sample of CEE countries, namely Slovenia, Croatia, Serbia and Czech Republic. The methodology used in explaining the short and the long term relationship among the variables is a classical error correction model (ECM). The authors start with a classical, well established, assumption present in main the mainstream literature according to which there is positive feedback between these variables. The empirical results confirm positive long-run influence of import coverage ratio, FDI stock and gross fixed capital formation on GDP growth for all of the countries, except Croatia. In the case of Croatia there is a significant negative feedback between level of FDI and GDP growth in the long-run and positive relationship in the short run. At first this sort of relationship seems counterintuitive especially since the mainstream literature claims that FDI is positive for economic growth. By using the findings of Horvat (2007) the authors identify and use five popular misconceptions about FDI in logically explaining this sort of paradoxical behavior. Second uncommon result which is encountered is the long run positive relationship between GDP and import coverage ratio, which goes against the prevailing popular trend of completely open economies, where the states are not be troubled by their import/export ratio. The obtained result speaks in favor of a conservative approach to national economy, where the states take care of their current account and their import-export ratio and try to achieve their growth not through foreign lending or FDI, but through stable, internally driven growth.

Keywords: *Error Correction Model, FDI, import coverage ratio, gross fixed capital, GDP, economic growth, CEE countries*

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GARCH Based Artificial Neural Networks in Forecasting Conditional Variance of Stock Returns

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Abstract

Portfolio managers, option traders and market makers are all interested in volatility forecasting in order to get higher profits or less risky positions. Based on the fact that volatility is time varying in high frequency data and that periods of high volatility tend to cluster, the most popular models in modeling volatility are GARCH type models which can account excess kurtosis and asymmetric effects of financial time series. The first ARCH model was proposed by Engle (1982). The model was extended by Bollerslev (1986) by its generalized version (GARCH). However, GARCH(1,1) model usually indicate high persistence in the conditional variance, which may originate from structural changes. Hence the estimates of a GARCH model suffer from a substantial upward bias in the parameters. The objective of this paper is to develop a parsimonious Artificial Neural Networks model which can capture the nonlinear relationship between past return innovations and conditional variance. The second objective of this paper is to determine if ANN outperforms standard GARCH model when high persistence of the conditional variance exist. Out-of-sample forecasts of ANN and GARCH model will be compared to determine their predictive accuracy by different forecast error measures. Also, the contribution of this paper is to determine which number of nodes is sufficient to be placed in a single hidden-layer ANN to establish a satisfactory volatility forecasts. The appropriate specification of ANN model will be chosen according to Akaike and Schwartz criterion and standard diagnostics (Ljung-Box test, Sign Bias test, LM test). In general this paper introduces ANN as semi-parametric approach and attractive econometric tool for conditional volatility forecasting. The data set consists of returns of the CROBEX index daily closing prices obtained from Zagreb Stock Exchange.

Keywords: *conditional variance, GARCH, ANN, forecast error, volatility persistence*

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AUTHOR INDEX

- Agami, Nedaa Mohamed Ezzat, 55
 Ahmed, Abd El-Hadi N., 55
 Akkoyunlu, Mehmet Cabir, 20, 37
 Akkoyunlu, Mustafa Tahir, 20
 Alić, Alen, 96
 Aljinović, Zdravka, 121
 Alvelos, Filipe, 66
 Anholcer, Marcin, 19
 Apostolou, Dimitris, 89
 Ar, Ilker Murat, 24
 Arnerić, Josip, 82, 121
 Asgharian, Masoud, 33
 Babić, Zoran, 48, 69
 Bahovec, Vlasta, 78, 98
 Bajer, Dražen, 92
 Basagoiti, Rosa, 53
 Bastič, Majda, 103
 Bekavac, Ivan, 114
 Bektas, Tolga, 28
 Bennell, Julia, 28
 Beroš, Ivo, 25
 Bogdanovski, Vasko, 79
 Boljunčić, Valter, 34
 Bolukbas, Ufuk, 63
 Borozan, Luka, 40
 Bosilj Vukšić, Vesna, 112
 Bralić, Antonia, 91
 Briš Alić, Martina, 96
 Car-Pušić, Diana, 47
 Carvalho, Pedro, 74
 Čeh Časni, Anita, 82, 88
 Celik, Erkan, 54
 Čerkez, Ninoslav, 23
 Charles, Vincent, 32
 Čižmešija, Mirjana, 98
 Cochran, James J., 12
 Čordaš, Rebeka, 23
 Ćorić, Dajana, 94
 Ćukušić, Maja, 91
 Čular, Marko, 82
 Ćurak, Marijana, 60
 Cvetkoska, Violeta, 102
 Cvrlje, Dajana, 78
 Dehouche, Nassim, 27
 Despotis, Dimitris, 89
 Drobne, Samo, 81
 Đumić, Mateja, 23
 Đumičić, Ksenija, 88, 118
 Đurđević Babić, Ivana, 113
 Dutta, Debashis, 52
 Emrouznejad, Ali, 14
 Engin, Orhan, 37
 Erjavec, Nataša, 101
 Fiala, Petr, 104
 Fuat Guneri, Ali, 63, 72
 Gao, Hengxuan, 35
 Garbin Praničević, Daniela, 114
 Gardijan, Margareta, 59, 106
 Gaspars-Wieloch, Helena, 87
 Gjeldum, Nikola, 38
 Grdinić, Maja, 120
 Grošelj, Petra, 46
 Gudac, Ivona, 47
 Gul, Muhammet, 72
 Has, Adela, 116
 Hell, Marko, 49
 Jablonsky, Josef, 104
 Jadrić, Mario, 91
 Jajac, Nikša, 31, 62, 65
 Janáček, Jaroslav, 22, 26
 Jaross, Weikko, 75
 Jeger, Marina, 97
 Jurčević, Branka, 80
 Jurun, Elza, 99
 Kabašinskas, Audrius, 77
 Kanduč, Tadej, 109
 Khachay, Michael, 41
 Khodabakhshi, Mohammad, 33
 Klimentova, Xenia, 66
 Klobučar, Antoaneta, 110
 Koháni, Michal, 43
 Kojić, Vedran, 39
 Koronakos, Gregory, 89
 Korotkov, Vladimir, 29
 Kotarac, Karlo, 105
 Krpan, Mira, 108
 Kubelka, Ozren, 95
 Kumar, Pavan, 52
 Kurnoga, Nataša, 98
 Kuzmin, Kirill, 29
 Kvet, Marek, 22, 26
 Lakner, Mitja, 81
 Lešaja, Goran, 13, 68
 Li, Yongjun, 35

- Liang, Liang, 35
 Ljubešić, Nikola, 95
 Lolić, Ivana, 101
 Lu, Wei, 35
 Lukač, Zrinka, 105, 108
 Maggioni, Francesca, 77
 Mamdouh, Amany Mohamed, 55
 Marasović, Branka, 119
 Marcikić, Aleksandra, 61, 71
 Marković, Darija, 40
 Maros, István, 45
 Marošević, Tomislav, 42
 Marović, Ivan, 47, 62, 65
 Marques, Rui Cunha, 73, 74
 Martinović, Goran, 111
 Matijević, Domagoj, 23, 111
 Meter, Joško, 25
 Mijoč, Josipa, 97
 Milanović Glavan, Ljubica, 112
 Miletić, Ljiljana, 84
 Milić Beran, Ivona, 100
 Mladineo, Marko, 31, 38, 62
 Mladineo, Nenad, 31
 Moro, Frano, 99
 Nakib, Amir, 16
 Naumovska, Elena, 102
 Neralić, Luka, 33, 70
 Neznakhina, Ekaterina, 41
 Nikulin, Yury, 29
 Njegić, Jovan, 60
 Nowak, Maciej, 117
 Onieva, Enrique, 53
 Özkan, Coskun, 20
 Palić, Irena, 78, 118
 Papić Blagojević, Nataša, 60
 Pavlić, Dino, 49
 Pečarić, Mario, 76
 Pejić Bach, Mirjana, 21
 Pekel, Engin, 44
 Perić, Tunjo, 69
 Perišić, Ana, 83
 Pivac, Snježana, 76, 119
 Poklepović, Tea, 48, 121
 Povh, Janez, 15
 Puljić, Ivona, 110
 Pusat, Šaban, 20
 Qu, Yi, 28
 Rabar, Danijela, 64
 Radovanov, Boris, 61, 71
 Raguž, Andrija, 56
 Rais, Abdur, 66
 Rashidi, Saba, 33
 Ratković, Nada, 99
 Rešić, Sead, 69
 Rodič, Blaž, 109
 Roldán, Raúl, 53
 Ross, Kai, 75
 Rukav, Marija, 30
 Sabo, Kristian, 93
 Saleh, Mohamed M., 55
 Sawada, Kiyoshi, 107
 Scitovski, Rudolf, 42, 92, 96
 Scitovski, Sanja, 115
 Simões, Pedro, 73, 74
 Smidla, József, 45
 Sniedovich, Moshe, 18
 Soner Kara, Selin, 44
 Sorić, Petar, 101
 Sotiros, Dimitris, 89
 Sotirov, Renata, 68
 Stojanović, Alen, 80
 Sušan, Zoran, 97
 Šarlija, Nataša, 115
 Ševerdija, Domagoj, 111
 Škrinjarić, Tihana, 58, 59, 106
 Šorić, Kristina, 56
 Šprajčak, Petra, 118
 Šutalo, Ivan, 56
 Šutienė, Kristina, 77
 Šuvak, Nenad, 30
 Tadić, Ivana, 119
 Taler, Petar, 93
 Taleski, Petar, 79
 Tar, Péter, 45
 Taskin Gumus, Alev, 54
 Tomas Žiković, Ivana, 120
 Tomljanović, Zoran, 30
 Tóth, Sándor F., 75
 Trzaskalik, Tadeusz, 117
 Tustanovski, Emil, 21
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 Valić Vale, Martin, 57
 Vanderpooten, Daniel, 27
 Veza, Ivica, 38
 Viana, Ana, 66
 Vidović, Ivan, 92
 Visković, Josip, 76
 Vlahović, Nikola, 112
 Vrankić, Ilko, 21, 108
 Vrečko, Igor, 103

Wendell, Richard E., 70
Zadnik Stirn, Lidija, 36, 46
Završki, Ivica, 65
Zekić-Sušac, Marijana, 116
Zenzerović, Robert, 57

Žerovnik, Janez, 67
Zigomitros, Athanasios, 89
Žiković, Saša, 120
Žmuk, Berislav, 88
Županović, Ivica, 49

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