IFORS

NEWS
2016

INTERNATIONAL FEDERATION OF OPERATIONAL RESEARCH SOCIETIES

WHAT'S INSIDE

FROM THE PRESIDENT

Creating Societies in Africa

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I have recently returned from a trip to Nairobi, Kenya, where a group of OR academics and practitioners came together to meet at the African OR Summit. The goal of the summit was to discuss a possible pan-African society to advance operational research throughout the continent. While the group was small, the enthusiasm was large. It is clear that Africa needs operational research, and that societies have a critical role in advancing the field there.

I was particularly taken with this issue when talking to one of the participants during a coffee break. This person worked for a large US-based retailer, and he was responsible for overseeing the supply chain of flowers that African farmers grew for the retailer. This is a great supply chain optimization problem! In the US, a huge fraction of flower purchases are done in the days preceding February 14, Valentine's Day, a holiday marked by flower giving. That holiday alone can result in half of the yearly sales of flowers. After a particular date early in February, flowers become essentially worthless. What a difficult supply chain to manage! Fortunately, he was well trained in OR methods and could use analytical techniques to help farmers plan their planting season and otherwise handle the different issues of getting flowers from Africa to the US at the right time and right cost.

As I talked to my new colleague, I realized there have to be thousands of people like him scattered all around Africa, handling challenges of distribution, production, transportation, resource extraction, and all the other fields of operational research. For many, they will be isolated practitioners, with no other OR-trained person around. They need a broader community to be part of, but that community cannot be too far-flung. It is

unlikely that they will fly off outside of Africa for an operational research conference. My colleague worked in Kenya, so he was able to attend the Summit, but that would not be possible if the Summit had been in Barcelona, New York, or Buenos Aires.

Having local societies matter. Whether it is at the range of a city, nation, or continent, it is important that academics and practitioners have a group to get together with to discuss issues, work out problems, create opportunities, and educate local businesses and universities about our field. So I am excited about the opportunity for a pan-African society, particularly one aimed at encouraging national or sub-regional societies. Right now, IFORS has only three African society members: Nigeria, South Africa and Tunisia. But there is far more need for operational researchers, and need for support for those researchers, than that can provide. I hope that in twenty years, when there are a dozen or more national societies in the region, we can see the Summit as an important step along the way.

And I hope that other nations and regions are inspired to create their own societies. IFORS has 50 member societies encompassing about 30,000 members: there is far more operational research going on than that! FIFA, the world's football organization, has more members than the United Nations: why shouldn't IFORS? The regional groupings of IFORS: APORS, ALIO, and EURO are all very active in trying to encourage new country members. Earlier this fall I was at the ALIO in Santiago, Chile, and was delighted to see plans for new South American societies. You can read more about the African OR Summit on page 4 of this issue, and I am grateful for all the hard work and excitement provided by the organizers and participants of the Summit. 🌐

M. Trick is 2016-2018 IFORS President and Professor of OR at the Carnegie Mellon's Tepper School of Business where he also serves as Sr Associate Dean for Faculty and Research.

Good Tidings!

Elise del Rosario elise.del.rosario@stepforward.ph

Excitement is building up for the IFORS2017 and all the activities that go with it! Abstract submissions have opened, the IFORS Prize competition applications are being finalized, and ICORD papers are starting to come in!

This flurry of activities comes after a very successful CLAIO conference of Latin American Operations Researchers. There was also an encouraging meeting of the minds during a recent summit to form an African regional grouping. Of course, we also see ongoing preparations for another regional conference for the Asia Pacific group (APORS) in Nepal.

In this issue, we put our spotlight on the OR Society of Israel (ORSIS) which has embarked on numerous activities. National OR societies hold annual conferences and we take you to three of them in Germany, China and the Philippines. Such conferences, including the international meet held in Turkey, are a great opportunity to interact and learn. But learning happens in our own bedrooms too, through online resources that are available. We acquaint you with Massive Open Online Courses (MOOCs) and freeware that OR workers will find useful. For OR professionals

who find lack of English skills a barrier to being published, this issue shows how such help could be accessed. There is a lot available for the taking, but these resources take a lot of work to build up. You are also encouraged to enrich these resources, in this case, by sharing other freeware you find useful as well as challenges for the MIPLib.

Still on continuous learning, we read the accounts of the PhD training programs of the NATCOR and the first EURO PhD program. Lifelong learning is also discussed in the Tutorial that seeks to mimic the body's immune system for making OR models work better.

The OR Impact article answers the question of how many dentists to put in the Sri Lankan supply chain! Talking about supply chain, the Tutorial section shows the potential and general principles of collaboration in vehicle routing as the key to maximizing profits and helping the environment. But as this tutorial shows, behavior of players is something that needs to be considered – something that makes this issue's Book Review on Behavioral OR very relevant.

Elise enters the venue of EURO 2016 – the Poznan University of Technology.

With all the above, it is obvious that 2016 has been another active year for the community. With an IFORS President who keeps his team engaged through monthly Administrative Committee meetings, and one who has shared meals, experiences and concerns with national society members in Poznan, Nashville, Santiago and Nairobi, 2017 is indeed a year to look forward to for IFORS.

Happy New Year! 🌐

ICORD 2017

OR: Impacting Development

http://ifors.org/icord2017

Deadline for paper submissions:

March 30, 2017

Dates: July 13 and 14, 2017
Venue: Salle Power Corporation du Canada (3452)
Carré des affaires FSA ULaval-Banque Nationale
1030, avenue du Séminaire Université Laval, Québec, Canada

The International Conference on OR for Development (ICORD) aims to bring together researchers from around the world to present and discuss models and methods to overcome issues existing in developing countries. Eleven ICORDs have taken place since 1992 in countries across Asia, South America, Africa and Europe and was held in México City in 2016. In 2017, the ICORD will be held in Quebec, immediately prior to the IFORS triennial conference.

In the past seven years as in this year, the EURO Working Group on OR for Development (EWG ORD) has been a co-organizer of the ICORD.

ICORD has a workshop format that allows participants to present their projects and receive formal feedback from assigned reviewers and comments from the general audience. The reviewers are identified from amongst the pool of participants and their objective is to provide a constructive evaluation of the paper.

ICORD is suitable for presenting papers that are close to submission to a peer-reviewed journal and demonstrate a

thorough OR analysis in a problem area important to developing countries. The feedback received at ICORD is an opportunity for authors to improve the quality of the paper in a short time.

The problems covered in submitted papers may include, but not be limited to, sustainability, healthcare, energy, mobility, education, natural resource management, public policy and infrastructure. Purely technical papers, or those that have no relevance in the developmental context, will not be accepted, and papers should clearly describe the relevance of the research to development. 🌐

Submit your full papers or extended abstracts not less than 1,500 words to: icord@ifors.org

Deadline for paper submissions: March 30, 2017
Notification of Acceptance: April 15, 2017
Deadline for early registration: April 20, 2017

Regular Registration Fee: USD 200
Inclusive of materials, snacks and lunches

Early registration fee: USD 150

IFORS
PRIZE FOR OR IN DEVELOPMENT

Deadline for paper submissions:

December 18, 2017

IFORS is pleased to announce that this long-standing Prize will be awarded again during the 21st Triennial conference on "OR/Analytics for a better world" to be held in Quebec City, Canada from 17-21 July 2017. It will be awarded at the close of the IFORS Triennial Conference and carries with it a grand prize of US$ 4,000.00 and a runner-up prize of US$ 2,000.00

The finalist papers are automatically considered for publication in the IFORS Publication 'International Transactions in Operational Research' (ITOR). Publication is contingent upon the usual refereeing process. Authors of these papers agree that the first right to publish their papers lies with ITOR; as such, they will not publish the same until and unless they receive permission to do so by the ITOR editor.

Important details about the competition follow:

TOPIC OF PAPER

The paper must describe a practical OR applicationand have been aimed at helping development indeveloping countries. The work should demonstrate how the researchers have assisted a specific organization in its decision-making processes with regard to education, health, and other basic services, water supply, technology, resource use (physical or financial), infrastructure, agriculture, industry, or environmental sustainability, and how the researchers have helped the organization improve performance within local constraints and limited resources. It should also demonstrate original features in methodology or implementation

The paper should include some description of the application's social context and its impact on the decision making process or on the organization for which it was conducted. Where appropriate, the relevance of the country's state of development to the study should be addressed. A stress on developmentalissues will be an important factor in the judging. Papers of a purely technical nature, or those, which have no relevance in the developmental context, will not be considered.

JUDGING CRITERIA

Qualifying papers will be evaluated on the following criteria: problem definition, creativity and appropriateness of approach, MS/OR/Analytics content, stress on developmental issues, innovative methodology, impact of the study, paper organization and structure, participation of local researchers and quality of written and (if selected as finalist) oral presentation in English.

OTHER INFORMATION

Principal authors and presenters of any nationality are welcome. If selected to be among the finalists, the entry must be presented by one of the principal authors during the IFORS Triennial Conference to be held in Quebec City, Canada from 17-21 July 2017.

Finalists' registration fees (one per team of authors) will be sponsored by IFORS.

All contributions must be submitted using the submission site http://mc.manuscriptcentral.com/itor, indicating in their cover letters that they are intended for this competition and submit to the special issue called "IFORS Prize 2017". 🌐

Other inquiries should be sent directly to the Prize Chair:

Prof. Mikael Rönnqvist
Professor Department of Mechanical Engineering,
Université Laval, Quebec City, Canada
E-mail:mikael.ronnqvist@gmc.ulaval.ca

Important Dates
Last date of submission of the full paper: December 18, 2016
Finalists will be notified by: February 28, 2017
Date of oral presentation: July 17, 2017

CLAIO 2016: Latin American OR Takes Center Stage in Santiago

Jorge Vera Andreo jvera@ing.puc.cl

The IFORS Administrative Committee dinner guests gather for a photo: (seated left to right) Jacky Epstein, Luciana Buriol, Marisa Weintraub, Sue Merchant, Karla Hoffmann, Mary Magrogan, Elise del Rosario, Claudia Duran (standing left to right): Bing del Rosario, Mike Trick, Simon Merchant, Rafael Epstein, Andres Weintraub, Katie Magrogan, Willy Duran, Jose Luis González, Celso Ribeiro and Roger Rios.

Conference Chair Jorge Vera welcomes the delegates.

Delegates compare notes and experiences during the coffee break.

John Bartholdi gives opening plenary.

The XVIII Latin Iberian American Conference on Operations Research (CLAIO), jointly organized by the School of Engineering at Pontificia Universidad Católica de Chile (PUC), the Chilean Institute for Operations Research, ICHIO, and the Latin Iberian American Association of Operations Research Societies, ALIO, was held from October 2 to 6 in Santiago, Chile.

More than 430 researchers, students and professionals from Latin America - Chile, Brazil, Colombia, Argentina, Mexico - and other parts of the world, as far away as Poland, gathered together for the Conference. With 123 papers published in the conference proceedings, more than 380 contributions were presented. Papers ranged from methods and algorithms to relevant applications in industrial management, health systems management, natural resources, logistics and supply chain management, finance and others. CLAIO is the most important event on Operations Research in Latin America and the excellent work presented in these conferences show the state of the discipline in the region.

The opening ceremony was presided by Conference Chair Jorge Vera who called on ALIO President José Luis González Velarde, VP (President of ALIO), ICHIO VP Sergio Maturana and Dean of the School of Engineering of the Pontificia Universidad Católica de Chile Juan Carlos de la Llera to open the Conference. The warm welcome was capped by the choral and instrumental rendition of Latin American music by the Choral Student Ensemble of the School of Engineering at PUC.

John Bartholdi from the Georgia Institute of Technology gave the opening plenary with an insightful OR application, *Self-coordinating Buses Improve Service.* The conference also included plenary lectures by other distinguished researchers like Shmuel Oren, from Berkeley, who spoke on *Opportunities and Challenges for OR in Electricity Markets* and Jorge Nocedal, from Northwestern University. The closing plenary was given by Andrés Weintraub from University of Chile. In

Good food, pisco sour, chicha, Chilean music and dances provide a festive ambiance for old and new friends at the banquet.

Chorale Student Ensemble of the School of Engineering impresses the audience.

addition, several keynote sessions explored the diversity of topics in Operations Research and its implications in areas like agriculture, supply chain, computational algorithms, and natural resources.

The IFORS Administrative Committee Meeting held its annual face-to-face strategic discussions during the regional conference. Thus, IFORS President Mike Trick was on hand to present the IFORS Distinguished Lecture (IDL) recognition to the IDL speaker Monique Guignard from the University of Pennsylvania. In her talk *Lagrangean Relaxation and Different Ways It Can Be Used* she discussed the relevance of Lagrangean approaches in Optimization. The IFORS Tutorial Lecture (ITL) given by Abdel Lisser from Université Paris Sud provided an extensive treatment on the topic *Introduction to Chance Constrained Optimization*. IFORS VP Luciana Buriol handed him the ITL award. The IFORS journal, the International Transactions in Operational Research

(ITOR) through its editor, Celso Ribeiro, hosted events for the journal editorial board and contributors during the conference.

Through the various social events, the conference provided a lot of opportunities for the participants to share and interact on a professional and personal level. Participants at the conference banquet enjoyed good food and traditional music most notably during the conference banquet at *Los Adobes de Argomedo*. Not missing out on the beauty of the host city and encouraged by the perfect weather around the conference dates, participants explored Santiago and the surrounding areas.

As customary, the Latin America Association ALIO held its meeting at the CLAIO, during which the new Executive Committee was presented and Lima, Perú selected as the place for CLAIO 2018. 🌍

AFROS: Kenya Hosts Meet to Form African Regional OR Federation

Charles Malack Oloo oloocm@gmail.com

Taking time out from the meeting are (left to right) Phillips Obasohan (President INFORN, Nigeria), Charles Malack Oloo (Kenya), Abdulfatai Lawal (INFORN), Opaleke Olesegun Taiwo (INFORN),Florence Kimathi (Kenya), Serigne Gueye (ORPA, Senegal),Winnie Pelser (President ORSSA, South Africa), Bernie Lindner (ORSSA), Nicholas Mwaura (Kenya). Hatem Masri from Tunisia participated via Skype.

With some help from IFORS President Michael Trick and Chair of IFORS Developing Countries Committee Sue Merchant, Abdulfatai Lawal (Nigeria) and Charles Malack Oloo (Kenya) gathered together African regional participants in Nairobi, Kenya on the 3rd and 4th November 2016 to deliberate and initiate the formation of a Federation of African Operations Research Societies. The Federation will function as an umbrella body to nurture national Operations Research Societies in Africa.

African countries that already have national OR societies are Nigeria (IFORN), South Africa (ORSSA) and Tunisia (TORS).

Other African regional bodies currently exist. In the East African Community, ORSEA is an economic grouping with Kenya, Uganda, Tanzania, Burundi and Rwanda as members. Started in West Africa, OR Practice in Africa (ORPA) promotes the use of OR in the region, and accepts individual members from countries where national operations research societies do not yet exist.

The name adopted for the new African regional body is African Federation of Operations Research Societies (AFROS) and the first elected President is Charles Malack Oloo of Kenya. Other committee members are proposed from South Africa, Tunisia, ORSEA and ORPA. Post holders will serve a two-year term. The office, for administrative convenience will be based in South Africa, the location of the AFROS first secretary, Berndt Lindner.

Among the key initiatives that AFROS intends to pursue will be the hosting of Winter/Summer Schools, developing a curriculum for teaching Operations Research at certificate and diploma levels, already being initiated by INFORN in Nigeria.

The new leadership is working out how best to establish itself and reach out to all stakeholders in Africa. It is counting on the support of IFORS and other regional bodies. OR people in Algeria, Benin, Botswana, Burkina Faso, Ghana, Senegal and Tanzania have expressed interest in the new federation although they were unable to attend the initial meeting. Participants in this meeting would be delighted to hear from others who would like to contribute to the discussion. 🌍

11th Triennial International Conference

of the Association of Asia Pacific Operational Research Societies (APORS)

August 6-9, 2018 / Kathmandu, Nepal

Kathmandu, the capital of Nepal, is situated in a valley that is an open-air museum of famous sites, ancient temples and shrines, golden pagodas, and inspiring deities. It is a city of inexhaustible historic artistic and cultural interest. Several beautiful and interesting villages and towns surrounding the valley offer ideal destinations for mini treks. The dazzling Himalayan peaks are visible from several points on the mountains around the valley. The whole world witnessed the massive earthquake and numerous after-shocks on April 26, 27 and May 12 of 2015 that rocked the country. More than a year later, Nepal is still trying to recover and rebuild itself. This is where Operations Research can help the country deal with the aftermath of this natural disaster.

It is but fitting that Operations Researchers see for themselves how relevant OR can be in this situation. Thus, the selection of the Conference theme, OR and Development. The conference aims to bring OR academicians and practitioners within the APORS community and throughout the world together to discuss theoretical development and practical applications of OR and related areas. The conference also provides a platform for sharing not only among professionals but also for the enrichment of students as they interact with experts.

The THEME of the conference is "Operations Research and Development". The research papers related to applications of operations research tools and techniques for development in any sector, such as, education, health, financial institutions, governance, energy, environment, water, agriculture are welcome. The research works of Ph D scholars and graduate students are also welcome. 🌐

Conference Streams

• Algorithm and Computational Design• Analytic Hierarchy/Network Processes• Artificial Intelligence• Combinatorial Optimizations• Computational Biology, Bioinformatics and Medicine• Computational Statistics• Constraint Programming• Cutting and Packing• Data Mining and Decision Making• DEA and Performance Measurement• Discrete and Global Optimization• Energy, Environment and Climate• Engineering Optimizations• Facility Logistics• Financial Modeling and Optimization• Fuzzy Optimizations – Systems, Networks and Applications• Game Theory• Heuristics and Metaheuristics• Health Care Management and Applications • Machine Learning and its Applications• Military, Defense and Security Applications• Modeling and Simulation• Network Optimization• Optimal Control• OR/MS: Beyond Mathematics• Project Management and Scheduling• Production Planning and Management• Quality Control and Management• Revenue Management and Dynamic Pricing• Scheduling• Stochastic Programming• Supply Chain Management• Sustainability and Green Systems• Timetabling and Rostering• Transportation Planning• Vehicle Routing• Multi-Criteria Decision Analysis • Inventory Management

Important Dates

Abstract Submission Deadline: 28 February 2018
Notification of the Abstract Acceptance: 15 March 2018
Early Bird Registration and Payment Deadline: 15 April 2018
Regular Registration and Payment Deadline: 15 June 2018
Full Paper Submission Deadline: 31 August 2018

Conference Fee

Early Bird Rate valid for registrations received by April 15, 2018.

Website:
http://www.orsn.org.np/apros2018/
Contact the Conference Secretariat at
apors2018@gmail.com 🌐

OR: Sharing the Stage at a Science Conference

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ICCESEN participants gather for a conference photo.

The "3rd International Conference on Computational and Experimental Science and Engineering" (ICCESEN 2016) was held in Antalya, Turkey, from October 19 to 24, 2016. Various universities in Turkey helped organize the event under the leadership of the Chair Iskender Akkurt from Süleyman Demirel University, Isparta.

Now on its third year, ICCESEN 2016 (http://www.iccesen.org/) again provided an excellent global forum for sharing knowledge and expertise and new findings in the wide spectrum of knowledge covering theory, methods and applications in natural science, social science and engineering. Big data was tackled by some speakers and generated a lot of interest.

The academic program included plenary talks from recognized academicians. These talks included: *Monotonicity Recovering Methods for Postprocessing Finite Element Solutions* by Oleg Burdakov (Linköping University Department of Mathematics Linköping-Sweden); *Development of Laser Device Based on Glass Material* by Mitra Djamal (Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Indonesia); *Küreselleşme-Bilim ve Teknoloji Ekseninde Toplumsal Çözülme* by Mustafa Eravcı (Yıldırım Beyazıt University, Ankara, Turkey); *The Impact of Knowledge Technology for Industry 4.0* by Madji Fathi (Dept. of EECS University of Siegen, Germany);*Production of The Charged Particles: Laser Based Techniques* by Hamdi Şükür Kılıç (Selçuk University, Konya, Turkey); *Laser Driven Beam Therapy – Where are we now?* by Ken Ledingham (Strathclyde University, Glasgow, Scotland, UK); *On the Mixed Set Packing and Covering Problem* by Janny Leung (The Chinese University of Hong Kong, China); *Radiation Protection Evaluations for the ELI-NP Facility with FLUKA Monte Carlo Code* by Maria-Ana Popovici (Politehnica University,

Bucharest, Romania); and *Controlling Factors which Influence the Quality of Primary Education in Developing Countries* by Gerhard-Wilhelm Weber (Middle East Technical University Ankara, Turkey).

The congress provided a very good opportunity to discuss emerging connections between science, engineering and Operational Research. Emphasis was given to the interactions between OR and such disciplines as biology, social sciences, energy, finance, decision support systems and data science. For instance, in their talks, Madji Fathi, Bilgehan Erdem and Zeynep İdil Erzurum Çiçek focused on the availability of "big data" and the tools to benefit from it. The invited talk of Gerhard-Wilhelm Weber gave a different perspective for researchers about *system dynamics* applications in Education. The talk provided the impetus for a project relating to the "big data" that is available at *Anadolu University* (Eskisehir, Turkey), the largest in Europe and the second largest university in the world by enrollment owing to its Distance Education system.

About 800 abstracts from 45 counties were submitted to ICCESEN 2016. In small group discussions, ideas were exchanged among attendees from Algeria, Iran, Germany on how Operational Research could help deal with issues of migration, integration challenges, as well as in providing information, healthcare, education, and other services through the advanced processing and mining of big data. Oral and poster presentations on different topics were organized in 15 themes and sessions. Not missing the chance, Weber expressed gratitude to the organizers of ICCESEN 2016 and their kind interest in EURO (upcoming conference in Valencia) and IFORS (the July conference in Quebec) activities. 🌍

OR 2016: Building Bridges to BetterDecisions

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Gerhard-Wilhelm Weber gweber@metu.edu.tr

Neue Elbbrücke in Hamburg

OR 2016 Venue at Hamburg

OR 2016, the annual International Conference of the German Operations Research Society (GOR), took place in Hamburg, Germany from August 30 to September 2, 2016 (http://or2016.de).

Organized by the Helmut-Schmidt-Universität / Univ. der Bundeswehr Hamburg, the conference hosted around 700 registered participants from about 40 countries. Practitioners and academics from mathematics, industrial engineering, computer science, business/economics, and related fields presented about 475 papers organized in 160 parallel sessions with thematic streams.

The conference theme of **Analytical Decision Making** focused on the process of researching complex decision problems and devising effective solution methods to make better decisions. The streams covered various aspects of Operations Research - Business Analytics and Forecasting, Control Theory and Continuous Optimization, Decision Theory and Multiple Criteria Decision Making, Energy and Environment, Finance, Fuzzy Systems and Artificial Intelligence, Game Theory and Experimental Economics, Graphs and Networks, Health Care Management, Logistics, Routing and Location Planning, Metaheuristics, Optimization under Uncertainty, Pricing and Revenue Management, Project Management and Scheduling, Security and Disaster Management, Simulation and Stochastic Modeling, Supply Chain Management, Traffic and Passenger Transportation. (The conference program and the book of abstracts can be accessed at http://or2016.de).

Plenary speakers were Kurt Mehlhorn (Max-Planck-Institut für Informatik, Saarbrücken, Germany) who spoke on *Network Flow and Equilibrium Computation in the Linear Exchange Economy*. The other speaker was Luk N. Van Wassenhove (INSEAD, Belgium/France) on *Perspectives on Research in Humanitarian Operations*.

Semi-plenary talks were given by: Jose R. Correa (Universidad de Chile, Santiago, Chile) on *Dynamic Pricing with Forward-Looking Consumers*; Johann Hurink (University of Twente, The Netherlands) on *Decentralized Energy Management: New Challenges for Operations Research*; Robert Klein (Universität Augsburg, Germany) on *Revenue Management: Selected Concepts and Applications*; Johan Marklund (Lund University, Sweden) on *Sustainable Supply Chain Inventory Control*; Kaisa Miettinen (University of Jyväskylä, Finland) on *Advantages of Interactive Multiobjective Optimization Methods*

Demonstrated with NAUTILUS Navigator Enabling Navigation without Trading-Off; Rüdiger Schultz (Universität Duisburg-Essen, Germany) on *Stochastic Programs in Gas and Power Networks*; Kenneth Sörensen (University of Antwerp, Belgium) on *A History of Metaheuristics*; Frits C.R. Spieksma (Katholieke Universiteit Leuven, Belgium) on *Scheduling A Soccer League*; Grit Walther (RWTH Aachen, Germany) on *OR for Future Mobility: Designing Sustainable Means of Transportation*; and Gerhard J. Woeginger (Eindhoven University of Technology, The Netherlands) on *New Answers to Old Questions on the TSP*.

The ample number of presentations and distinguished array of speakers complemented by the exceptional social program in a beautiful campus setting made the conference very memorable, owing of course, in no small part to the efforts of the conference chairs Andreas Fink and Martin J. Geiger. The participants had a unique chance to explore the modern port city of Hamburg during the conference, because the conference dates coincided with the annual Alster Festival, thus providing an entertaining activity for participants in the evenings. The public transportation network consisting of underground trains (U-bahn), rapid transit trains (S-bahn) and HVV busses within the city provided easy and safe access to the conference venue. The conference badges served as free public transit cards, which was a nice touch by the organizers and a boon to the participants.

Hamburg is the second largest city of Germany with 2,300 bridges, more than one can find in Venice, London and Amsterdam combined. *Gate to the world* is also a name attributed to Hamburg which has a port that is second only in size to Rotterdam. Parks and gardens that cover 14% of the city make Hamburg one of the greenest cities in Europe.

OR2017 has been scheduled for September 6-8, 2017, at the Freie Universität Berlin, with the theme *Decision Analytics for the Digital Economy*. It will be noted that the long tradition of German Operation Research Society (GOR) conferences started in 1998 in Zurich, followed by Magdeburg 1999, Dresden 2000, Duisburg 2001, Klagenfurt 2002, Heidelberg 2003, Tilburg 2004, Bremen 2005, Karlsruhe 2006, Saarbruecken 2007, Augsburg 2008, Bonn 2009, Munich 2010, Zurich 2011, Hannover 2012, Rotterdam 2013, Aachen 2014, and Vienna 2015. 🌐

ORSC Conference Draws Big Attendance; Elects New Leadership

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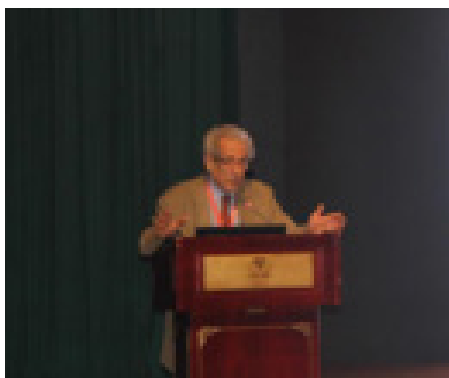
Nelson Maculan gives his plenary talk.

Yaxiang Yuan (right) awards the Best OR Contribution Prize to Meigu Guan.

Xinmin Yang (right) receives the Best Research Work Prize from Xiangsun Zhang.

The biennial national meeting of ORSC members (ORSC2016) was held in Kunming, Yunnan Province from October 14 to 16, 2016 with attendance of over 700 from all over China. The seven invited plenary speakers include IFORS immediate Past President Nelson Maculan, Dingzhu Du from the University of Texas at Dallas, Xiaojun Chen from the Polytechnic University of Hong Kong, and four other internationally active professors from mainland Chinese universities and the Chinese Academy of Sciences. The big national event also featured 30 speakers at thematic sessions organized by the ORSC special interest groups with topics ranging from theoretical mathematical programming, graph and combinatorics to applied data analytics in industrial processes and biological engineering.

The three-day program also included Prize Competitions for applications, young researchers, and Journal of the ORSC best paper awards. Meigu Guan from Wuhan University was given the excellent OR contribution award for his various research achievements, among which is his seminal work on Chinese

Postman Problem in the 60s. This top prize of the ORSC is awarded every two years with the winner receiving RMB 50,000 (or USD 8,000). The best research work award went to Prof. Xinmin Yang from Chongqing Normal University for his work on generalized convex optimization.

During the congress, ORSC also elected a new set of officers for a 4-year term led by President Xiaodong Hu of the Chinese Academy of Sciences along with 9 vice presidents from all over the country and 45 active council members. The election also yielded the heads of the 8 working committees for publication, education, application, and OR promotion activities. The newly elected council is set to further improve China's OR community activities and work closely with international colleagues. In line with this, the ORSC council has planned two collaborative events with EURO and German OR Societies for the coming 2017. The president further encouraged members to participate the IFORS2017 and other joint workshops in Europe. 🌍

Philippine National Conference Highlights Analytics At Work

Elise del Rosario   elise.del.rosario@stepforward.ph

The Operations Research Society of the Philippines held its 10th National Conference at the Richmonde Hotel in Quezon City, Manila last November 25, 2016.

With the theme, *Analytics: Exploring New Frontiers*, plenary speakers discussed how Analytics has and continue to enable new ways of doing things. Andres Torres, Head of Market Research, Revenue Management and Demand Planning of Coca Cola Philippines cited examples in business where old paradigms, widely-held beliefs, rules of thumb, and intuition have been proven erroneous upon examination of data that is available. On

the other hand, the COO of AFPayments, Inc, Mickey Gonzaga related how the company is enabling contactless payment transactions in the Philippines and the potential of the data so gathered from the spending patterns to be used for analysis in aid of governance. With the Philippines as the second most disaster prone country in the world, studies such as the one conducted by the third speaker, Vicente Reventar for the government is very relevant. It determines the storage and transport requirements that would minimize response times for aid to reach typhoon-hit areas.

Philippines: Philippine National Conference Highlights Analytics At Work

Participants listen intently to the plenary presentations.

Various applied topics were presented, including those for patient flow in hospitals, football performance in a school, dropout rates in colleges, cacao beans harvesting patterns, renewable energy project management optimization, maximization of poverty responsiveness, intermodal freight network identification of Philippine shipping hubs, and an assessment of behavior patterns on renewable energy.

Around 200 participants – comprising of operations researchers from the industry, the academe and students were present. The business meeting was also conducted to induct new members and discuss past accomplishments and plans for 2017. Regular annual activities of the Society include a student competition, technical forum, workshop, and a national conference. 🌐

DOCTORAL SCHOOLS

NATCOR: Ten Years of Doctoral Training in OR

Adam Letchford a.n.letchford@lancaster.ac.uk

The National Taught Course Centre in Operational Research (or NATCOR for short) is a UK-based consortium that provides training for doctoral students in OR and related fields. It was established in 2006 and has the approval of the UK OR Society, EURO, the EPSRC (Engineering and Physical Sciences Research Council) and the Smith Institute for Industrial Mathematics, as well as an external advisory board headed up by Tony O'Connor, chair of GORS (the UK Government OR Service).

NATCOR runs residential courses, similar in spirit to Spring or Summer schools. In odd-numbered years (2015, 2017, . . .), it runs week-long courses in Stochastic Modelling, Simulation and Combinatorial Optimisation. In even-numbered years (2014, 2016, . . .), it runs week-long courses in Convex Optimisation and Heuristics and Approximation Algorithms, together with occasional short courses on other topics (such as Systems Dynamics and Predictive Analytics). For details, please see our website, which can be found at http://www.natcor.ac.uk.

The members of NATCOR (in alphabetical order) are Brunel, Cardiff, Edinburgh, Kent, Lancaster, Loughborough, Nottingham, Oxford, Salford, Southampton, Strathclyde and Warwick universities, with Lancaster taking the lead. Key objectives expressed in the original proposal were:

> To establish a national centre to develop and deliver taught courses for doctoral students in OR
> To develop a syllabus at the level of courses at leading US institutions, yet with a technical focus which reflects UK research strengths
> To make the above provision available to up to 70 UK-based OR students annually.

Not only has this been achieved, but NATCOR has recently broadened its scope: we now admit students from overseas and students from fields outside OR, such as computer science, finance and engineering. (Post-docs and junior lecturers are also welcome to attend our courses, subject

to the agreement of the Director.) Since 2014, EURO has very kindly provided support for up to ten EU students per year to attend one or more of our courses. For details, please see http://www.euro-online.org/web/pages/1568/natcor-bursaries. On balance, it is fair to say that NATCOR has been a great success, with buoyant attendance and very positive student feedback. We have found that students particularly appreciate the opportunity to network with their peers. Indeed, we have observed that many friendships and collaborations formed during our courses endure long after. 🌐

EWG on Sustainable Supply Chains Holds first PhD School

Larissa Doré & Grit Walther walther@om.rwth-aachen.de, Operations Management, RWTH Aachen University

The first EURO PhD School on Sustainable Supply Chains took place in Aachen and Koblenz, Germany from June 26 to July 2 2016. With 30 early-stage PhDs from 12 countries, the School was organized by the Euro Working Group on Sustainable Supply Chains through the support of the Association of European Operational Research Societies (EURO). Topics included: Concepts and models for Sustainable Supply Chains: multicriteria decisions, trade-offs between economic, environmental and social objectives; Inter- and multidisciplinary approaches, e. g. combining optimization and life cycle assessment, development of sustainable business models; and Specific characteristics of Biobased SCs, Closed-Loop SCs, Food SCs, Automotive SCs

Lectures given by Jacqueline Bloemhof (Wageningen University), Erwin van der Laan (Erasmus University Rotterdam), Ana Paula Barbosa-Póvoa (University of Lisbon IST, Portugal), Martin Grunow & Renzo Akkerman (Technical University of Munich, Germany) and Grit Walther (RWTH Aachen University, Germany) were interspersed with supervised training, software tutorials and exercises.

Participants applied the methods they learned on industrial cases involving bio based Supply Chains, renewable materials and green logistics. Representatives from the FORD Motor Company and Henkel Global Supply Chain B.V. presented the cases at the beginning of the School, and by the end, the PhDs presented their results to a jury.

Participants also gained insights into OR practice by joining an excursion to the INFORM GmbH (Aachen). At the end of the school, participants took part in the 1st Conference of the EURO Working Group on Sustainable Supply Chains that took place at RWTH Aachen University. During the conference, students presented their case study results, attended conference presentations conducted by well-known speakers, and discussed their PhD topics and methods with experienced researchers during the poster event.

The School offered a unique opportunity for young PhD students to get into contact with renowned researchers and to experience Sustainable Supply Chains in practice. Apart from the learning experience, the School enabled the creation of a network in the field. A report on the EPS is available at http://www.sustainablesc.rwth-aachen.de/data/uploads/eps-sustsc-2016-final-report.pdf. More information is available at http://www.sustainablesc.rwth-aachen.de/eps-sustsc/. 🌐

Students and instructors take in the great view of the Rhine & Moselle Valleys from Koblenz.

the ōbex project

Obex: One Less Barrier to Getting Published

An interview with James Bleach, Founder and Managing Editor of the ōbex project theobexproject@gmail.com

Dr Bleach is a Senior Analyst for the UK Government, and has also been a member of the Editorial Board for the science journal Open Physics since 2003, and a Language Editor for Paladyn. Journal of Behavioral Robotics since 2013. Furthermore, he has managed a number of highly successful recruitment campaigns to gain volunteer editorial support for a number of scientific journal publications.

What is the ōbex project? The ōbex project is a new free language editing service for operational researchers from non-English speaking regions seeking publication in an English language journal.

How did the project come about? Whilst I was lucky to be born a native language speaker of the dominant language of science and technology in my time – it could have been very different, and with this in mind, I have spent many years providing voluntary editorial support to projects that support scientists from non-English speaking regions seeking publication in English language journals.

This year, I undertook the role of Managing Editor for the Keynote and Extended Abstract Handbook of the UK Operational Research Society Annual Conference OR58. As a result of the positive feedback received from a number of authors on the benefit of the language editing provided by the editorial team during the publication process, and also on their challenges more generally with publishing in English, I decided it was time to apply my editorial experience more extensively within the field of Operational Research.

Please enlighten us on the name of the project. ōbex is Latin for barrier (obstacle, hurdle, etc.) - and so is used to represent the barrier to publication that the English language can be for some operational researchers.

What is the current status of the project? The ōbex project is a new venture that is now entering a test phase, which will help assess the level of interest in the service from the international OR community. We ask that submitting authors are patient with us during this test phase - and also provide feedback on the service they receive.

Any advise to those who are interested to avail of the service? Submissions should be emailed in Microsoft Word format to the following email address: theobexproject@gmail.com

The service will only review manuscripts relating to the field of Operational Research. Priority will be given to manuscripts to be submitted for journal publication; other manuscripts such as submissions for conference proceedings will be considered. Details of where the manuscript is to be submitted should therefore be provided at the time of submission to our service. Best efforts must be made by authors to make the English as good as possible before it is submitted to our service.

We hope to review manuscripts within a two to three week time frame, with some potential dependency on the length of document and the extent of revision required (all the language editors provide their support on a voluntary basis and therefore reviews need to be scheduled around their existing work commitments).

Authors are asked to indicate the date by which the review is required to be completed - bearing in mind the target response time above.

the ōbex project is a free language editing service and does not provide technical review. The language editors are all suitably qualified to undertake language editing but in some instances may not be experienced operational researchers.

For further information please contact the managing editor. 🌐

MOOCs: OR Courses for Free!

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Several courses in Operational Research and related subjects are available for free in MOOCS - Massive Open Online Courses. Many of these courses address Computer Science, Maths and other OR related subjects, but a range of courses from other areas are also available, from Artificial Intelligence to Writing. People all over the world can attend these for free: it is a great opportunity for many operations researchers!

The courses last for about 2-10 weeks, taking 2-6 hours per week. The classes are given by video/audio-classes, and each course can have such extra resources as student discussion forums, student work, lecture notes, assessments, online textbook, interactive simulations. Some of the courses charge (about US$60 per course) for having access to some of the extra resources, even giving a certificate at the end. However, a free version of the course is usually available.

Although courses are available in about 17 languages, most of them are in English. Some courses have subtitles in other languages. The courses are offered dynamically, usually announced 2-4 months before they start.

To find a course of interest, you can access the MOOC aggregator at www.class-central.com. Searcher need only to type a keyword at the top bar. Be aware that the term "Operational Research" is not a very useful keyword – it is better to search on the specific subject or topic within OR. For example, searching on November 9th 2016 on Dynamic Programming gave a list of 36 courses (many of which had taken place and some which were not relevant) including one by Stanford University starting on 5th December on 'Greedy algorithms minimum spanning trees and dynamic programming'. A search on Linear Programming gave 30 results, one of which was for 'Discrete optimisation' by Melbourne University starting on 11 December. 🌐

Useful Software for OR Analysts

Jon Tecwyn UK Department of Business, Energy and Industrial Strategy c/o felicity.mcleister@theorsociety.com

The OR Society launched its O.R. Pro Bono initiative for UK based third sector organisations in September 2013. The society wants more organisations to benefit from operational research and recognises that third sector organisations have an even greater need to be more efficient. It is a service to third sector organisations in order to provide them with access to OR at the cost of expenses only.

To help analysts who want to volunteer their services but who do not have access to appropriate software, the author started setting up an evolving list of tools that are largely free and/or open source. It is hoped that this list would be of benefit to the greater IFORS audience.

The list so far includes 50 tools across a range of areas including:

Statistical analysis (e.g. PSPP, R)
Data visualisation (e.g. D3, Gephi, Vizable)
Geospatial and mapping (e.g. QGIS, GDAL, MapsData)
Programming languages (e.g. Python, Ruby)
Databases (e.g. PostGres, SQLlilte, ArangoDB)
Optimisation (e.g. Pyomo , OpenSolver)
Simulation (e.g. SimPy, Insight Maker)
Supply Chain (e.g. OpenBoxes , Odoo)
MapsData: Mapping car crashes in the UK 🌐

The list can be accessed at: http://ow.ly/HVvY305MkYc and click on 'List'
To add to the list please contact: felicity.mcleister@theorsociety.com

MIPLIB 2017: Call for Contributions to the 6th Mixed Integer Programming LIBrary

Ambros Gleixner gleixner@zib.de (On behalf of MIPLIB 2017: an initiative by Arizona State University, COIN-OR, CPLEX, FICO, Gurobi, Matlab, MIPCL, MOSEK, NuOPT, SAS, SCIP, and Zuse Institute Berlin.)

Since its first release in 1992, MIPLIB has become a standard test set used to compare the performance of mixed integer linear optimization software and to evaluate the computational performance of newly developed algorithms and solution techniques. It has been a crucial driver for the impressive progress seen over the last decades.

Six years have passed since the last update in 2010. Again, the progress in state-of-the-art optimizers and improvements in computing machinery have made several instances too easy to be of further interest. New challenges are needed!

MIPLIB2017 will be the sixth edition of the Mixed Integer Programming LIBrary. To continue the diversity and quality standards of the previous editions, we are looking for interesting and challenging (mixed-)integer linear problems from all fields of Operations Research and Combinatorial Optimization, ideally ones that have been built to model real world problems.

For the first time, model files and data will be collected and made available as supplement to the raw instance format. Though an optional add-on, this is highly encouraged to provide researchers with richer information on the instances.

Readers are asked to contribute and help shape the future of mixed integer programming by submitting instances at https://miplibsubmissions.zib.de/ by February 28, 2017. 🌐
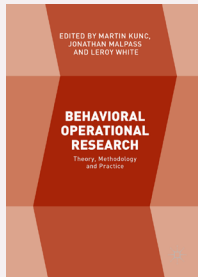

The IFORS website On line Resources has a lot of available material for use of the OR worker. Reader is invited to visit IFORS Education Resources and the Developing Countries On line Resources

Better OR with BOR

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Behavioral Operational Research
Theory, Methodology and Practice

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A development within Operations Research (OR) that has emerged over the last number of years is the renewed emphasis on the decision maker as a human being. This subfield has become known as **Behavioral Operations Research (BOR)** where the emphasis is on gaining a better understanding of human behavior especially in the process of decision making. How can this then be captured and represented in models together with the appropriate and associated analysis? Although modelling behavior has been applied in such areas as decision analysis and systems dynamics, there has been a growing resurgence and recognition of the need to include behavioral factors such as human judgment and decision-making heuristics and biases, decision-making under uncertainty and bounded rationality into a wider spectrum of quantitative modelling approaches and methods.

Thus, innovative ideas, methods and research frameworks, influenced by recent similar developments in other fields, are now being used by operations researchers to allow for a more rigorous approach to addressing behavioral issues within OR. As more and more research papers on the topic are published, so have special editions of journals devoted to BOR. This has culminated in the publication of the book **Behavioral Operational Research.** This is possibly one of the first books on behavioral OR and covers a wide array of relevant topics.

The book has four main parts, each with a number of chapters written by whole host of authors. Part I covers theoretical aspects; Part II focuses on diverse methods used to address behavioral issues in OR; Part III illustrates, with practical OR cases, how behavior plays a key role in model performance and discusses insights thus derived; and Part IV entitled "The Past, Present and Futures of Behavioral Operational Research" presents a concise wrap up.

Chapter 1 provides an introduction to BOR. It points out that maturity implies recognizing that developing technically correct and valid models is not sufficient anymore - behavioral factors that could enhance or even hinder the effectiveness of such models - need to be considered. This "return" to BOR is achieved through an empirical examination of human behavior in OR-supported processes. An integrative framework based on three concepts, namely: OR methods (techniques or tools), OR actors (those involved) and OR praxis (OR activity) is proposed to drive the development of BOR. Emphasis is made on conducting empirical studies to examine what people actually do within a system or when engaged in OR-supported processes. The next three chapters in Part I are more theoretically oriented, covering such issues as: "Behavior with Models: The Role of Psychological Heuristics in OR", "Behavior in Models: A Framework for Representing Human Behavior" and "Behavior Beyond the Model".

In all three chapters, there is an effort to provide a framework which would allow for embedding behavior with, in and beyond models.

All six chapters in Part II focus on specific OR methods, both "hard" and "soft", to address behavioral issues. Chapter 5 shows how a queuing environment modeled using simulation and laboratory experiments show that when customers in queues have learned patterns, the assumption that they arrive according to some random process no longer holds. System dynamics is the topic of the next chapter where errors in understanding of feedback structures in the supply chain environment can lead to poor mental models that cause systematic errors. Some mechanisms that involve misperceptions in these situations are discussed. The next two chapters deal with behavioral issues in agent-based modeling and behavioral modeling in decision making. Chapter 9, "Big Data and Behavior in OR: Towards a "Smart OR"", address a very current issue of how analytical techniques can be used to extract behavioral insight from Big Data including social media data. Behavioral issues related to two "soft OR" approaches, namely facilitation in scenario planning and group model building, conclude Part II.

In Part III, the focus is on relevant practical examples of OR. Its first chapter provides a literature overview of practical BOR that highlights the breadth and extent of studies that have been undertaken in the area. Each of the next five chapters addresses a different example where behavior is a key component of the model. Healthcare is the first example where a concern on the "lack of reported implementation of model findings and recommendations" is addressed. The issue of whether human behavior should be incorporated in the conceptual design of simulation models is tackled using two case studies. The availability of "real" human behavior data is shown to be a huge challenge.

A number of case studies relating to the use of BOR in British Telecommunications is described in chapter 14. It outlines lessons learnt and presents illustrations of how incorporating behavior in OR models has led to successes. The use of big data and BOR in "smart" cities context is illustrated through a number of case studies, including energy efficiency planning in different districts and the use of a city dashboard for real-time reporting. A term SMART OR to refer to "the creative use of Big Data with Hard and Soft OR to enhance behavior and positive results for decision makers" is advanced to illustrate what has been done and achieved. Chapters on "Mergers and Acquisitions" as well as "Resource Conceptualization Processes" show how behavior is included in models that deal with both strategic issues and the development of strategies, respectively.

The final chapter is in essence a review of the past, an assessment of the present, and a forecast of possible futures of BOR. Covering a wide range of topics *"ranging from the modeling of thought and behavior and the incorporation of behavioral factors in models to how people understand models and how thought and behavior is influenced by modeling work",* the book makes a clear case for incorporating behavior into OR projects. The objective of illustrating "behavior with models", "behavior in models" and "behavior beyond models" has clearly been achieved in this publication. This is a great reference for those who want to get familiarized with BOR.

As early as September 1964 during the first international conference held by the Operational Research Society with the theme "Operational Research and the Social Science", Sir Charles Goodeve, stated: *"operational research people are very much concerned with change and can deal with the logic, including the economics, of it. But attitudes of people - managers, technicians, workpeople, salesmen, customers etc. - can throw the best of predictions into confusion".* These are words that ring true, even today. The book Behavioral Operational Research is therefore an important and essential addition to further enhance and broaden the impact of OR as a discipline. 🌍

Combinatorial Auctions In Collaborative Vehicle Routing

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The highly competitive transportation industry has put pressure on carriers to increase efficiency. Collaboration has been encouraged by public authorities since it serves such ecological goals as reducing road congestion, noise pollution, and harmful emissions.

In horizontal collaboration, carriers form coalitions in order to perform parts of their logistics operations jointly. By exchanging transportation requests, they can operate more efficiently. In the full truckload market, different types of auctions have been successfully applied to meet these goals (e.g. Sheffi 2014; Kuyzu et al. 2015). However, in less than truckload (LTL) settings, the application of these methods becomes more challenging. The exchange of requests can be organized through combinatorial auctions, where collaborators submit requests for exchange to a common pool. In combinatorial auctions, requests are not traded individually but are combined in bundles. This is of particular importance in vehicle routing, where a request might be worthless unless combined with others. Figure 1 shows such an example for 3 carriers with their pickup and delivery requests.

If a bidding carrier's price is accepted, the carrier receives the full bundle. The carrier with a rejected bid does not get any item in the bundle. This eliminates the risk of obtaining only a subset of requests that does not fit into the current request portfolio.

Alternatively, generation of bundles can be moved to the carriers themselves. Thus, the auctioneer could offer the set of requests without grouping them into bundles. The carriers then give their bids on self-created packages of requests. Since the auctioneer cannot guarantee that all requests will be assigned to carriers, the outsourcing option is included. In this case, a carrier can get a set of requests that exceeds its capacity.

Without outsourcing, an LTL combinatorial transportation auction typically follows a 5-phase procedure (Berger and Bierwirth, 2010):

1. Carriers decide which requests to put into the auction pool.
2. Auctioneer generates bundles of requests and offers them to the carriers.
3. Carriers place their bids for the offered bundles.
4. Auctioneer allocates bundles to carriers based on their bids (winner determination problem).
5. Collected profits are distributed among the carriers.

Combinatorial auctions can be effective mechanisms to allocate transportation requests (e.g., Ledyard et al., 2002; Song and Regan, 2003; Krajewska and Kopfer 2006; Berger and Bierwirth, 2010; Ackermann et al., 2011; Dai et al., 2014). Nevertheless, each of the 5 auction phases bears a complex and at least a partly unsolved decision problem. In the first phase, participating collaborators can decide either on self-fulfilment, i.e. they plan and execute their transportation requests with their own capacities, or to offer some of them to other carriers. Aiming at network profit maximization, carriers should try to offer requests that are valuable for other network participants. Otherwise, the auction mechanism will not yield improved solutions. However, the identification of requests that are valuable for collaborators is not trivial since the actors do not want to reveal sensitive information. This auction phase is illustrated in Figure 2.

An intuitive solution would be to let the carriers solve a team orienteering problem and put requests that do not appear in the optimal tour into the pool (Archetti et al., 2014). However, Gansterer and Hartl (2016a) show that the best request evaluation criteria take geographical aspects into account. They clearly dominate pure profit-based strategies. Schopka and Kopfer (2016) analyse several other heuristic pre-selection strategies.

In the second phase, the requests in the pool are grouped into bundles. These are then offered to participating carriers. From a practical point of view, offering all possible bundles is not manageable, since the number of bundles grows exponentially with the number of requests that are in the pool. Gansterer

Combinatorial Auctions In Collaborative Vehicle Routing

and Hartl (2016b) show that the complete set of bundles can efficiently be reduced to a subset of attractive ones. They develop a proxy function for assessing the attractiveness of bundles under incomplete information. This proxy is then used in a Genetic Algorithms-based framework that aims to produce attractive and feasible bundles. With only a little loss in solution quality, instances can be solved in a fraction of the computational time compared to the situation where all possible bundles are evaluated.

Bundles are then offered to the carriers in Phase 3. By giving a bid on a bundle, a carrier reflects its willingness to acquire the bundle. Typically, a bid is based on the carrier's marginal profit, which is the difference of the profits including and excluding the bundle in the tour. Hence, for each bid, a routing problem has to be solved. Buer (2014) proposes heuristics for the identification of promising bundles in order to decrease the bidding effort.

Phase 4 addresses the winner determination problem. Bundles are assigned to carriers in such a way that the total coalition gain is maximized. Models for the winner determination problem need to ensure that requests (that can be part of more than one bundle) are only assigned once. Carriers should not receive more requests than they can handle, unless the outsourcing option is included. The framework proposed by Gansterer and Hartl (2016b) guarantees that a feasible assignment of bundles to carriers is found without making it necessary for carriers to reveal sensitive information and without the need of outsourcing. The winner determination problem is an NP-hard optimization problem (Rothkopf et al., 1998). Figure 3 shows a possible re-assignment of requests after the winner determination problem.

The main advantage of horizontal collaboration in logistics is that the total profit of the coalition will be higher than the sum of the carriers' stand-alone profits. However, the collaboration gain should be distributed in such a way that each partner benefits from participating in the coalition (Phase 5). If this is not the case, carriers may leave the coalition. The profit sharing method should additionally force companies to avoid strategic behavior that negatively influences the coalition gain, and reward behavior that benefits the coalition (Vanovermeire et al., 2014). Strategic behavior can occur in each of the phases. Behavior that negatively impacts the coalition might involve carriers not using their real marginal costs for generating bids or not following the rules for selecting requests. For example if in Figure 2, Carrier A selects A1 and A3 which for it are not attractive, the opportunity for greater profits for the coalition is affected. Nonetheless, the impact of strategic behavior on the outcome of these collaborations is still unknown.

Admittedly, many challenging questions still have to be answered to make combinatorial auctions efficiently applicable to real-world LTL settings. For instance, the strong relationship between the phases has not been investigated. In addition, the realistic assumption that carriers might behave strategically opens many interesting research questions. Therefore, collaborative vehicle routing is an active research field with a high practical importance in the LTL area. Combinatorial auctions have the huge potential of becoming powerful mechanisms for increasing collaboration profits. 🌐
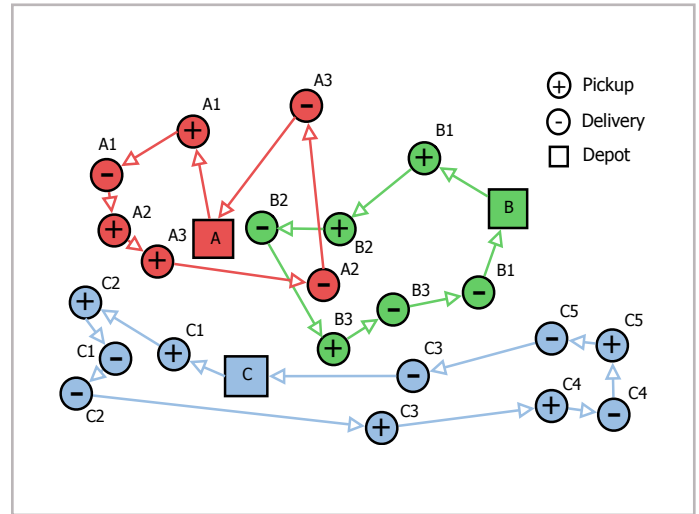

Figure 1: Illustration of the non-collaborative tours of 3 carriers. For carrier B, buying request C4 alone will probably not be profitable. However, the extra travel cost will probably be compensated if C5 is acquired additionally.
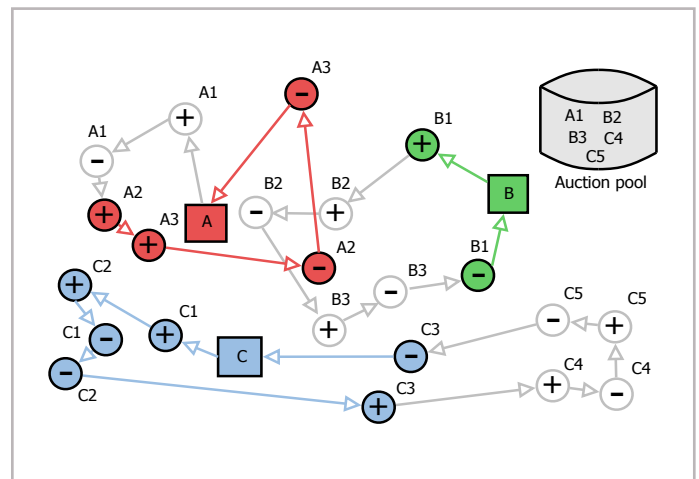

Figure 2: Carriers submit request to the pool. Carrier A selects requests based on marginal profits, while carriers B and C take geographical information into account.
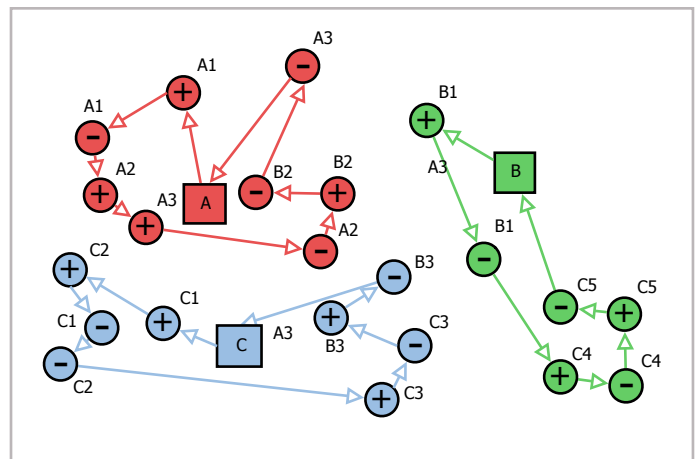

Figure 3: Possible re-assignment of requests to carriers.

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Lifelong Learning in Optimisation

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A food-processing factory manufactures different products based on customer orders from a stock of raw ingredients. They want to create weekly schedules that ensure that all orders are manufactured on time. They commission an optimisation algorithm from the OR department at the local University, supplying historical data to allow the algorithm to be tuned, and at first are very pleased with the results. Over time, however, the company begins to notice that the quality of the schedules produced seems to be deteriorating, with several orders delivered late, causing them to lose confidence in the algorithm.

Unfortunately, the experience of the factory is typical – the market in which the factory operates is dynamic: their customer base slowly changes over time, the type of products demanded by consumers changes, and the availability of the raw ingredients fluctuates due to changes in suppliers. The optimisation algorithm that was tuned to work well on the original problem instances no longer works on the new problem instances that now have very different characteristics. Of course, the manager can return to the OR department to ask for the algorithm to be re-tuned – or perhaps a completely new algorithm is required – but either way it's a time consuming process that requires considerable expert input.

As human problem-solvers, we cope much better than machines with adapting our problem-solving processes to change. We modify existing processes, drawing on prior experience if relevant, and generate completely new strategies if the magnitude of the change demands it. In contrast, optimisation algorithms rarely work in this way - an algorithm is usually designed and tuned to work well across a class of instance using a range of examples drawn from the class and then 'fixed'. At best, some adaptive methods can alter parameter values online as a single instance is solved, based on feedback from the solver, but any knowledge gained during this process is lost as soon as the algorithm terminates.

In response to this, we propose a new model of optimisation system – in which systems not only learn how to solve a problem but learn continuously over a lifetime. Such systems improve their problem solving abilities over time: retaining knowledge, using it to improve future learning, and generating new knowledge when required.
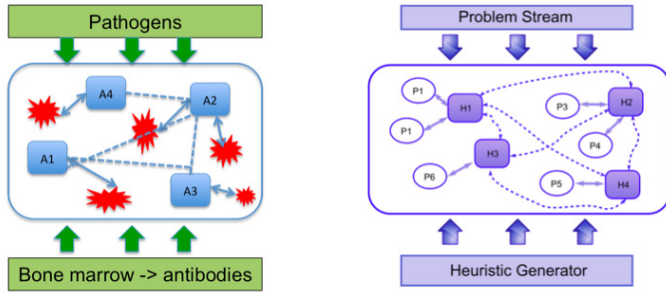
Lifelong Learning in Optimisation

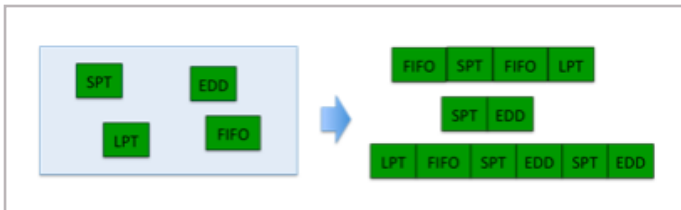*Figure 1: The immune system architecture inspires a continuously learning optimisation system*

Figure 2: A library of component rules is used to construct variable length heuristic sequences

In order to design such a system, we turn to nature for inspiration, and particularly to the *natural immune system* as an example of a system that has been highly and effectively evolved to solve problems and learn continuously over time. Four features of the immune system are particularly appealing:

*1. The immune system can generate **novel** immune-cells in response to pathogens that it has never encountered before.*
*2. It **remembers useful information**: immune-cells that have proved effective at destroying a pathogen are retained, which is of course the basis of vaccination – this memory can last anywhere from weeks to years.*
*3. It **learns from experience** – when faced with a pathogen that has some similarity to one previously encountered, it uses responses to similar pathogens stored in its memory as a starting point.*
*4. It can **rapidly improve its response** to a pathogen over a very short timescale through a process called clonal-selection, that optimises the response.*

Translating to optimisation, we propose a system that continuously generates new knowledge in the form of novel deterministic heuristics, each of which produces a solution to subset of problem instances within the overall problem space. The heuristics are integrated into a network of interacting heuristics and problems: the problems incorporated in the network provide a minimal representative map of the problem space; the heuristics generalise over this space, each occupying its own niche. Memory is encapsulated in the network and is exploited to rapidly find solutions to new problems. The network is plastic both in its contents and its topology, enabling it to continuously

adapt as the problems in its environment change.

The system should produce effective solutions, but also respond efficiently to changing problems in terms of the response time required to obtain an effective solution.

System Overview
The system is shown in Figure 1. The ***heuristic generation*** subsystem is responsible for continuously generating new heuristics, which are trialed for a short period in the network – exactly analogous to the manner in which the bone marrow in the human body continuously generates new immune-cells. In immunology, the bone marrow is able to generate a wide range of diversity in new cells through random recombination of non-contiguous germ-line gene segments from a gene-library; mutation provides further diversity, leading to an antibody repertoire that is estimated to be $>10^{13}$. In the same way, we create large numbers of new heuristics from a *library of heuristic components*. In its simplest form, components consist of existing well-known processing rules (e.g. select items to schedule according to *shortest-processing-time (SPT), Earliest-Due-Date (EDD)*). These are combined into new random, variable-length, sequences as shown in Figure 2. Rules are applied in the sequence given, cycling around, until the problem is solved.

Additional diversity can be generated by constructing *new components* to add to the library. For example, *Genetic Programming* can be used to evolve tree structures representing new rules (Figure 3).

The generation process can also attempt to *improve existing heuristics* – selecting strongly performing heuristics from the network and applying mutations (neighbourhood operators) to intensify search around them. All new heuristics created are injected into the network with a fixed "concentration" that enables them to stay alive for a short period in order to try to 'win' problems.
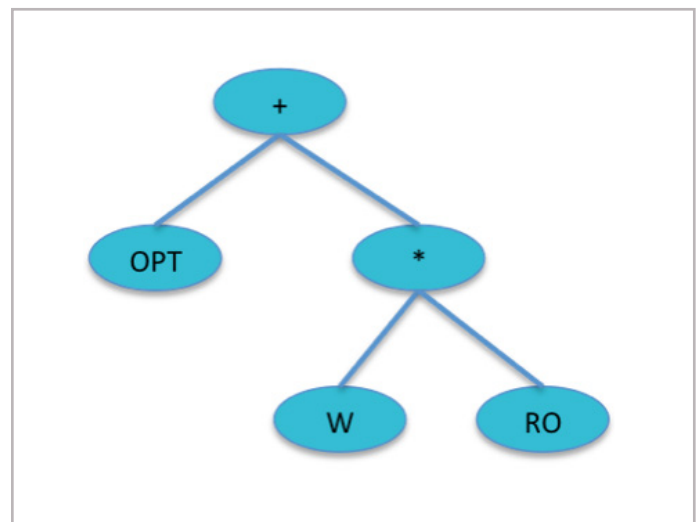

Figure 3: A new component for scheduling: the tree returns a numeric value indicating the priority of each operation that can be scheduled. The operation with highest priority is chosen. OPT = operation processing time, W = job weight, RO = number of remaining operations in the job
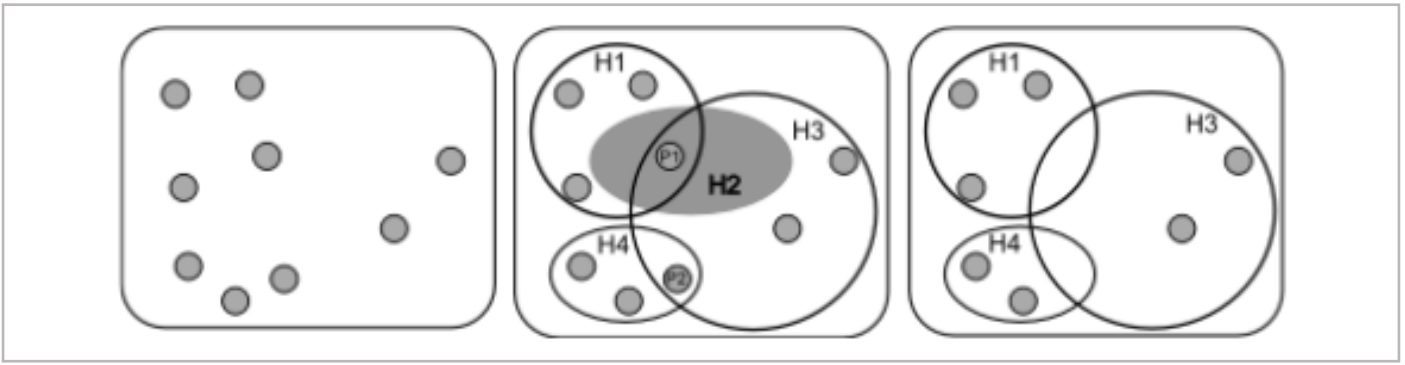
Figure 4. Step (1): new problem instances are introduced. Step (2): 4 new heuristics are injected: heuristic H2 does not uniquely win any instances and hence is subsumed by H1 and H2 . Step (3): problem P1 and P2 are won my multiple heuristics and are removed as they are not representative of 'hard' regions
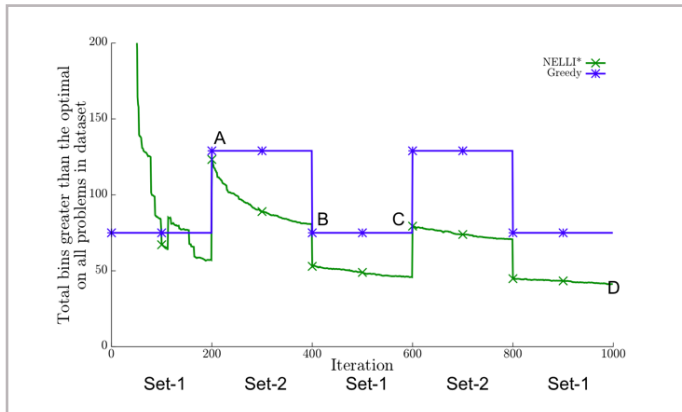

Figure 5: Alternating sets of instances are presented to the system. The total number of bins over optimal summed over all instances (both sets) is recorded.

of redundant heuristics, while new heuristics are incorporated if they outcompete existing ones.

Application to bin-packing
Results from the system which we call NELLI (Network for Lifelong LearnIng), tested using 1370 well-known bin-packing instances, are shown in figure 5. The problem instances are divided into two sets of problems; the instances in set-2 have very different features to those in set-1. First, all instances in set-1 are presented; 200 iterations later, they are replaced with the instances from Set-2, etc. At each iteration, the results obtained by NELLI are compared to those obtained by an algorithm that simply makes a greedy selection for each instance from the heuristics that make up the component library.

Comparing A and B (set-2 instances), we see that NELLI is able to *learn over an epoch* – there is a continuous improvement in fitness as new heuristics are generated or improved.

Comparing points B and C demonstrates *memory:* at point B, the heuristics from set-2 are removed, and reintroduced at point C. The fitness at C is similar to B, due to the system retaining memory of useful heuristics, despite solving heuristics from Set-1 during the intervening period.

Comparing points C and D, we demonstrate the NELLI continues to *learn over a lifetime* – the fitness at D is better than that at point A for set-1.

Conclusion
A new approach to designing optimisation systems has been described, representing a shift in thinking from "run once" optimisation algorithms to optimisers that run continuously, enabling them to autonomously adapt to changes in problem characteristics. The system learns from experience as it is exposed to new problem instances, which enables it to improve existing solvers. At the same time, it is able to generate new solvers when faced with novel problem instances. Heuristics occupy individual niches and generalize over all instances within the niche. Currently, the system has been tested extensively in the bin-packing and job-shop scheduling domains, demonstrating superior performance to existing algorithms across very large problem sets, and adaptive capabilities when presented with new instances with unseen characteristics. 🌍

Within the *network*, new heuristics compete with existing ones to tackle problems instances currently in system - problems are injected by the user and can arrive at any time. Each heuristic must "win" at least one problem in order to persist (that is, outperform all other heuristics): winning a problem causes a heuristic to increase its concentration, in proportion to the size of the win. Vice-versa, heuristics gradually lose concentration over time if they do not win new instances and are eventually removed. This results in each heuristic occupying its own niche within the instance space (Figure 4).

Problem instances gain concentration by being difficult to solve. Problems with high concentration remain in the system marking interesting regions of the problem space, providing mutual stimulation to heuristics to also survive in these regions. On the other hand, those problems solved by multiple heuristics disappear from the system. The topology of the network defines a set of heuristics that is specialised to the set of instances to which the system has been exposed and implicitly forms a **memory:** injecting problems that are similar to those in the network stimulates an existing heuristic to respond and perhaps be improved. The gradual decay of concentration over time resulting from lack of stimulation enables a gradual forgetting

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How Many Dentists Does Sri Lanka Need?

This project was a finalist in the IFORS Prize for OR in Development, Melbourne, 2011.

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Background

All Sri Lankan-trained doctors and dental surgeons (referred to as dentists in this article) are, in theory guaranteed state employment. However, the government had funded too many university places in dentistry from the early 1990's onwards and as a result has been unable to employ all its qualified dentists. At the start of 2010 there were over 250 dentists, nearly 25% of the total, awaiting Government employment. Many either left to work overseas, or set up private practice. This under/unemployment among dentists was increasing, due to the political agenda and a lack of coordination between the trainer (the Ministry of Higher Education) and the main employer (the Ministry of Health). Meanwhile, the University Grant Commission, which decides the number of undergraduates to be trained, was under continuous political pressure to increase the intake of dental students.

As one of the "underemployed" dentists himself, Dileep De Silva took up a managerial post within the Sri Lankan Ministry of Health. He studied for an MBA, during the course of which he discovered that the problem could be tackled using system dynamics (SD) and simulation modelling. By enrolling for a PhD at Southampton University he was able to enlist expert technical support from his supervisor Prof Sally Brailsford in developing appropriate models and then to utilise his contacts at the Ministry of Health to demonstrate implementable solutions to the problem.

Modelling the availability of and demand for dentists in Sri Lanka

Two SD models were developed, one to represent the supply of dentists, through training and in practice until retirement; and the other to represent the demand for dentists under various scenarios of population change and economic activity over the same time period.

Supply Side Model

Sri Lanka has one Dental School at the University of Peradeniya in Kandy. The normal duration of a dentistry degree is 4 years, and the annual intake was 80 students per year in 2010. After graduating, newly qualified dentists should, in theory, immediately obtain full-time state employment, usually working in a hospital. Other career options, chosen by a small number of dentists, include joining the defence sector as a military dentist, or (for a very few) remaining in academia. Sri Lankan dentists can switch between these different career options over the course of their working lives, subject to certain employment contract restrictions. For example, dentists in the defence sector are bonded to serve for a minimum time, normally 12 years. Some may choose further specialist training in one of five areas: maxillofacial surgery, orthodontics, restorative dentistry, oral pathology and community dentistry. Others may leave the profession altogether, and a few will die in service. Most dentists augment their income by doing private practice. This is normally initially on a part-time basis but can shift to full time as they acquire more experience and the resources to set up their own practice. There is no mandatory retirement age in the private sector. Retirement is at 60 for state employment although such employees generally retain part-time private practice, gradually reducing work hours at the age of about 60 to 65.

A simplified version of the supply side stock flow model is shown in Fig 1, where the rectangles (stocks) represent the number of dentists in each employment category. After graduation from university, newly qualified dentists join the stock Entrants, which contains dentists seeking employment. In the past, the Entrants stock would have been almost empty most of the time but in 2010 this stock contained around 250 people. Once dentists finally obtain a post they pass from the Entrants stock to an employment category and work as practising dentists until they exit the system because of retirement, attrition or death. Furthermore, people changing their job category also re-join the Entrants stock.
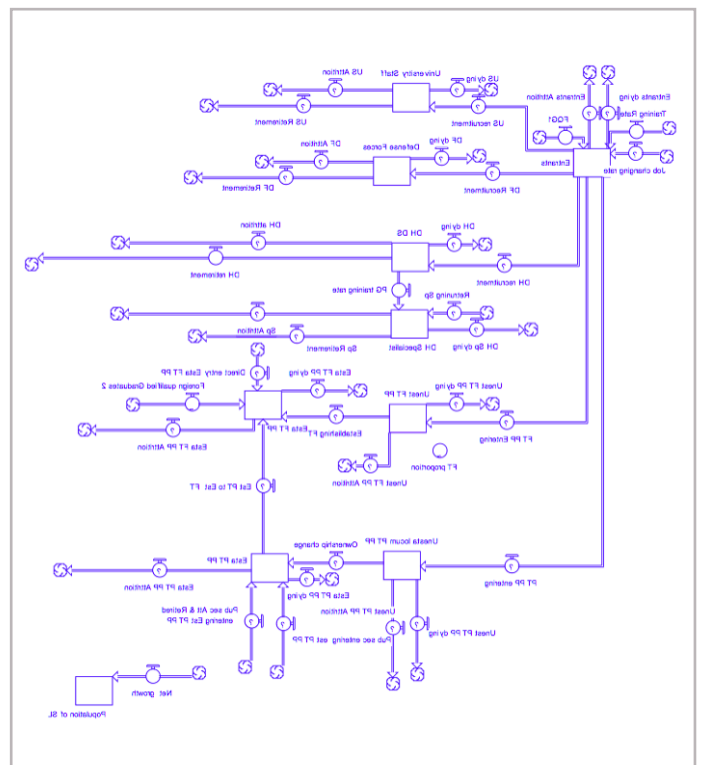

Figure 1: Simplified stock-flow diagram depicting the entire career structure. (DH=Department of health (state sector); US=University sector; DF=Defence forces; PP=Private practice; Sp=Specialist; PT=Part-time; FT=Full-time; Est(a)=Established; Unest=Unestablished (new).

Table 1 Model validation results for 1991-1995

Year	Number of State employment seekers		Waiting time for state employment (months)	
	Model	*Actual*	*Model*	*Actual*
1991	29	26	7	6
1992	24	23	5	5
1993	37	35	8	7
1994	47	44	10	10
1995	56	55	12	12

Table 2. The three demand scenarios (% of people with need who demand care)

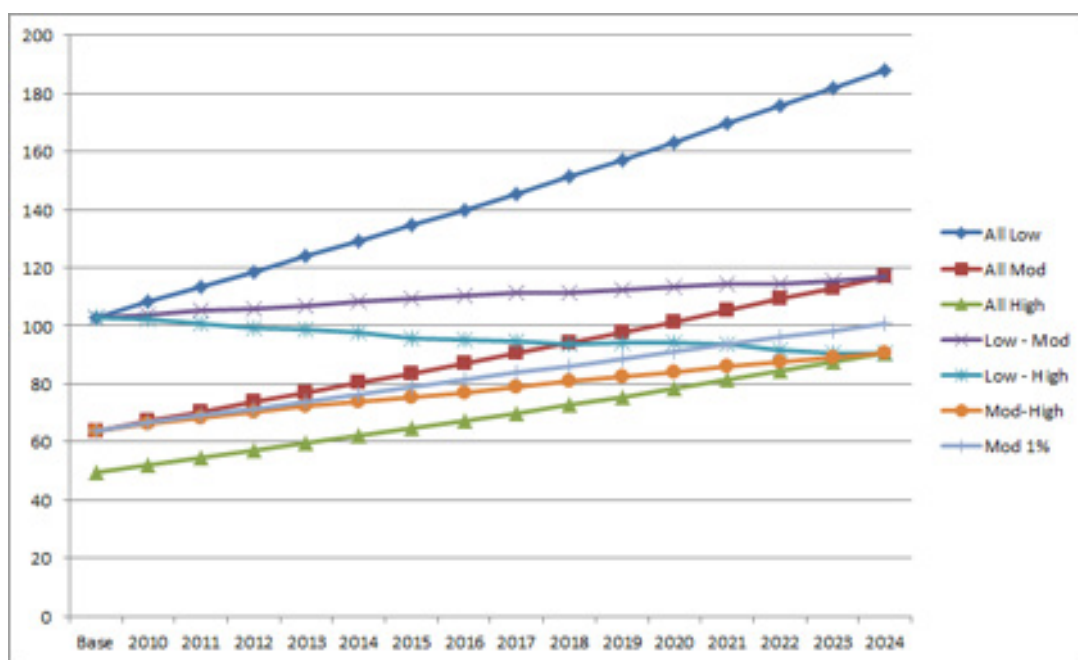| Age (years)	Low	Moderate	High
0-14	65	82.5	100
15-29	65	75	85
30-64	30	47.5	65
65 and over	10	20	30

Figure 2: Percentage of demand met using baseline policy for different demand scenarios.

The stock-flow model thus constructed depicts the dynamic evolution of the dental workforce over time. The model requires data on the initial numbers in each stock at time zero, plus the annual transition rates from stock to stock and a large number of auxiliary variables such as the ratio of state to private dentists, and the ratio of full-time to part-time employment (since 'part-time' can mean anything from a couple of hours a week to nearly full-time). Moreover, in order to calculate the capacity of this workforce to provide dental care, it was necessary to convert the headcount in each stock into available service hours. The challenging task of collecting data to parameterize this model is beyond the scope of this article but data for 1991 to 1995 has shown the model to be realistic. See Table 1.

Demand Side Model

The World Health Organisation (WHO), together with Fédération Dentaire Internationale (FDI), has developed an internationally recognised model to estimate the need for dental care (based on objective clinical criteria and demand), which is influenced by socio-economic and cultural factors. Demand for dental care is based on local circumstance. In this study, 3 different levels were considered, representing the percentage of people with a need for dental care that will then actively express a demand for care. See Table 2.

The timings for the main treatments provided were estimated by dentists working in a range of settings and scaled to estimate the population demand at national level. The fact that one of the authors was a qualified dentist engendered trust and a high response rate from participating dentists, thus helping to ensure that the estimates are realistic.

Results

Policy makers are interested in the fraction of demand met, the number of qualified but unemployed/underemployed dentists, the waiting time for state employment and the dentist to population ratios. Thus, the model contains two key decision variables or policy levers: 1) annual recruitment rate of admitting new students to university, and 2) creation of new state-funded clinical posts. The former has a delayed effect, since it takes 4 years to train a dentist, but the latter can change capacity immediately. The model was run for a planning horizon of 15 years, starting in 2010 for a range of possible demand scenarios and supply options, such as reducing the number of training places, introducing voluntary early retirement and increasing the number of clinical posts. Some results are given in Figure 2 for the baseline policy, which was judged the most realistic (The current intake of 80 students to the University Dental School was to remain unchanged over the next 10 years, and would then increase to 85 per year for the final 5 years of the simulation period; and the number of new state-funded posts would increase by 2% annually over the whole period.) Figure 2 shows the percentage of demand met under the seven demand scenarios - less than 100 denotes an undersupply and greater than 100 denotes an oversupply. Thus the 'moderate demand throughout the period scenario' (All Mod) shows an initial undersupply of dentists, leading to an oversupply from 2020.

The Implementation Process

Through his employment and contacts at the Sri Lankan Ministry of Health, De Silva was in the fortunate position of having excellent access to policymakers. He presented the model at a Cabinet subcommittee

meeting of the Sri Lankan government and demonstrated the effect of different policy options. The model was run for a range of different demand scenarios, to ensure that any decisions taken would be robust to future change. Reducing the university intake was never going to be politically feasible, but based on the model findings, in October 2010 the Sri Lankan Ministry of Higher Education finally agreed to fix the intake of dentistry students at its current level of 80 for another 10 years. Moreover, the Ministry of Health was convinced, based on the model results, of the long-term adverse consequences of widespread unemployment among dental surgeons and created 400 additional state vacancies, 250 in 2011 and 150 over 3 years (2012–2014). The implemented policy achieves a rapid reduction in both the number of dentists seeking state-funded employment, and the waiting time to secure state-funded employment after graduation.

Reflections

The use of the model by policy makers has enabled the following benefits: taxpayers' money has been better utilised and Sri Lankan dentists have improved career prospects. However the main beneficiaries are the Sri Lankan people. By the end of 2012, when only 250 of the planned 400 new posts had been created, more than 1 million people who previously had no access to care now visit a state dentist at least once a year, and will benefit from improved dental health in the future. Moreover, many of these 250 new dentists also work in the private sector after hours, which have resulted in 500 000 additional patient visits per year in the private sector.

There are several factors that contributed to this successful outcome. As a practising dentist, De Silva was able to explain the purpose of the model and gather reliable data that were acceptable to the dental fraternity, a crucial part of gaining professional acceptance of the model. He was 'one of them', and knew and understood first-hand the issues they faced every day. He also had connections within the Ministry of Health, which gave him access to policymakers denied to most academics. Moreover, his connection with an established UK university gave him academic respectability and an element of objectivity, which undoubtedly helped from a political standpoint. 🌐
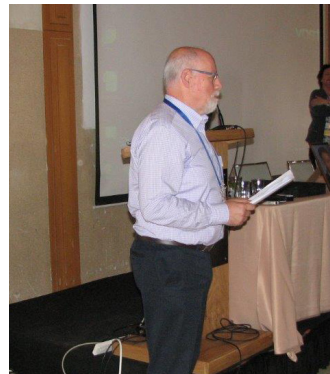
Reference S. Brailsford, D. De Silva (2015) How many dentists does Sri Lanka need? Modelling to inform policy decisions J Opl Res Soc 66, 1566-1577

OR SOCIETY IN FOCUS

ORSIS: Thriving As A Part of the Greater Community

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Michal Tzur and Avishai Mandelbaum taken during the 2016 ORSIS national conference.

The Operations Research Society of Israel (ORSIS) is a non-profit organization, established in 1966 with the goal of promoting and enhancing the research and practice of Operations Research in Israel and worldwide. Its founder and first president was the late Pinhas Naor, well known for his seminal contributions to queueing theory. ORSIS operates to strengthen the contacts among people engaged in Operations Research by initiating activities such as conferences and workshops on the Israeli level, as well as promoting and supporting the hosting of International conferences in Israel. ORSIS has about 150 registered members, most of them from academia. Other members come from the high-tech industry, as well as from the public sector in Israel. About a third of its members are graduate students. ORSIS is a member of IFORS and EURO.

The primary meeting of ORSIS is a two-day annual conference which is organized by alternating teams from different universities and held at various locations in Israel. In this meeting, ORSIS members and their students present original research papers, knowledge in Operations Research is exchanged and disseminated, and research prizes are awarded. A plenary lecture commemorating Pinhas Naor is given each year by a prominent researcher from abroad.

ORSIS also organizes and sponsors several specialized events and workshops. The recently established Workshop for Research Students in OR introduces students from various universities to the different facets of OR by giving them the opportunity to present their work in a less formal setting, get to know each other, and attend keynote lectures by faculty. A first Workshop on Applied Operations Research was held in February 2016. Initiated by an ORSIS member from IBM, the Workshop is meant to highlight successful applications of OR in industry, and to provide a meeting ground for OR practitioners and researchers. Another recently established activity is an industrial challenge in the area of OR, set forward in cooperation with an industrial company: Participating teams are invited to present their results in the Annual Conference, where winners are announced. The first Challenge, presented by Optibus Ltd., addressed scheduling of drivers to bus trips.

During its annual meeting, ORSIS presents several research awards that are intended to promote, encourage and recognize excellence in Operations Research. The ORSIS Award in the name of Uriel Rothblum recognizes an outstanding recent paper in Operations Research, and the Abraham Mehrez Prize is awarded to a graduate student for excellent work in OR. The Life Achievement Award recognizes ORSIS members who have made significant and continuous contributions to the field of Operations Research. Award recipients, as of 2003, include Itzhak Ravid, Uri Yechiali, Mordecai Avriel, Benjamin Avi-Itzhak, Reuven Rubinstein and Arie Tamir. Among the international prizes awarded to ORSIS members is the EURO Gold Medal, awarded in 2007 to Aharon Ben-Tal for his seminal contributions in the field of optimization. Co-sponsored by ORSIS, the 2017 POMS (Production and Operations Management Society) International Conference will be held in Israel in June 2017 http://orsis.net.technion. ac.il/2016/08/21/event-2/.

The field of Operations Research continues to thrive in the Israeli academia. Close ties and collaborations exist with related societies and areas such as game theory, statistics and computer science, as well with OR practitioners in the hi-tech industry. ORSIS sees as part of its mission to further these relations, while promoting all areas of OR research and practice. 🌐

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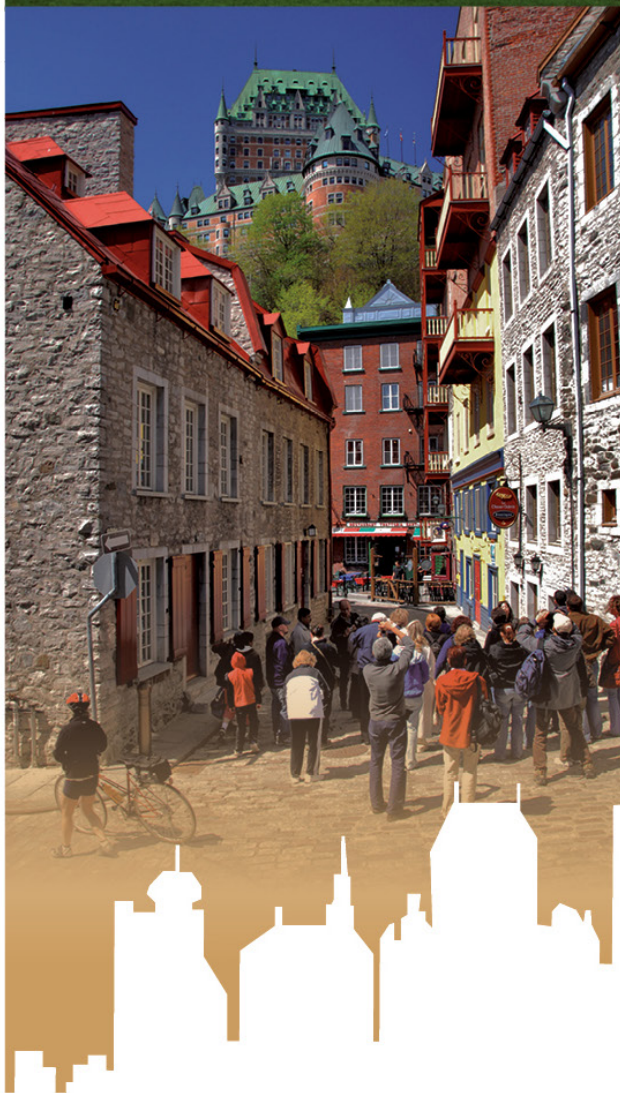
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