

# IFORS

NEWS

2016

INTERNATIONAL FEDERATION OF OPERATIONAL RESEARCH SOCIETIES

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## FROM THE PRESIDENT

## The Regions of IFORS

Mike Trick [trick@cmu.edu](mailto:trick@cmu.edu)

As I write this, I have just returned from a EURO (the Association of European Operational Research Societies) conference in Poznan, Poland. It was a fascinating conference with interesting plenary sessions, a wide range of technical talks, and outstanding social activities to encourage interactions among participants. EURO is a grouping of IFORS member societies based mainly in Europe and is a very successful organization with robust publications, active working groups on many topics, conferences and workshops, summer schools for doctoral students, and many other activities.

EURO is just one of the regional groupings of IFORS. Two other active groups are APORS (Asia-Pacific Operational Research Societies) and ALIO (Association of Latin-Iberoamerican Operational Research Societies) grouping operational research societies in their respective regions. Administratively, IFORS has also defined NORAM (North America) as a regional grouping, but it consists just of the United States society (INFORMS) and the Canadian Society (CORS/SCRO), both of which are extremely active on their own, though they periodically combine for some joint activities.

Regional groupings provide an extremely important level between the national societies and IFORS. Perhaps most importantly, their conferences allow researchers and, particularly, students to experience a broader audience than national society meetings. If operational research is going to reach its potential, there is much work to be done at the national and regional levels. The meetings of EURO, ALIO and APORS facilitate interactions among people with similar issues and institutions. While a large global meeting can explore the breadth of operational research, regional meetings provide the structures to let operational research have an immediate impact.

In early October, ALIO will hold its regional meeting (called CLAIO) in Santiago, Chile.



Santiago is one of the most interesting cities in Latin America, and October should provide great weather. The conference has a broad mix of plenary speakers, including Monique Guignard-Spielberg, the IFORS Distinguished Lecturer, speaking on one of my first loves: lagrangian relaxation. The IFORS Administrative Committee will be getting together at the conference, so this will also be a chance to meet the members of the AC to talk about directions of IFORS.

The next meeting of APORS will be held in 2018 in Kathmandu, Nepal with the theme "OR and Development". EURO meets every year where there is not an IFORS conference, so its next meeting is in 2018 in Valencia Spain, followed by its 2019 conference in Dublin, Ireland.

I greatly enjoy my time at the regional meetings. Each one is different, reflecting both the country where the conference is organized and the region for which the conference is designed. I have met many people I would not have met otherwise, and I have seen how operational research is being used to meet the particular needs of regions around the world. I highly recommend attending both your regional conference, and the conferences of other regions.

I, of course, also recommend attending the conference when all these regions get together: the IFORS Triennial, to be held in Quebec City, Canada July 17-21. This is the conference where the world comes together to celebrate operational research: I hope to see you there! 🌐

*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.*

# Olympics Fever!

Elise del Rosario [elise.del.rosario@stepforward.ph](mailto:elise.del.rosario@stepforward.ph)

The Rio 2016 Summer Olympics has been concluded, yet a lot of the excitement remains. The IFORS News has succumbed: our regular Book Review and Tutorial sections show how OR has become a game changer in decision-making strategies and scheduling in various sports. A third Feature article contributed by our President is an entertaining piece on how OR was used to maximize the number of events to watch in a day at the Olympics.

Still from Rio, our editor of the International Transactions in Operational Research (ITOR) brings good news! ITOIR continues to fulfill the IFORS mission of helping the community exchange information about OR. A specific IFORS area of involvement in OR for Development – has a long and continuing history. Just in June and July of this year, two IFORS-supported events were held: the International Conference on OR for Development (ICORD) and the EURO Working Group on ORD Workshop.

The latter was a satellite event of the EURO 2016 held at the Poznan University of Technology. From all fronts, this EURO conference was a big success, as you would

read in two accounts of its organizers and delegates. Various other smaller and special interest conferences were held in Germany and Hungary. Interestingly, we feature an OR conference and a workshop in Mongolia, which does not yet have a national OR society!

As you recall, IFORS is composed of national OR society members, which in turn are grouped into the regions of North America, Latin America, Asia-Pacific, and Europe. Our President tells us more about these groups in his Editorial.

Latin America has recently concluded its highly successful Summer School in Cali, Colombia and planning another one in Buenos Aires and Miramar in Argentina this coming February. This is to develop skills and promote networking among young OR professionals. We, of course, don't forget the mentors – and pay our deepest respects to two departed gentlemen who have played a big part in our profession and in IFORS.

Apart from its role in Sports, OR has been used extensively to deal with environment issues, as our OR Impact section points out.



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

When talking about environment protection, efforts of organizations in New Zealand come to mind. In this issue, we discover about another aspect - how the Analytics movement is sweeping the country.

Olympic reporters Victor and Sarah took the challenge of seeing how many games they can see in a day. I invite you to see how many articles in this issue you can read - from the Olympics in Brazil to Analytics in New Zealand - in just one sitting! 🌐

## FEATURE

### How Many Olympic Events Can Be Seen In One Day?

Michael Trick [trick@cmu.edu](mailto:trick@cmu.edu)

***This is the question reporter Victor Mather of the New York Times asked me when he was trying to optimize his day during the recent Rio Olympics. Sarah Lyall, another reporter would provide competition by doing no planning. Does planning help?***

Not surprisingly, operational research and optimization helps a lot, with a few caveats. Since the Rio Olympics were spread over the city, the planning problem had aspects of the traveling salesman problem. But Victor also wanted to see the events, so there were time windows associated with when events were being held. Fortunately, with “just” 20 events held on a day, modern optimization methods could give Victor his optimal schedule where he could see all but one of the events.



Photo By Tal Levi. CC BY-SA 4.0

That is, until the plan met reality in the form of traffic gridlock, non-existent buses, unclear event locations, and multiple other aspects of the model deviating from reality. Victor was off schedule within 30 minutes of starting. Fortunately, he was able to get back on schedule a couple hours later, and he ended up seeing 14 events.

Did optimization help? Sarah ended up seeing 5 events.

#### Victor's story

<http://www.nytimes.com/2016/08/19/sports/olympics/reporter-race-to-events-rio-games-mather.html>

#### Sarah's story

<http://www.nytimes.com/2016/08/19/sports/olympics/reporter-race-to-events-rio-games-lyall.html>

#### More on my story

<http://mat.tepper.cmu.edu/blog/?p=8867>



## ITOR Impact Factor Continues Upward Trend

The 2015 release of the ISI Journal Citation Reports in the last week of June brought very good news for the International Transactions on Operational Research (ITOR), the IFORS Journal edited by Celso Caneiro Ribeiro.

ITOR impact factor has increased from 0.977 in 2014 to 1.255 this year. This brings ITOR ranking to 39th out of 82 titles in Operations Research & Management Science and 100th out of 192 titles under the Management category.

It will be recalled that it was only in 2011 when ITOR was first indexed, getting an impressive impact factor of 0.648 (49th out of 77 titles in OR&MS, 125th out of 166 titles in Management).



### SUMMER SCHOOLS

## ELAVIO XX: A Unique Academic and Cultural Experience

**Amélia Stanzani** [alstanzani@gmail.com](mailto:alstanzani@gmail.com)

The XX edition of ELAVIO (Escuela Latinoamericana de Verano en Investigación Operativa) took place between 9 and 13 May 2016 in Cali, Colombia. The conference venue was the Casa Santa Maria de los Farallones, better known as "Casa de las Palmas", a convention center for personal development in the peripheries of Cali.

ELAVIO 2016 was attended by about 60 master and doctoral students from several universities located in 10 different Ibero-American countries (Argentina, Bolivia, Brazil, Chile, Colombia,

Cuba, México, Peru, Spain and Venezuela). Two Ph.D. Students from UK and Belgium had the opportunity to attend the school thanks to two EURO scholarships. The school aims to promote the participation of young researchers and graduate students who are presented research topic updates through short courses and plenary conferences. It also seeks to create networks among the participants, thus stimulating collaboration and promoting inter-cultural integration.

**Continued on Page 4**



## ELAVIO XX: A Unique Academic and Cultural Experience

Continued from Page 4

During the days of the school, presentation of students' papers in parallel sessions were complemented by lectures and short courses given by OR professors, which included: *Application of Metaheuristic Methods In OR Problems* by Rodrigo Linfati (Universidad del Bío Bío, Chile) which discussed practical applications of classical metaheuristics and tips on how to improve computer performance by changing, for example, input data or way of implementation. Treating the same theme, José Luis González Velarde (ITESM Campus Monterrey, Mexico) presented *Theory Behind Classical and Hybrid Metaheuristics Applied In Logistic and Production Problems*. Other topics covered were: *Mathematical Optimization As A Tool to Visualize Data* by Emilio Carrizosa Priego (Universidad de Sevilla, Spain); *Phase-Type Distribution And Their Application In Several Practical Stochastic Systems* by Raha Akhavan Tabatabaei (Universidad de los Andes, Colombia); *Sensitivity Analysis On Practical Problems Through the Shadow Price Calculation for Linear Problems and Mixed Integer Linear Problems* by Alejandro Crema (Universidad Central de Venezuela, Venezuela); and *Practical Application Of OR Models*

*For Healthcare Planning* presented by Elena Valentina Gutiérrez; and *Facility Location* presented by Juan G. Villegas both from the Universidad de Antioquia (Colombia). ELAVIO participants were exposed to the Colombian culture through the meals served during the school.

A cultural activity included a visit to Universidad Javeriana of Cali where a dance tutorial of Latin-American rhythms was followed by a cultural tour to the sights of Cali. As a first time participant of ELAVIO, I was impressed with the opportunity it afforded me to meet people from different cultures, to improve my understanding of the Spanish language in several accents, to build friendships and establish connections with professionals in the field of routing and inventory control, which is my doctoral research area. As I go back to the Federal University of Sao Carlos (UFSCar) in Brazil, I shall treasure all the enriching knowledge that I gained, both in my research area and of the Latin culture. I thank IFORS which made this possible by granting me the scholarship, and the opportunity to participate in this event. 🌟

## ELAVIO Comes Back to Colombia

### A Note from the Organizers

In 2005, ELAVIO took place in Villa de Leyva, Colombia. This year marks only the second time that ELAVIO visited Colombia. It is heart warming to note that some of the people in the organizing committee were products of the ELAVIO 2005.

ELAVIO 2016 is one of the first international activities carried out by the new Colombian Operational Research Society (ASOCIO- Asociación Colombiana de Investigación Operativa). Collaborating for this activity were: the School of Industrial Engineering of the Universidad del Valle; the Department of Civil and Industrial Engineering of the Pontificia Universidad Javeriana-Cali; the Department of Basic Sciences of the Universidad de Medellín; and the Department of Industrial Engineering of the Universidad de Antioquia.

The organizers wish to highlight Emilio Carrizosa's lecture on *Optimization Models For Data Visualization*, which discusses how Operations Research is one of the professions better suited to face the challenges and opportunities brought about by the rise of big data and data science.

For this ELAVIO, networking is made easier thanks to social networks and apps technologies- for example, ELAVIO 2016 students have a WhatsApp group where they post questions and share knowledge on different OR topics. Moreover, the school of Industrial Engineering of the Universidad del Valle did a complete coverage of the School in Facebook and created a Youtube video <https://www.youtube.com/watch?v=CRYOOIcLWBw>. 🌟

### ELAVIO Organizers

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**The organizers gratefully acknowledge the support given by IFORS, without which ELAVIO 2016 would not have been possible.**



ELAVIO Organizers and lecturers (l to r): José Luis González Velarde, Juan Pablo Fernández, Rodrigo Linfati, Raha Akhavan-Tabatabaei, Juan G. Villegas and Emilio Carrizosa Priego.

# Call For IFORS Scholars

## ELAVIO 2017 - Escuela Latinoamericana de Verano en Investigación Operativa

Operations Research Summer School for Young Latin American Scholars  
February 24th to March 4th 2017, Buenos Aires and Miramar, Argentina

**The Summer School. The first edition of ELAVIO was held in Chile in 1994. Since then, the School has run the event every summer to promote education in operational research among young researchers and graduate students (PhD and Master's degree levels).**

The purpose of ELAVIO is to stimulate new collaborations and encourage the involvement of young people in OR by bringing them up to date on research topics through short courses and plenary conferences. Participants also have the opportunity to present and discuss their works. At all previous editions of the School, a strong sense of camaraderie developed, solidifying contacts between the members of research groups from different countries.

ELAVIO XXI will be held in 2017 in Argentina from February 24th to March 4th, in the cities of Buenos Aires and Miramar. Located 450 km (280 mi) south of Buenos Aires on the Atlantic coast, Miramar is an attractive tourist destination known for its beautiful beaches and a wide range of cultural and culinary attractions that should significantly enrich the experience for participants. Hosting the event will be the University of Buenos Aires, Argentina's main centre for scientific and academic activity.

Registration for ELAVIO XXI and the Opening Ceremony will take place on Friday, February 24th at the University, in Buenos Aires City. Various talks and a poster session will also be held that afternoon. The weekend will be free to take in the sights of the city, and on Sunday afternoon a bus chartered by the School will transport invited professors and students to Miramar. Over the following 5 days, a range of mini-courses and

tutorials on advanced topics of specific interest will all be held at the Alto Miramar Resort & Spa (<http://www.altomiramar.com.ar/site/>). Closing Ceremony will take place on Saturday morning, and that afternoon the bus will transport back all the participants to Buenos Aires.

The School is organized by the University of Buenos Aires (Buenos Aires, Argentina) and sponsored by: CELFI (Centro Latinoamericano de Formación Interdisciplinaria, Ministerio de Ciencia, Tecnología e Innovación Productiva); CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas, Ministerio de Ciencia, Tecnología e Innovación Productiva); and IFORS (International Federation of Operational Research Societies).

**The Scholarship.** IFORS is offering one scholarship for a participant to this event. IFORS will cover the participant's airfare from his/her country (subject to a maximum limit) while ELAVIO organizers will provide local transportation, meals and accommodation during the dates of the school.

### IFORS requires the applicant:

- 1 to have done work in the fields of interest of the School;
- 2 to be at an early stage of her/his career;
- 3 to present an unpublished work in the poster session; and
- 4 to be highly recommended by the advisor/supervisor of her/his work

### Topics covered by the School include, but are not limited to, the following:

- 1 Combinatorial optimization and polyhedral theory; linear, nonlinear and integer programming
- 2 Graph theory
- 3 Metaheuristics and its applications
- 4 Discrete, continuous and agent based simulation, stochastic processes and probabilistic models
- 5 Applications of operational research to problem solving in areas such as sustainability, health care, logistics, sports, agroindustry, engineering, telecommunications, finance and production, big data.

Those candidates satisfying the requirements are encouraged to submit their curriculum vitae, an extended abstract (up to 1 page) of the work to be presented in the poster session, and a recommendation letter by the advisor until November 15th, 2016 to:

**IFORS Vice President for ALIO, Prof. Guillermo Durán, [gduran@dm.uba.ar](mailto:gduran@dm.uba.ar).**

The selected applicant will be notified by November 30th, 2016. Candidates from developing countries will have an advantage in the selection.

The official languages of the school are English, Spanish, and Portuguese. Participants can make their posters in any of these languages. Short courses and lectures will be given in any of the official languages (with English slides). 🌐

# Call For IFORS Scholars

## EURO Winter Institute in Italy

University of Padova, February 14-23, 2017

**The office of the IFORS Vice President for EURO is pleased to announce the sponsorship of a participant to join the 2017 EURO Winter Institute on "Methods and Models in Transportation Problems" to be held at the University of Padova Winter-Summer Campus, Bressanone (Italy), 14-23 February 2017.**

The Euro Summer and Winter Institutes (ESWI) are organized to encourage good social and working relationships among promising OR scientists in the early stage of their careers.

The selected IFORS- EURO scholar will receive joint sponsorship from IFORS and EURO. IFORS will sponsor the travel costs of the delegate coming from non-EURO member society. EURO will shoulder expenses related to the registration, accommodation, meals, and social activities to the IFORS fellow. Applicants from developing countries will be given preferential treatment for the slot. Those who have joined EURO Institutes in the past need not apply.

The ESIs and EWIs aim is to facilitate the establishment of a network of promising early stage researchers (with less than 10 years experience in OR), thereby encouraging future collaborative work. EWI 2017 seeks to involve about 20 participants. While featuring lectures by invited speakers, the participants are expected to present and discuss their papers. A special issue of an international journal will be produced, based on the papers presented during the EWI. The varied

social program prepared for the participants is one of the unique features that enhance the learning activities.

**The applications should be sent by email to:**

**Professor Jacek Blazewicz**

IFORS Vice President for EURO  
Poznan University of Technology  
Institute of Computing Science  
60-965 Poznan, Poland  
Tel: +48-61-8790 790  
Fax: +48-61-8771 525  
Email: jblazewicz@cs.put.poznan.pl

**Applications should include**

1. A complete CV with a list of papers
2. A paper proposal (complete text or 3-5 pages long extended abstract).
3. A letter of recommendation from one referee (preferably the thesis advisor or head of department).

**Important dates**

Deadline for applications: November 30, 2016  
Notification of acceptance: December 15, 2016

### About EWI 2017

**Theme. Main topics of interest are OR methods, mathematical models and computation algorithms to solve and support the solution of problems in the field of Transportation and Logistics.**

**Other related fields of main interest are:**

- Land-use and transportation planning
- Traffic control and simulation models
- Traffic network equilibrium models
- Public transport planning and management
- Applications of combinatorial optimization
- Vehicle routing and scheduling
- Intelligent transportation systems
- Logistics and freight transportation
- Environment problems
- Evaluation methods.

**Location:** The EURO Winter Institute on "Methods and Models in Transportation Problems" will take place in Bressanone, Italy, from the 14th to the 23rd of February 2017. The event will be hosted by University of Padova and is organized by Euro Working Group on Transportation, under the patronage and sponsorship of the Association of European Operational Research Societies (EURO).

Saturday and Sunday is for a joint cultural and outdoors activities. The organizers plan a guided tour at one of the Bressanone area's

impressive cultural / historical sites and by sport activities as ski, sledge or racket ski in the high-alpine area.

**Background:** EURO Summer and Winter Institutes (ESWI, <http://www.euroonline.org/web/pages/458/summerwinter-institutes>) provide an excellent forum for PhD students and early career researchers to discuss their research at length with experts in the field, as well as to form links with other early stage researchers.

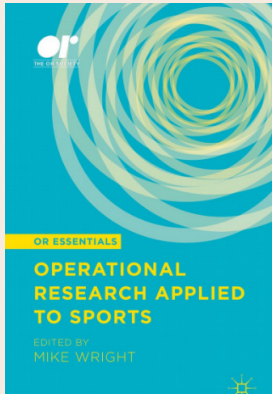
**Format:** Around twenty early stage researchers (PhD students and/or those who have less than two years research experience post PhD) from EURO member societies will be invited to participate at the EWI. Each participant is expected present an unpublished work and discuss it with colleagues and invited senior experts in the field. The EWI will also present a series of lectures by the invited senior experts. After the EWI, the papers can be submitted to a special issue of an OR publication to be announced later.

With the main objective of providing a limited number of carefully selected representatives the unique opportunity of establishing a personal network, addressing an international audience, and eventually creating new research groups around the chosen topic, the ESWI accepts only those who have not participated in any ESWI in the past

**Homepage** [http://www.ewgt.org/index.php?option=com\\_content&view=article&id=42&Itemid=119](http://www.ewgt.org/index.php?option=com_content&view=article&id=42&Itemid=119) 

# A Whole New Ballgame with OR

Hans W. Ittmann, University of Johannesburg hittmann01@gmail.com



## Operational Research Applied to Sports

Mike Wright and Susan Perry (Eds.)

The first book to provide a broad look at how Operational Research methods can be applied practically to the field of sports, with applications including timetabling, scheduling, and strategy.

*Operational Research Applied to Sports* by Mike Wright and Susan Perry Eds. 2015, Palgrave Macmillan UK, Hampshire UK, pp. 250, ISBN: 978-1-137-53465-1, 75 Pounds (Hardcover).

Sport has world-wide appeal and it has become a big industry. Those involved, both individuals and teams, are professional, competitive and continually striving to improve their performance. It was thus inevitable that Operational Research (OR) would venture into sporting applications. OR has indeed a definite role to play in planning game strategies; analysing data to improve performance; analysing the opposition's game plans, tactics and strategies; as well as optimising the logistic aspects of sporting events in a way that is seen to be fair to all involved. Operations researchers' interest in sport over the years can be found in Wright (2009) and Ladany and Machol (1977) while reviews on sport event scheduling are covered in Kendall et al. (2010) and Rasmussen and Trick (2008).

*Operational Research Applied to Sports* is one of a series of books published by Palgrave which introduces OR as it is applied to a variety of fields. With an introductory chapter by one of the editors, the book contains thirteen papers that had been carefully selected to cover a range of different sports. These papers were published over the period 1975 to 2012 in the Journal of the Operational Research Society (JORS), thus the definite bias towards sports that are of interest to British readers.

The introduction to this volume outlines the history of OR in sport and the main areas covered in the book. The first three papers deal with a diverse, and possibly less familiar, range of sport types and issues. In long jump, the athlete is disqualified when overstepping the official take-off line. Paper 1 describes a simulation model that determines the "optimal distance" between this take-off line and the arbitrary line at which the jumper should aim for his take-offs. A table of approximate take-off lines for different combinations of jumping strategies are given.

Paper 2 addresses the social conflict that could arise as a result of the interaction between soccer "hooligan fans" and "authorities". Using Hypergame Analysis, different representations of possible "games" are developed from which predictions can be derived for possible outcomes under various circumstances.

Playing darts is fairly popular and with many different rules. The variant "301" is the topic of paper 3. In simplistic terms, the objective is to start with a score of 301 and see who gets to zero first within three throws of the darts but one needs to start by hitting a "double" and end with a "double". Dynamic programming and branch-and-bound methods are used to determine optimal strategies to address this problem.

Four papers feature analyses involving the game of cricket. In paper 4, a dynamic programming formulation is presented to analyse One-Day Cricket Optimal Scoring Rates. Calculations yield optimal scoring rates, total number of runs to be scored, the chances of winning, possible batting tactics, among others. The well-known Duckworth/Lewis method is outlined in paper 8. This method is used to determine the winners in limited-overs matches affected by rain, bad light or other factors that forcibly shorten the match. A curve-fitting approach is used that is not only fair to both teams but also understandable enough to be implemented. The method gives the number of runs that can be scored, on average, in the remainder of an innings as a function of the number of remaining overs and the number of wickets fallen.

Paper 5 develops a system to schedule English cricket umpires for games played in England. The method finds a quick, semi-random initial solution which is improved using a local improvement method. The cost function in this case is extremely complex, because of the large number and variety of constraints and objectives.

A number of different cricket leagues are played in England annually and these need to be scheduled to the satisfaction of those involved. A Tabu Search heuristic method is discussed in paper 7 to schedule these country cricket fixtures.

Outcome prediction of the Australian Rules football matches that appear in a daily newspaper is the topic of paper 6. The paper discusses the exponential smoothing methodology used, with the data required and accumulated. In paper 9, Data Envelopment Analysis (DEA) is used to assess the relative



efficiency of nations that have participated at previous Summer Olympic Games.

In football, professional fouls are a reality and players, especially of weaker teams, commit these to benefit their teams. Paper 10 proposes a simple remedy after showing the drawbacks of the current system of punishing such fouls. This is obtained through a dynamic programming model that uses actual data to assess tactics and deterrents.

Rules used in badminton were changed in 2006 to make the game faster and more entertaining. Paper 11 shows how using methods such as combinatorics, probability theory and simulation help analyse the fairness of the new set of rules.

In sports with single round robin tournaments, various constraints come into play that increase the complexity of scheduling these tournaments. Cost and fairness need to be

considered as well. A branch-and-price algorithm is described in paper 12 to address these issues.

Though players can now call on technology to assist in challenging umpire decisions in such sports as cricket and tennis, there is a limit to the number of challenges that can be made. In paper 13, a dynamic programming approach investigates the optimal challenge strategy that players or teams can follow. Interestingly, it was shown that in tennis, players should be much more aggressive in challenging calls made in the latter stages of a match.

This book focussing entirely on OR applied to sports is a welcome addition to literature. Though some might dismiss it as just a collection of previously published papers, including them all in one volume gives the reader a good insight into the impact of OR in sports. 🌐

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## OBITUARY



## Jack R. Borsting (1929-2016)

**IFORS Treasurer (1980-88)**

**By Graham Rand** [g.rand@lancaster.ac.uk](mailto:g.rand@lancaster.ac.uk)

It is with sadness that we report the death on August 16th of Dr. Jack Borsting, former IFORS Treasurer, at the age of 87, as a result of a heart attack.

He was President of the Operations Research Society of America (ORSA) in 1975, and during the 1980s he served IFORS with distinction as Treasurer. During that time he was Assistant Secretary of the Defense (Comptroller) from 1980 to 1983, appointed by Presidents Jimmy Carter and Ronald Reagan. He was responsible for the department's management systems and

budget preparation and was a member of the Defense Resources Board. Before this, he had been at the Naval Postgraduate School in Monterey, California, for twenty years, serving first as professor and Chair of the Department of Operations Research and Administrative Sciences, and then as Provost from 1974 to 1980.

After his time at the Pentagon, he returned to academe. From 1983 to 1988, he was Dean of the School of Business Administration and Professor of Management Science at the University of Miami, and then from 1988 to 1993, he was Dean of the School of Business Administration and Robert Dockson Professor of Business Administration at the Marshall School of Business of the University of Southern California (USC). From 1994 to September 2001, he was the Morgan Stanley Professor of Business Administration and served as the Executive Director of the Center for

Telecommunications Management (CTM) at USC.

Jack Borsting received numerous awards. These included ORSA's Kimball Medal in 1982 for Distinguished Service to the Profession, its Steinhardt Prize for Military Operations Research in 2000 and in 2002, he was one of the first group of INFORMS Fellows. He was President of the Military Operations Research Society (MORS) in 1970-71, and in 1981 received its Vance R. Wanner Award for Distinguished Service to the Profession. He became a fellow of MORS in 1997. The United States Department of Defense twice awarded him its Medal for Distinguished Public Service. All these honours, and others, reflect a life of dedicated service to his country and to the OR profession.

He leaves his wife Peggy, who regularly accompanied him to OR conferences, a son Eric and daughter Lynn. 🌐





Lyn, shown here with his wife Margery.

## Lyn Thomas (1946 – 2016)

by **Graham Rand** g.rand@lancaster.ac.uk

With sadness, we report the death of Lyn Thomas on 14th July, 2016. He had many connections with IFORS, including being the Chair of the Organising Committee for the conference held in Edinburgh in 2002. The photograph is of Lyn attending the dinner at the IFORS conference in Barcelona in 2014 with Margery, his wife. Later that year, he delivered the IFORS Distinguished Lecture at the INFORMS conference in San Francisco. His subject was *Credit Where Credit is Due: Lessons for O.R. Modelling From the Global Financial Crisis*. <https://www.youtube.com/watch?v=fYfrIEqJGm0>.

It is in the field of credit scoring that Lyn particularly made his mark, with scores of published papers and many collaborators worldwide. He initiated a series of credit scoring and credit control conferences that have been held biennially in Edinburgh since 1989, which have played a seminal role in the development of his field. One of the most significant papers was the plenary he gave in 2001 on *The Impact of the Basel Committee's Internal Ratings Based approach for Capital Adequacy on Credit Scoring*. Lyn was amongst the first to recognise that the Capital Accord proposed by the Basel Committee would introduce an important new application of credit and behavioural scoring. In his paper he highlighted the opportunities, the developments needed, and the threats that this upgrading in the use of credit scoring for capital adequacy provisioning would bring.

Lyn has been associated with the universities of Oxford (undergraduate at the end of the 60s and then PhD in 1971), post-doc at UC Swansea in the early 70s, Manchester in the late 70s/early 80s, Edinburgh from 1985 before taking up his final position, Professor of Management Science, at Southampton in 2000. He had close links with several overseas universities such as Naval Postgraduate School, Monterey, California, and University of Western Australia in Perth.

Lyn commented at the end of a recent Festschrift conference held in his honour that unlike in a funeral where you have to be present but could not remember a thing, the event was something he will well remember. He was very appreciative of the kind words that had been said. They were very well deserved. 🌍

## OR FOR DEVELOPMENT

# Infusing the ICORD Tradition with A Mexican Flair

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Since 1992, IFORS has sponsored the ICORD (International Conference on OR for Development). The 11th such conference visited Mexico City for the first time and was held at the Instituto Tecnológico Autónomo de México (ITAM) from the 9th to the 10th of June 2016. Held at an attractive leafy site that used to be a monastery, the Conference was lively and well attended with 40 participants from Argentina, Chile, Cuba, Colombia, Holland, UK and USA and of course, Mexico. The local delegation included graduate students from different local universities supported by the Mexican National Council on Science and Technology (CONACYT).

The first day began with a warm welcome from co-chair Adrián Ramírez (ITAM) and program chair David Muñoz (ITAM), followed by a brief presentation from Sue Merchant on the role of IFORS and its developing countries activities in particular. She encouraged delegates to attend future developing countries events, one run by the EWG ORD immediately prior to EURO in Poland (July 2016) and another in Quebec (ICORD in July 2017) immediately prior to the IFORS conference there which would include the IFORS Prize competition. She invited ICORD 2016 participants to send in their entries to the Competition.

The first keynote speaker, Rafael Epstein from the University of Chile, treated the group to a fascinating talk about his work on

several important studies where the results had been successfully implemented in practice (and had resulted in his winning some prestigious prizes). The studies included, for example, the optimum worldwide routing of a company's container ships (to rectify the imbalance of stocks of containers across the world); the efficiency of open cast iron ore extraction in Chile; and the combinatorial auction process for supply of school meals in Chile, where it was important to remove the 'winner's curse' i.e., bidding firms going bust because they bid too low.

Ten papers (some in two parallel sessions) followed. These covered a wide range of different topics from rural telecoms network design to the effect of rapidly growing cities on home healthcare services. OR methods ranged from algorithmic models to simulation.

Jesus Velasquez, Chief Scientist of DO ANALYTICS LLC, ended the day by describing to the group the powerful new optimisation product which his firm had developed: the OPTeX Mathematical Modelling System. The system (based on algebraic sets theory) was aimed at saving analysts a great deal of routine programming effort. He said that with OPTeX, a modeller would only have to 'think' the algebraic model and the software would be written by the system in a number of different systems from AIMMS to Xpress.

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## Infusing the ICORD Tradition with...

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*Participants take a break from the sessions.*

On the second day, the programme commenced with a brief introduction from Roger Z. Rios, the President of SMIO (the Mexican OR Society) who reported that SMIO was growing steadily and thriving. His talk was followed by a most interesting presentation by Andres Medaglia, from the University de Los Andes in Colombia, on the value of network structures in a wide range of engineering design problems. He described four

different case studies where networks had been valuable such as in the provision of fire breaks in forests to minimise damage in the event of a fire (where to site tools most effectively; how many tools to provide at each storage point; the best method of distributing goods after a disaster, etc); and maintenance of sewers which involved a preventative maintenance routing problem covering some 31 thousand manhole covers in Bogota.



*Adrian Ramirez Nafarrate receives his Certificate of Appreciation from Sue Merchant*

This was followed by two parallel sessions covering six papers on the topics of healthcare delivery analysis and service delivery analysis. These included papers on: the relative efficiency of hospitals in a Latin American city; the location of emergency services on Mexican toll roads; the efficiency of the Mexican Seguro Popular health service; customer rating by a scoring method; selecting the best strategy for document scanning; and multi-objective optimisation in the field of decision support systems. After-lunch talks covered areas of humanitarian logistics and systems design: clustering Mexican municipalities with high risk of meteorological disasters; metaheuristic algorithms for humanitarian logistics; the use of multicriteria decision analysis and simulation in a 6 Sigma framework; and a model-based capacity analysis of introducing the A380 airplane into Mexico City's airport. The latter paper elicited a lot of reaction from delegates travelling home by air.

Finally Gilberto Calvillo Vives from the Instituto de Matemáticas, UNAM, México gave a most interesting talk on the potential role of OR in Mexican economic, social and environmental development. Starting off with *what does development mean?*, he gave definitions from a number of different sources including the UN and OECD (*promote policies that will improve the economic and social well-being of people around the world*) and discussed the measurement of 'development' by indicators. He spoke about the



millennium goals 1990-2015 and the new long list of ambitious goals for 2016-2030 (e.g., zero hunger). He asked what role OR can play in fostering development and suggested trying to model development goals looking for conflicting objectives. He added that an ideal OR person must be able to understand problematic situations, have ideas on how to approach and model these, be able to work in interdisciplinary groups, construct scenarios and plans, and be ready to ask for advice if analytical problems arise. He ended with proposed projects for OR communities: management of vehicles in Mexico City; production of the national development plan; managing forests; prevention/mitigation of wild fires; detecting money laundering activities; systems approach for tackling bribery and corruption.

ITAM was most hospitable to delegates, providing excellent catering throughout the two days including a lively dinner with tasty Mexican specialities and entertainment by a guitar/harp/banjo trio (who were excellent and had made up little amusing songs about many of those present). The organisers had also arranged an optional trip to the Teotihuacan pyramids.











Luis A. Moncayo, co-chair of the conference, delivered the Closing Remarks and Sue Merchant (IFORS) thanked him and everyone else who had assisted in the organisation, especially Adrián Ramírez who had worked tirelessly for months to make the event a success, for all their excellent efforts; invited speakers for their words of wisdom; delegates for attending and participating so



*Delegates enjoy lunch in a cave near the Teotihuacan Pyramids. In the picture (l to r) are: Adrian Ramirez, Rafael Epstein, Andres Medaglia and wife, Sue Merchant and participants from Cuba.*

fully and enthusiastically; reactors for their helpful comments on presentations; the administrators (including IFORS' office for their help with badges and certificates), volunteer photographers, catering and driving staff, and not forgetting Elise del Rosario (working on behalf of both IFORS and the EWG - ORD) who had given invaluable advice throughout the planning stages. 🌍

### Past ICORDs around the world

1992	Ahmedabad, India		2001	Kruger National Park, South Africa		2012	Djerba, Tunisia	
1996	Rio de Janeiro, Brazil					2013	Rome, Italy	
1997	Manila Philippines		2005	Jamshedpur, India		2014	Lleida, Spain	
			2007	Fortaleza, Brazil		2015	Colombo, Sri Lanka	

## EWG ORD: A Decade of Promoting Development

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The EWG ORD 2016 workshop took place from 30 June to 1 July in Poznan, Poland in celebration of a decade since the EURO Working Group on OR for Development (EWG ORD) was first put up and started organizing a vibrant community working in the area of OR for development. The Workshop was co-sponsored by the IFORS Developing Countries Committee (IFORS DC) and was a satellite event of the EURO 2016.

The 23 delegates from Australia, Colombia, India, Ireland, New Zealand, Nigeria, Philippines, Poland, Russia, Turkey, Ukraine, UK, and USA coming from various backgrounds in industry and academe performed various roles of mentor, student, and colleague. This was along the ideals behind the workshop to encourage practitioners and academicians and OR community worldwide in enriching their knowledge through learning and interaction related to education, health, infrastructure, environmental sustainability, energy, population growth, poverty and climate change, among others.

During the Workshop, each 30-minute presentation of papers was followed by constructive feedback from two previously assigned reactors. Apart from honing their presentation skills, participants benefited from the opportunity to get perspectives of graduate students, academicians, early stage practitioners and more experienced mentors for suggestions on further improvement of their work. Effectual conversations and productive idea sharing were made possible with the sights, sounds and flavors of Poznan in the background - during the pre-workshop tour of Imperial Poznan on June 29, the Classic tour starting at the Old Market Square on June 30, and on the last night, the simple dinner at Papierówka Restaurant.

Presentations for the morning were kicked off with a talk by EWG ORD Co-Chair and IFORS DC member Elise del Rosario, who shared her consulting experience and her vast experience in the field of OR through three projects in the area

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## EWG ORD: A Decade of Promoting Development

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Top: Workshop participants pose beside the EURO 2016 banner with the Poznan Technological University name in the background.



Ashley Carreras guide participants as they try their hand on the use the oval post-its to facilitate causal mapping.



Cathal Brugha stresses a point as he explains the Priority Pointing Procedure methodology.

of: globalization of manufacturing facilities, national power dispatching, and city port operations. These cases which had different implementation outcomes gave a clear view of problems and successes an OR analyst encounters in real life situations, drawing learnings from both the successful and unsuccessful implementation of recommendations.

This was followed by a Workshop by Cathal Brugha, Emeritus and Adjunct Professor at the University College Dublin Center for Business Analytics who engaged participants in an interactive exercise to answer the question: *What is needed to help OR be more effective in addressing development problems?* He showed how the Priority Pointing Procedure can lead to a strategy.

Ashley I. Carreras, Principal Lecturer in Economics and Decision Analysis at the De Montfort University, presented a

Tutorial/Workshop on *A Practicing Academic Perspective on Problem Structuring Methods*. Participants, divided into two groups, learned to do causal mapping, leading to a shared understanding of the problem that was: *What are the key issues that need to be addressed by OR researchers in order to ensure that OR research continues to effectively influence policy makers?* Carreras then summarized through causal mapping, the discussions of the two groups.

The conference closing session had Gerhard-Wilhelm Weber, Professor of Applied Math at the Middle Eastern University in Ankara, giving the background on the history, purpose, growth and participants of all previous workshops. Having been one of the founders of the group, he cited people who had contributed significantly to the group, namely, Leroy White, Honora Smith, Elise del Rosario, and members of the EWG ORD Managing Boards. He also stressed the importance

of young members who should be taking over the leadership of the Group. He led the distribution of certificates to all the participants and the organizers.

Papers presented were carefully selected from various abstract submissions. Sectors addressed were: **Health:** *Designing Blood Supply Chain: A Location-Allocation Model with Collection and Production Considerations* (Osorio) and *Urban Mobility and Disease Spread Dynamics in Medellin, Colombia* (Loterio); **Education:** *Evaluation of Student Affairs Services Program* (Neroza); **Agriculture:** *Increasing the Resiliency of Vietnam's Rice Supply Chain* (Khanh); **Governance:** *Efficiency of Local Government Units to the Attainment of MDG* (Baldemor); *Agent-Based Approach to Modeling Poverty in the Philippines* (Marquez); and *OR Investigation into Traffic Congestion in Cities* (Olabode); **Finance:** *Evolution of Trading, OR and Neuroeconomics in Global Finance Instruction* (Dash and Kajiji); and *Loan and Deposit Activities Modeling for Rationalising Commercial Bank Strategy* (Ilchenko and Nazarenko); **Others:** *Developing Agility and Resilience Framework for Humanitarian Supply Chain under the Moderating Effect of Culture* (Ali) and *Unleashing Third Sector Potential: Using Community Operational*

*Research to Develop Guidelines for Volunteering Best Practices in Aotearoa, New Zealand* (Moore).

Nina Kajiji and Gordon Dash, both professors at the University of Rhode Island, were cited as models for giving comprehensive and well thought out feedback to younger presenters. Feedback gathered from participants at the end of the Workshop showed great support for the session format that encouraged deep discussions as well as appreciation for the invited speakers who were able to effectively impart their knowledge and skills.

The Workshop was not only an effective forum for discussion of researches in various areas impacting development but also a memorable bonding experience for all delegates. Most of the delegates attend these EWG ORD Workshops year after year, looking forward to renewing academic and personal links. At the end of each Workshop, experienced and early-stage OR workers go back to their countries and drawing boards, knowing that elsewhere in the world, similar problems and methodologies are being tackled by people they could easily call on for help and collaboration. 🌐

## Syngenta and INFORMS Use Analytics to Address World Hunger With Launch of 2017 Syngenta Crop Challenge in Analytics

RESEARCH TRIANGLE PARK, NC, August 8, 2016 – The Syngenta Crop Challenge in Analytics has launched and is accepting submissions from applicants who are ready to put their analytics skills to the test for the chance to win \$5,000. Syngenta has teamed up with INFORMS for the second annual Crop Challenge, a competition that focuses on using analytics to address the problem of world hunger.

***"We're looking for individuals and teams with strong applied mathematical skills to help us solve these difficult challenges we face in agriculture," said Joseph Byrum, Ph.D., MBA, PMP and senior R&D strategic marketing executive with Syngenta. "Anyone who wants to make a strong contribution to global food security is encouraged to get involved with this challenge."***

The Crop Challenge was initiated in 2015 by Byrum after being named the winner of the INFORMS Franz Edelman award. He donated his prize winnings to INFORMS to further idea creation, in effect launching the Syngenta Crop Challenge.

Each year, farmers have to make decisions about what crops to plant given uncertainties in expected weather conditions and knowledge about the soil at their respective farms. To ensure there is enough seed of the desired varieties for farmers, it is critical to evaluate which variety or varieties are more likely to be chosen by farmers based on growing region.

Using provided datasets, Crop Challenge participants are asked to predict which soybean seed variety or mix of up to seven varieties in appropriate proportions is more likely to be chosen. Entries will be evaluated based on the rigor and validity of the process used to determine which variety or varieties are selected for planting and should include documented methodology.

The winner will receive \$5,000; the runner-up \$2,500; and the third place entry \$1,000. Entries must be submitted by Jan. 16, 2017, and finalists will be announced Feb. 24, 2017. Contestants must be 18 years or older to participate. For more information, including criteria and deliverables, visit [www.ideaconnection.com/syngenta-crop-challenge](http://www.ideaconnection.com/syngenta-crop-challenge).

***"Syngenta strives to modernize agriculture and ensure the industry's practices are as advanced and efficient as possible," said Byrum. "We value the talents and skills of those who do not necessarily have an agriculture industry background. The Syngenta Crop Challenge is the epitome of collaboration and crowdsourced problem solving."***

Syngenta, a leading innovator in plant genetics, and the Analytics Section of the Institute for Operations Research and the Management Sciences (INFORMS) have partnered to highlight the critical next step for agriculture to succeed when faced with the challenge of feeding a growing world population with less arable land: advanced analytics and data analysis. 🌐



# Operations Research for Scheduling South American World Cup Football Qualifiers



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An important aspect in the organization of sports competitions concerns scheduling. In the past, most leagues used to rely on simple methods, such as manual or random procedures, to schedule their competitions. As more parties get involved in major sport leagues (including teams, TV broadcasters, local authorities), a good schedule nowadays must cope with a number of constraints. Operations Research (OR) can play an important role in helping league managers construct such schedules.

Consider a league where every team must play against every other team a certain number of games. The league duration usually consists of predefined time slots or rounds. These can be, for example, all the weekends in a year. Every team has a venue where it plays its home (H) games. Games played at other teams' venues are referred as away (A) games. A schedule is a set of games indicating which pairs of teams play on every round and in which venue they play. It is usually required that every team plays against every other team twice (double round robin tournament), once at home and once away. Also, in every round each team must play exactly one match (compact tournament).

Apart from these requirements, there are other constraints that are desirable to have when scheduling a real-world league. An outline of frequently used constraints can be found in a survey by Rasmussen and Trick (2008). Some of the most typical constraints concern the sequences of home and away games. A break corresponds to two consecutive home games or two consecutive away games. The so called pattern constraints

are special requirements on the home-away sequences such as restrictions on the number of consecutive breaks, certain sequences that should be avoided, or all teams must have similar number of breaks. Other typical requirements are the so called separation constraints, which set a lower bound on the number of rounds between two games with the same opponents. In a mirrored double round robin tournament of  $n$  teams, there must be exactly  $n-2$  games between the two games played by the same pair of teams. This implies that the second half of the tournament is completely symmetric with respect to the first half, in that the order in which the games of the second half are played is the same as in the first half but the home venues are exchanged.

It often happens that the desirable requirements conflict with each other. For example, in leagues with more than two teams it is not possible to create a compact double round robin schedule without breaks for all teams. Note there are only two patterns with fully alternating sequences (H-A-H-A...; and A-H-A-H...), and if two teams would have the same pattern they could never play against each other. Coping with all conditions and such types of conflicts makes sports scheduling problems very hard in practice, as most major leagues have many teams.

A variety of OR techniques can be applied to sports scheduling. One that has shown effectiveness is integer programming. While its application varies from one problem to another, it usually represents each possible game by a binary decision variable. Also, in order to cope with pattern constraints, binary variables are used to represent home and away breaks. The requirements are represented by linear relations among these variables. Some models only aim at finding a feasible schedule. Alternatively, if there is a measure of performance, an objective function can be formulated. IP models can be implemented in optimization software. Due to the complex combinatorial features of sports scheduling problems, it may still be not viable to solve a model using a regular solver. A common approach is to decompose the problem into different stages, where the home-away patterns of the teams are defined including only some requirements first and then attempting to generate a schedule with the remaining requirements included..

Typical objective functions include: minimization of breaks; minimization of distances travelled by teams; and minimization of penalties from violated constraints. A relatively new criterion, established by the authors in the context of the qualifiers to the Football World Cup, is the minimization of breaks within double rounds. A double round is a pair of consecutive rounds. In most qualification processes to the World Cup, the continental confederations arrange tournaments in which each odd-numbered round



(1st, 3rd, 5th, etc.) is followed within a few days by the next (even) round, after which there is a relatively long gap before the next double round. This adheres to the FIFA dates, which enables national teams to have their players (often playing in other countries) for two qualifier matches before they are released to their respective regular commitments with teams to which they belong.

Consider for example a compact double round robin tournament of 8 teams. The tournament must be played over 14 rounds. Suppose these are divided into 7 double rounds, such that every odd round is played on a Wednesday and the following even round is played on the Saturday of the same week, after which there is at least a couple of months until the next double round. Ensuring that all teams play exactly one home game and one away game within each double round depends on which additional conditions are required for the schedule. For this example, Figure 1 shows a schedule that minimizes the number of breaks within double rounds subject to a mirrored format. As highlighted in the figure, the optimal objective value in this case is equal to 12. By giving up the mirrored format, it is possible to find schedules without breaks within double rounds. It is, however, desirable in some competitions to keep a certain symmetry in the schedule, whether for ease of understanding by fans, or simply called for by tradition, as in the case of the South American Football Confederation (CONMEBOL).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	@5	3	@4	8	@6	2	@7	5	@3	4	@8	6	@2	7
2	@6	8	@7	3	5	@1	@4	6	@8	7	@3	@5	1	4
3	@8	@1	5	@2	@7	4	@6	8	1	@5	2	7	@4	6
4	7	@5	1	@6	8	@3	2	@7	5	@1	6	@8	3	@2
5	1	4	@3	7	@2	6	8	@1	@4	3	@7	2	@6	@8
6	2	@7	@8	4	1	@5	3	@2	7	8	@4	@1	5	@3
7	@4	6	2	@5	3	@8	1	4	@6	@2	5	@3	8	@1
8	3	@2	6	@1	@4	7	@5	@3	2	@6	1	4	@7	5

Figure 1: A mirrored schedule with minimum number of breaks within double rounds for a compact double round robin tournament of 8 teams.

Five Football World Cup tournaments were played between 1998 and 2014. For all these tournaments, CONMEBOL used a mirrored double round robin format. Moreover, not only the same format but also the same schedule was used for all tournaments between 2002 and 2014. This schedule had many breaks within double rounds and the distribution of these among the teams was highly unbalanced. Because of these and other shortcomings, many national associations presented proposals to change the schedule over the years. However, none of them received the support of a majority required to implement a change. Due to the lack of agreement and wide criticism, in January 2015, CONMEBOL decided that the schedule for the 2018 qualifiers would have to be defined by a random draw. Since a totally random schedule is impractical, the CONMEBOL countries were allowed to

propose generic schedules that could serve as template for the draw.

The authors used an integer programming approach to create a schedule that takes into account several conditions. Among these is the balance of home-away sequences ensuring that in every double round, all teams play one home game and one away game. The schedule, constructed according to a French scheme (Goossens and Spieksma, 2012), also keeps some symmetry resembling the traditional mirrored format, making it easy to understand for fans, players and the press. Figure 2 shows a schedule constructed according to such scheme that minimizes the breaks within double rounds for the example with 8 teams. As can be seen, this schedule has no breaks in double rounds and its only departure from a mirrored one is that the last round of matches in the second half is the reverse of the first round in the first half.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	2	@4	@6	5	7	@3	@8	4	6	@5	@7	3	8	@2
2	@1	7	@4	3	8	@5	6	@7	4	@3	@8	5	@6	1
3	@5	6	8	@2	@4	1	7	@6	@8	2	4	@1	@7	5
4	@6	1	2	@7	3	@8	5	@1	@2	7	@3	8	@5	6
5	3	@8	7	@1	@6	2	@4	8	@7	1	6	@2	4	@3
6	4	@3	1	@8	5	@7	@2	3	@1	8	@5	7	2	@4
7	8	@2	@5	4	@1	6	@3	2	5	@4	1	@6	3	@8
8	@7	5	@3	6	@2	4	1	@5	3	@6	2	@4	@1	7

Figure 2: A non-mirrored (but symmetric according to a French scheme) schedule with no breaks within double rounds for a compact double round robin tournament of 8 teams.

This schedule proposal was presented at a CONMEBOL meeting by the Chilean Professional Football Association (ANFP), where other countries presented their own proposals. This proposal was unanimously selected and is now being used for the qualifiers to the 2018 Football World Cup to be held in Russia. The authors have collaborated with the ANFP in the application of OR to football scheduling for more than ten years (Alarcón et al., forthcoming) in a project which was selected by INFORMS as one of the six finalists for the 2016 Franz Edelman Award competition.

This is only one of many other applications of OR in sports scheduling. A literature search yields applications in the main football leagues of several countries, such as Austria, Belgium, Brazil, Denmark, Ecuador, Germany, Honduras, and Norway, as well as in other sports such as baseball in the USA, volleyball in Argentina, basketball in Germany and Argentina, ice hockey in Finland, and cricket in England and Australia. There is also vast literature on algorithmic approaches to sports scheduling. There are many benchmark instances, especially for the traveling tournament problem (Easton et al., 2001). Finding the optimal solution for several of these instances still remains an interesting challenge. 🌐



## Baden: Immersion in Simulation

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Organizers and speakers pose for a photo (l to r): Davorin Kofjač, Manuel Mora, Karmen Pažek, Mirko Gradišar, Sonja Šterman, Miroljub Kljajić, Gerhard-Wilhelm Weber, Črtomir Rozman and Khalid Aboura.

The 6th International Symposium on Simulation Based Decision Support and Business Intelligence was held as part of the 28th International Conference on Systems Research, Informatics and Cybernetics in Baden-Baden, Germany, on August 3, 2016. With the aim of presenting research achievements in the area of systems approach and decision support systems for the assessment of complex problems, the Symposium was coordinated and chaired by Miroljub Kljajić from the University of Maribor, Faculty of Organizational Sciences, Slovenia.

The 28th International Conference on System Research, Informatics and Cybernetics itself was part of the 36th Annual Meeting of the IIAS (The International Institute for Advanced Studies in Systems Research and Cybernetics). The Conference provides a forum for the presentation and discussion of short reports on current systems investigations in humanities, sciences and engineering. A number of specialized symposia were organized to focus on research in computer science, synergetics, cognitive science, psychocybernetics, sociocybernetics, logic, philosophy, management, ecology, health care, education and other related areas. ([http://www.iias.edu/frameset\\_start\\_inters\\_ann.html](http://www.iias.edu/frameset_start_inters_ann.html)).

The Symposium participants came from: the Autonomous University of Aguascalientes (México), University of Oldenburg (Germany), 3CCADET, UNAM (México), Middle East Technical University, (Turkey), Dana-Farber Cancer Institute (Boston, MA, USA), The Broad Institute of MIT and Harvard (Cambridge, MA, USA), Yeditepe University (Turkey), University of North Sumatra (Indonesia), University of Maribor (Slovenia), University of Ljubljana (Slovenia), University of Primorska (Slovenia), University Medical Centre Ljubljana (Slovenia), University of Dammam (Saudi Arabia), National Institute of Chemistry (Slovenia). The rich cultural diversity of the researchers contributed to the fruitful and inspiring presentations and discussions.

The Symposium featured eleven talks dealing with OR methodologies such as modeling and simulation, combinatorial optimization, continuous optimization, artificial intelligence, and multi-criteria decision-making applied to a wide variety of decision making situations, as follows: A Survey Of Simulation-Based DMSS For IT Service Management; Analyzing and Controlling the Factors Influencing the Quality Of Primary Education in Developing Countries; Contribution to Learning and Education for Simulation Based Decision Support; Defining New Educational System for Tourism through Systems Thinking and Modeling; Simulation Model for Determining the Wage Payment System; Systems Engineering Approach to Corporate Clothing Development; Option Modelling in Agri-Food Production; Simulation Model for Educational System Reform in Tourism; Exact Solution of Nurse Rostering Problem for Small Group; Gaussian Process in Computer Model Emulation; Comparison of Regression Modeling and Artificial Neural Networks for Herbage Dry Matter Yield Forecasting; and Development of Web Application for Evacuation Plan Visualization in Case of Hazardous Gas Dispersion.

During the Symposium, G.-W. Weber invited participants to actively participate in the upcoming IFORS 2017 in Quebec, Canada and the EURO 2018 in Valencia, Spain.

Symposium participants had the opportunity to experience the historical town of Baden-Baden in the Baden-Württemberg state of Germany, surrounded by several natural springs rich in salt. The town dates back to the Roman era and the reign of Caracalla (around 210 AD). The 19th century Baden-Baden was mainly a casino and spa center for European nobility and is now a spa town offering cultural, sports and shopping activities. The site provided the perfect environment for forging friendships and future research efforts. 🌍

# Budapest: ECCO XXIX: Beginnings to Advancements in Combinatorics

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The ECCO XXIX conference was held on May 26-28, 2016 in Budapest, a place regarded as the birthplace of combinatorial optimization. It was in Budapest that the first book ever written on graph theory was published by Dénes König in the Thirties during which time the fundamental results obtained by Jenő Egerváry laid down the bases of a new discipline that fully emerged twenty years later.

Inspired by this history, 110 participants from 14 countries learned about current developments from the 92 paper presentations and the four well-received plenary speeches, as follows: Andrej Brodnik *Two Tales from Applied Combinatorial Optimization*; Andras Frank *Unweighted Graph Optimization*; Leo Liberti *Controlling Fixed Points*; David Pisinger *Large-scale Optimization Problems in Liner Shipping*. The Program and Organizing Committee was chaired by Tamas Kis. Social activities included a bus tour in Buda and Pest, followed by a Danub boat tour with gala dinner.

ECCO, the European Chapter on Combinatorial Optimization, is a Working Group within EURO that counts almost 1,500 members. Annually, ECCO holds a Spring meeting that gathers around 100 participants in an exciting atmosphere. Every fourth year, the ECCO conference is jointly held with the International Symposium on Combinatorial Optimization (CO), a series of conferences that started in the UK in 1977. The latest conferences were held in Capri, Bonn, Lugano, Molde, Beirut, Minsk, Porto, Cyprus, Dubrovnik, Jerusalem, Malaga, Amsterdam, Antalya, Paris, Munich, and Catania. In the same period, fourteen special issues of the ECCO conferences have appeared: eight in the European Journal of Operational Research, two in Discrete Applied Mathematics, and



Silvano Martello shown here introducing David Pisinger

one in each of Computational Optimization and Applications, Journal of Scheduling, Annals of Operations Research, and Optimization. Submissions are currently encouraged for a special issue of Discrete Applied Mathematics dedicated to the Budapest conference and open to all ECCO and CO members who may submit until November 30, 2016 online to (<http://ees.elsevier.com/dam>) by selecting, as Article Type, \SI: ECCO2016.

The next ECCO conference will be sponsored by EURO and jointly held with the Chinese Operations Research Society. The EURO/ECCO/ORSC Conference on Combinatorial Optimization will take place in Koper (a Venetian-style Slovenian town at 180 Km from Venice), from May 3 to May 6, 2017. A pre-conference two-day tour in Venice is planned. 🌐



## ICOTA: Optimizers Troop to Ulaanbaatar

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The 10th International Conference on Optimization: Techniques and Applications (ICOTA 2016) held at the Soyombo Hall of the Best Western Premier Tuushin Hotel in Ulaanbaatar, Mongolia last July 23-26, 2016 (<http://iom.num.edu.mn/icota2016/>) was the largest one ever held in Mongolia, prompting national press coverage. The conference aimed to be a forum where scientists, researchers, software developers, and practitioners can exchange ideas and approaches, present research findings and state-of-the-art solutions, share experiences on potentials and limits, and open new avenues of research and development on issues and topics related to optimization and its applications.

Poster presentations, along with 120 papers came from 25 countries. Parallel sessions were held on the following topics: Linear and Non-linear Programming, Combinatorial Optimization and Integer Programming, Conic Optimization, Equilibrium Problems, Global Optimization, Non-smooth Optimization, Stochastic Programming and Dynamic Programming, Multi-objective Optimization, Heuristic Methods, Optimal Control, Applications of Mathematical Modeling and Optimization Theory and Methods in Various Areas, Optimization in Management

Science, Statistics and Optimization and Optimization and its Applications.

Plenary Lectures included: Shu-Cheng Fang (North Carolina State University, USA) on *Linear Reformulation of Polynomial Discrete Programming for Fast Computation*; Panos Pardalos (University of Florida, USA) on *A New Information Theory Perspective on Network Robustness*; Akiko Yoshise (University of Tsukuba, Japan) on *Some Tractable Subcones for Testing Copositivity*; Alexander Strekalovskiy (Matrosov Institute for Systems Dynamics and Control Theory of Siberian Branch of RAS, Russian Federation) on *Global Search Theory on Nonconvex Optimization*; Frank Lewis (University of Texas at Arlington, USA); and Joydeep Dutta (Indian Institute of Technology, Kanpur, India).

ICOTA is one of the official conference series of POP, Pacific Optimization Research Activity Group. Enkhbat Rentsen and Altannar Chinchuluun of the National University of Mongolia with Altangerel Lkhamsuren of the German-Mongolian Institute for

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### ICOTA: Optimizers Troop to Ulaanbaatar

Continued From Page 17



Posing for a group picture (l to r): Altannar Chinchuluun, Kok Lay Teo and Enkhbat Rentsen, with author M. Baldemor (2nd from left).

Resources and Technology comprised the Organizing Committee and the Steering Committee was led by Kok Lay Teo of Curtin University, Australia.

POP Working Committee Liaison with Europe and Africa and ICOTA 2016 International Program Committee member Gerhard-Wilhelm Weber of the Middle East Technical University (METU) was unable to make it, but Milagros Baldemor from the Philippines delivered his talk.

The participants gave positive feedback and comments on the organization of the conference, the lectures and the research presentations, in the same way that they appreciated the opportunity to taste the local food while exploring the beautiful tourist spots that the area had to offer. 🌍



## Mongolian Mission Accomplished

James Cochran jcochran@cba.ua.edu

The National Registration and Statistics Office of Mongolia (NRSO) and the National University of Mongolia (NUM) recently co-hosted a series of events under the theme of Applied Statistics: Teaching, Research and Business Innovation on 24-26 May 2016. The events were organized jointly with professors from the University of Alabama, Yale University, and Penn State University. Four related events took place:

**May 24 2016** - the day-long workshop Basic Operations Research for Statisticians was held at the National University of Mongolia. The workshop featured two sessions:

Introduction to Linear Programming for Statisticians led by James J Cochran, University of Alabama; and Stochastic / Probabilistic Models session led by Edward H. Kaplan, President of INFORMS and Professor of Yale University, the USA

Cochran and Kaplan used active learning techniques and provocative counter-intuitive examples in covering a wide variety of operations research topics. Cochran addressed the basics of linear programming including problem formulation, the geometry of an LP problem, sensitivity analysis, integer restrictions, interpretation of solutions, and use of Excel Solver®. Kaplan introduced and discussed several important concepts in stochastic modeling including random incidence, Markov chains, and Little's Theorem and queueing theory. Numerical calculations were supported with Excel and the freely-available Queueing ToolPak add-in. Over seventy statisticians from academia, government, and private industry in Mongolia participated in this workshop.



Meeting at the NRSO Headquarters (l to r) with: Altantsetseg Sodnomtseren, Demberel Ayush, James J. Cochran, Mendsaikhan Sonomtseren, Edward H. Kaplan, Oyunchimeg Dandar and Ganchimeg Mijiddorj.

**May 25, 2016, am** - the half-day workshop Introducing Statistics into the High School Mathematics Curriculum was led by Cochran and James L Rosenberger of Penn State University. The workshop covered ways high school mathematics teachers can develop statistics courses appropriate for high school students and integrate these courses into their existing mathematics curriculum. Participants learned about topics that can be covered, the order in which they can be covered, and the relationships between some core high school mathematics concepts and concepts in statistics and probability. Over 100 mathematics teachers from secondary schools in Mongolia participated in the workshop.

**May 25, 2016, pm** - Cochran gave a demonstration lesson and

afterward led a group discussion at the 1st Secondary School of Mongolia. Twenty-five high school students of the 1st Secondary School took part in the demonstration lesson using a case to teach basic statistics concepts. Several high school mathematics teachers, college mathematics and education instructors, college administrators, and government officials observed this demonstration. In the ensuing group discussion the students and observers commented and shared their thoughts on the efficacy of the case method for teaching that had been demonstrated to them.

It should be noted that statistics is not taught at the high schools of Mongolia; because of this, students face difficulties when they apply for admission to undergraduate programs with universities in the USA and other developed countries. Therefore, developing secondary school statistics education programs, bringing resources, and building capacities are an important part of school curriculum reform in Mongolia. The initiatives of American professors will help Mongolian schools teach students basic statistics literacy and introduce them to careers in the profession.

**May 25, 2016** - the international conference Applied Statistics: Teaching, Research, and Business Innovation was held at the Chingis Khaan Hotel in Ulaanbaatar. This provided a lively forum for academics, researchers, and practitioners to exchange ideas and share knowledge on recent developments in operations research, management science, statistics, and

other related areas. The conference also fostered networking among the conference participants in the core areas of Operations Research, decision science, mathematics, statistics, and ICT, and highlighted various applications of these areas.

Faculty members from several universities and colleges including the National University of Mongolia, Mongolian Education University, State of University of Life Sciences, and Institute of Finance and Economics participated and presented their work in the conference. Additionally, representatives of state organizations (NRSO, Bank of Mongolia, Ministry of Finance, etc), research organizations, and industry practitioners presented their research papers at this conference.

Conference topics included: Teaching and learning in operations management, operations research, and statistics; Operations research methods and techniques; Operations research education; Applications of operations research; Use of mathematical and analytical methods in business strategies; ICT and innovation in data use; Big data; Open data; Data Science; Business analytics; Decision analysis; Optimization; Financial modeling; Simulation, stochastic programming and modeling; Risk management; Managerial accounting; Mathematical economics; Revenue management; Project management; Production management; Industry-academic collaboration in operations management; Operations and supply chain management; Operations management and finance; and Sales and operations planning. 🌐

Interested readers can visit (<http://ubseg.gov.mn/conference/index.html>) or contact either Altantsetseg Sodnomtseren ([altsodnom@hotmail.com](mailto:altsodnom@hotmail.com)) or Khuslen Zorigst ([khuslen@nso.mn](mailto:khuslen@nso.mn)) for more information.

## REGIONAL CONFERENCE

# EURO XXVIII: Polishing Up on OR in Poznan



**Daniele Vigo**

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Program Chair



**Joanna Józefowska**

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Organizing Chair

The 28th European Conference on Operational Research, EURO 2016, was held in Poznan, Poland from July 3 to July 6, 2016. The Conference attracted more than 1800 participants from 170 countries. In keeping with tradition, the EURO Awards were given during the Opening and Closing Sessions, which for this year, was broadcast live via the Internet.

The **EURO Gold Medal** was given to two outstanding researchers: Yurii Nesterov and Maurice Queyranne. The **EURO Distinguished Service Medal** was awarded to Yannins Siskos. The **EURO Doctoral Dissertation Award** went to Raca Todosijević. A large group of researchers involved in the *Evaluating Gas Network Capacities* project and headed by Thorsten Koch bagged the EURO Excellence in Practice Award. Fernando S. Oliveira, Carlos Ruiz, and Antonio J. Conejo were the winners of **EURO Award for the Best EJOR Paper** in the category of Innovative Applications of OR while the award of the category Review went to M. Steadie Seifi, N. P. Dellaert, W. Nuijten, T. Van Woensel, and R. Raoufi. Award in the Theory and Methodology category was awarded to Thibaut Vidal,

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### EURO XXVIII: Polishing Up on OR in Poznan

Continued From Page 19



The central plenary lecture by Robert Aumann took place in the beautiful Earth Hall with a capacity of 1800 seats.



Welcome reception provided an excellent start for the social program.



Plenary lectures (here Dimitris Bertsimas) took place in Aula Magna with live transmission to surrounding auditoria and professional recording.

Teodor Gabriel Crainic, Michel Gendreau, and Christian Prins. Finally, the winners of the **ROADEF/EURO Challenge** were Tamara Jovanović in the Junior category, Simon Crevals, Mieke Defraeye, Otto Carpentier, and Kay Van Wynendaele in the Special category and Ahmed Kheiri for the Senior category.

The Program Committee chaired by Daniele Vigo from the University of Bologna offered excellent plenary and keynote lectures and included more than 1600 presentations organized in 465 sessions. The opening session held at the Aula Magna featured one of the award-winning performances of the Volantes Soni – the choir of Poznan University of Technology.

The central plenary lecture was delivered Robert Aumann, laureate of Nobel Memorial Prize in Economic Sciences for 2005. The lecture entitled "Why Optimize? An Evolutionary Perspective" took place in the beautiful Earth Hall at the grounds of Poznan International Fair and got attention of the whole community of Poznan, an academic town with students comprising 20% of the population. **The 2016 IFORS Distinguished Lecture (IDL)** was delivered by Dimitris Bertsimas of MIT while Rolf Moehring of the Beijing Institute for Scientific and Engineering Computing gave the Closing Plenary Lecture. Finally, the two EURO Past Presidents Rolfe Tomlinson and Maurice Shutler, who recently passed away, were remembered during a special Memorial Session which outlined their strong contribution to the growth of EURO. Plenary and keynote sessions and many of the special sessions mentioned here were broadcast on-line and professionally recorded. They are available at: <http://www.euro2016.poznan.pl/speakers/> and will be included among the resources in the EURO website.

Poznan University of Technology campus with its modern, well-designed facilities and friendly atmosphere turned out to be the perfect choice for hosting the conference. It offered a comfortable, efficient, and very pleasant environment, complemented with excellent services and social activities provided by the Organizing Committee chaired by Joanna Józefowska. 🌐



# EURO 2016: A Delegate's Perspective

**Milagros R. Baldemor** milagros\_baldemor@yahoo.com.ph., **Gerhard-Wilhelm** gweber@metu.edu.tr

EURO 2016 was a very well organized gathering of OR academicians, practitioners, graduate students, and enthusiasts who were treated to a high-quality scientific program.

The event covered 25 areas from Data Analytics to Behavioral OR chaired by very competent and intelligent stream and session organizers from different parts of the world. Participants presented papers and attended streams/sessions of their choice to gain more knowledge and skills on how OR could make an impact in their work and in their lives. The talks shared by three plenary and eleven keynote speakers left people asking if there are questions that OR cannot answer.

The equally enriching social program included a welcome reception, gala dinner and farewell party, where old friends and new acquaintances met, exchanged ideas and shared past OR experiences. First time visitors found it convenient that the invitations included a map of Poznan, facts about the venue, means of transportation and currency used. As part of the registration fee, free public transport was given for the duration of the conference, making it convenient to explore Poznan after the sessions. In addition, tours of museums, the Old Market Square and other places were organized to give a historical perspective of Poland, its people, and where it began. The trip to Amazon's largest fulfillment center in Europe was an opportunity to see first hand the logistics involved in getting millions of goods to countries worldwide. This visit turned out to be both a social event and an informative one!

Of special interest to the authors was the award given out by the EURO Working Group on Ethics and OR (EthOR), made up of scientists, lecturers and practitioners of OR committed to integrating ethical aspects and considerations in their research, teaching, consultancy and decision-making. With the aim of encouraging young researchers to develop and implement OR methodologies for solving contemporary problems with ethical



*The ubiquitous red shirts of the EURO 2016 guides became synonymous with gracious assistance. The complete team shown here above, being introduced by Joanna Buszkiewicz at the Closing Session. With her onstage is Sarah Fores, EURO Manager.*

dimensions in such fields as energy, environment, health care, peace studies, economics, and corporate social responsibility, the EthOR Award recognizes outstanding OR researchers who are still PhD students. The 2016 Award went to Rossen Kasakov from Bulgaria, for his paper on *Exploring Cultural Corruptions in Financial Organizations: a Hybrid Modeling Approach*.

The close collaboration within and between the lively EURO Working Groups together with the active presence of IFORS represented by its President, Mike Trick, played an important role in achieving an unforgettable experience with a highly sustainable impact. Appropriately themed *Pathways to Development*, the event gave an opportunity to honor leaders who recently left us, to learn from experienced community members, and to celebrate the youth. Participants would always remember the many young volunteers in their red t-shirts who showed us the pathways to our sessions! . 🌍

## OR IMPACT

**Section Editors:** Sue Merchant suemerchant@hotmail.com, John Ranyard jranyard@cix.co.uk

## Let A River Run Through It: Optimising the Removal of Fish Migration Barriers

**By Jesse O'Hanley** J.Ohanley@kent.ac.uk, Kent Business School, University of Kent, UK

### INTRODUCTION

Many migratory fish, such as salmon and eel, need to return to high quality breeding grounds in order to spawn but are impeded by engineered structures within rivers that form physical barriers. Whilst these barriers provide socio-economic benefits, such as water supply, flood suppression, power generation and transport infrastructure, the adverse impact on migratory fish is often not taken into account. In the UK, 48% of salmon bearing rivers in England and Wales are classified as "endangered, critical or extinct", whilst in the US Pacific Northwest, salmon have

disappeared from over 40% of their range. In both cases, the presence of river barriers has been one the main causes for the sharp decline in fish populations.

There are a number of ways in which these barriers can be removed or modified to alleviate their impact (see examples in Figs 1 and 2) but the cost can be high and in many cases, unaffordable. What is needed is an approach that can identify the most cost-effective solutions in a given river system.

**Continued on Page 22**

## Let A River Run Through It....

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Fig 1: Removing barrier impacts on fish migration - install a Fish Pass (A Fish Ladder) at the John Day Dam on the Colombia River – source US Army Corps of Engineers)



Fig 2: Removing barrier impacts on fish migration - replace culverts (Reproduced by permission of Engineering Ventures PC)



Before (above)/After (below, with trout pass recreated)

### COMMON PLANNING APPROACHES TO MITIGATING BARRIER IMPACTS

Until recently two approaches have been used:

Expert Judgement, where a group of 'experts', often biologists, brainstorm what to do. This approach can work on small-scale problems but is not suitable for large, complex river systems

Scoring and Ranking, where: step 1- each barrier is scored based on a set of assessment criteria (e.g. potential habitat gain, severity of barrier) and then step 2 - each barrier is ranked, based on its score. Unfortunately, this approach produces extremely inefficient solutions.

Optimisation approaches have also been tried, usually mixed integer linear programming (MILPs) but have had to assume that passability through barriers is binary (full passability or none), whereas in practice, barriers are usually partly passable.

### AN OPTIMISATION APPROACH THAT WORKS IN PRACTICE!

The approach used here is an efficient linear model for optimising river barrier repair and removal decisions in order to maximise upstream habitat gains for migratory fish. MILP is still used but this time incorporating the newly developed technique of 'probability chains' (O'Hanley et al. 2013), which identifies cost-efficient barrier mitigation actions to maximise accessible habitat above barriers. A decision support system, OptiPass, with a graphical user interface, has been designed to enable non-technical users to generate optimal solutions quickly and easily, as well as to provide options for various 'what-if' analyses. OptiPass integrates information on barrier passability, net upstream habitat and barrier mitigation cost and, crucially, accounts for the spatial relationships of barrier networks (i.e. upstream/downstream positions) and the interactive effects of mitigation decisions on river connectivity.

An example barrier network is shown in Fig 3. For technical details of this work see King and O'Hanley 2016.

### APPLICATIONS OF OPTIPASS

The work was originally sponsored and used by the California Fish Forum, a consortium of 13 government and non-government bodies involved in the removal of barriers to fish migration within California. The results were very impressive, as can be seen in Fig 4 which shows the habitat gain for various budget availabilities. The figure also demonstrates the power of OptiPass compared to a standard scoring and ranking approach.

Several other environmental organisations are also successfully using the software, including the US Fish & Wildlife Service, the Nature Conservancy, and the Alaska Department of Fish and Game. An application of particular interest was to the Johnson Creek Watershed, complex network of rivers that lies in the Portland area in Oregon (Fig 5). At the start of the application, Johnson Creek contained 273 stream crossings, 202 of which (74%) limited fish passage (Fig 6).

The use of OptiPass enabled the identification of those barriers which, if removed, would give the greatest ecological gain (Fig

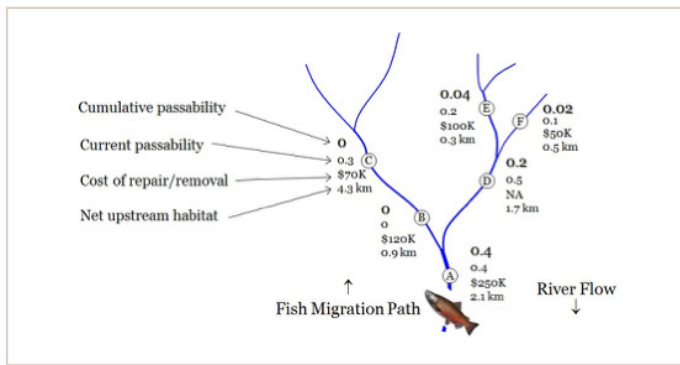


Figure 3. Example Network.

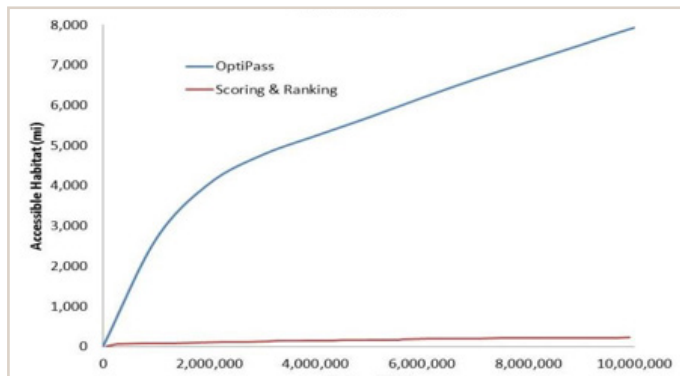


Fig 4 Potential habitat gain (river miles) in California



Fig 5: Portland area watersheds, including Johnson Creek Watershed

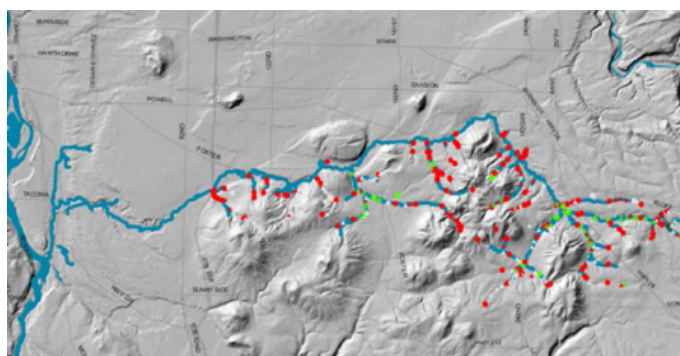


Fig 6: Johnson Creek Watershed – 273 stream crossings, including 202 (74%) fish barriers (red dots).

7). Further applications of OptiPass in ‘what-if’ mode showed the most effective barriers to remove for increasing levels of budget availability (Fig 8). Robin Jenkinson, former Johnson Creek Watershed Council Science Director, has reported: “By running the OptiPass model at stepped levels of potential funding for barrier removal (replacement of culverts with bridges or bottomless culverts and other retrofits), we determined which projects would offer the best bang for the buck. Now, the results of this prioritization effort are galvanizing our partners (five cities, two counties, Metro regional government, plus county, state, and federal agencies) to collaboratively open tributaries to Johnson Creek to migrating salmon. In fact, we have already been granted funding to design solutions to three of the top fifteen passage projects identified through this effort.”

### WHERE TO NEXT?

This work has illustrated not only how research developments, such as probability chains, can bring optimisation to a very important and complex issue, but also how the design of a user-friendly decision support system, based on such research, can be used in practice to deliver significant benefits. It is expected that the use of OptiPass will increase when it is available via the web and as more and more environmental groups are aware of its benefits.

There are still some research challenges, such as barrier mitigation combined with other types of river restoration actions and locating new hydropower dams in an eco-friendly manner, some of which are now being addressed. Watch this space! 🌱

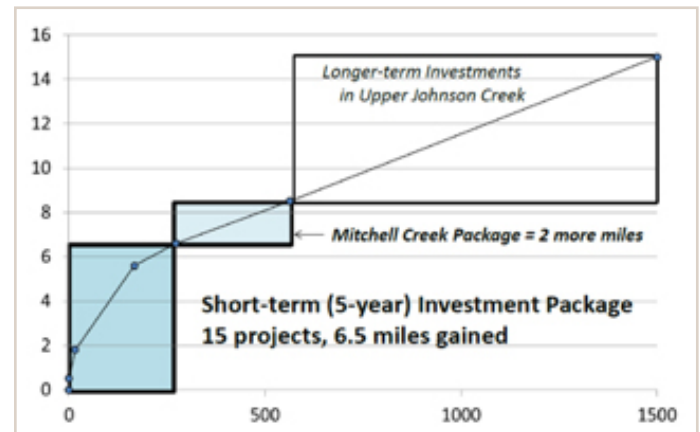


Fig 8 Habitat gain vs investment – Johnson Creek Watershed

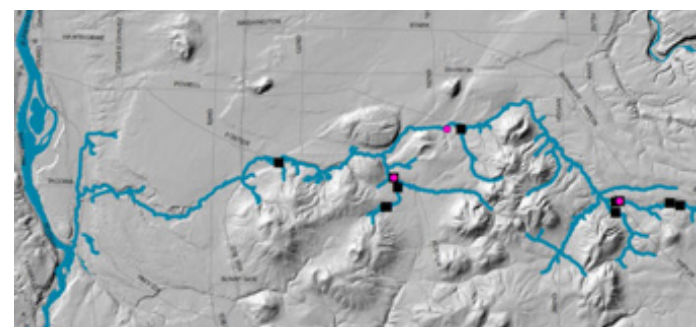


Fig 7 Barrier prioritisation in the Johnson Creek Watershed - Top 10 barriers based on ecological gain (black squares) and selected barriers given a \$25k budget (pink dots)

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## Analytics in New Zealand

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It is nowadays almost trivial to remark on the extent that analytics is changing our way of life. 'Data scientist' is now one of the most sought-after job titles, and private and public sector organizations are racing to take advantage of the increasing availability of data. But it is easy to forget that this is a relatively recent phenomenon. This short piece offers a personal perspective of the emergence of analytics in New Zealand over the past three years.

In the eighties, nineties and noughties, Operations Research in New Zealand was essentially confined to its Universities. The Operations Research Society of New Zealand (ORSNZ <http://orsnz.org.nz>) is populated and led mainly by academics. Some industries, notably the government owned electricity industry, and Air New Zealand and Norske Skog (a newsprint producer), adopted OR as an essential ingredient in their businesses. But, in general, collaboration between academia and industry was sporadic, and initiated through personal contacts. Operations Research graduates were faced with a job market that was ignorant of their ability to contribute to commercial success through their training, and many ended up in software engineering or management roles.

Analytics has changed all of that. INFORMS recognized early that the word 'analytics' was emerging as a compelling brand for the contribution our profession can make. It saw that the word would open up pathways for our profession to gain access to many complex problems. Moreover the proliferation of data enables us to contribute to solving problems in ways that we could only dream about in previous times. And managers and organizations are prepared to listen.

In 2012, virtually nobody in New Zealand was talking about analytics. In a series of conversations late in 2012 Kevin Ross and Andy Philpott of ORSNZ discussed how to get industry in New Zealand excited about OR. It was decided to run an industry workshop in which we could talk about success stories of analytics and try to stimulate some interest. Kevin's role as Chief Scientist, Optimisation Modelling at Fonterra, New Zealand's largest commercial organization, guaranteed that we would have the ear of some of New Zealand's biggest companies. The workshop ran on March 4, 2013. About 50 people attended to listen to two talks, and to socialize over drinks afterwards. They were invited to sign on to a mailing list, to be called the New Zealand Analytics Forum, as a means to advertise a possible follow-up workshop.

As of June 30, 2016, there have been 22 Analytics Forum workshops since March, 2013. These have expanded from Auckland, to Wellington and Christchurch. The membership of the Forum has grown from the 50 who attended the launch to over 1500. Unlike the ORSNZ, a very small proportion of these are academics. The Forum is run by a Steering Group of mainly industry volunteers that is led by Kevin Ross. Members belong to a Linked-In group and have a web page <http://analytics.org.nz>. Many key Forum members are also on the ORSNZ Council, resulting in a close working relationship between the two bodies. This is evident at the annual conference of the ORSNZ which now includes a Forum workshop within the conference programme.

The Analytics Forum has been in the vanguard of the growth of business analytics in New Zealand. The advocacy of the Forum led to the New Zealand government funding Te Punaha Matatini ([www.tepunahamatatini.ac.nz](http://www.tepunahamatatini.ac.nz)), one of ten national centres of research excellence that focuses on complex data analytics. Analytics has also been included as a central theme in one of the government's National Science Challenge programmes (<http://www.sftichallenge.govt.nz>) in which ORSNZ members (including the last three Society presidents) are principal investigators.

The Analytics Forum continues to prosper. Many of its members run start-up data-science businesses, and the Forum provides an environment for them to share experiences and ideas, and identify occasional opportunities for new projects. The public sector is also engaged. On March 11, New Zealand's Minister of Finance the Hon Bill English addressed the Analytics Forum in Auckland describing how data and analytics are transforming New Zealand's public sector. This is particularly important in the New Zealand Department of Social Welfare who are starting to use machine learning techniques to help identify children at risk of abuse, and to understand the causes of recidivism in criminal offenders.

So the analytics revolution has truly taken hold in New Zealand's private and public sectors. This will provide our profession with opportunities to apply our tools in very new domains. There are also obvious social challenges: on the privacy of data; on the nature of human work in a machine-learned environment; and on the emergence of data monopolies. These also confer a responsibility on our profession to use OR to help in their solution. All of us in ORSNZ look forward to the rest of what will be a golden decade of analytics. 🌐