



Newsletter 16 of EUROPT

EUROPT - The Continuous Optimization Working Group of EURO

<http://www.iam.metu.edu.tr/EUROPT/>

August 2009

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Words from the chair

Dear Members of EUROPT, dear Friends,

It was a great pleasure to meet most of you during the 7th EUROPT Workshop "Advances in Continuous Optimization", held in the RheinAhrCampus of Remagen. The workshop constituted itself the best proof of the high scientific level that EUROPT has reached through its still short life. We enjoyed the highly interesting programme composed by six plenary and 82 parallel talks, distributed in 38 sessions. Some participants started to claim that the EUROPT Workshops are becoming so attractive for an increasing number of researchers and practitioners in the field, that they will require in the close future a three-days event (instead of two days, as now).

I keep still very fresh in my memory the main highlights of the workshop. From the professional point of view, I feel some pride for the remarkable plenary and semi-plenary talks, delivered by Profs. Amir Beck, Sven Leyffer, Yurii Nesterov, Juan Parra, Leonidas Sakalauskas, and Philippe Toint. Thank you very much to all of them, as well as to the members of Scientific Committee for such a good choice of the invited speakers panel.

From the social point of view, everything was perfect, but the dinner/excursion in the Rhein river was unforgettable. On behalf of the Managing Board of EUROPT, I want express here my deep gratitude to all the members of the Organizing Committee, mainly to Oliver Stein and Mirjam Dür, also to the local organizers Jürgen Kremer and Claus Neidhardt, and to Gisela Niedzwetzki and Chantal Ausoni. All of them contributed with their generous effort and enthusiasm to the big success of this event.

During the Opening Ceremony, I expressed our gratitude to our sponsors: EURO (the Association of European Operational Research Societies), GOR (the German OR Society), as well as the company Schlock Baulösungen. I recall now that we are truly thankful to them.

As EUROPT Chair, I feel very happy of the extremely high quality, both professional and human, of our EUROPT Fellows, whose list now is enlarged with the last one, nominated this year, Prof. Adil Bagirov. My congratulations, Adil; you deserved this distinction and we are proud of having you as our Fellow 2009.

I would like to specially thank our friend, and Past Chair, Prof. Gerhard-Wilhelm Weber for the nice presentation of the achievements and expectations of EUROPT. He gave impulse to most of these initiatives, contributing to the wonderful moment we are living now. Thank you, Willi!

In his speech, Willi, reminded us that the next EUROPT Workshop will have some special significance, because it will be held after the 10th birthday of EUROPT. This fact will require a special care in the organization of our Workshop, and this is why we asked our friend, Prof. Domingos Cardoso, and the team around him co-leadereed by Tatiana Tchemisova, to organize the event in their University of Aveiro (Portugal). They were very kind and accepted with en-

thusiasm, and since that moment, we are completely convinced that they will prepare another memorable meeting. All the Managing Board is wishing to help you in this challenge. Thanks for your generosity, and good luck.

I wish all of you a very pleasant summer. Thank you very much for your attention.

With my best wishes, Yours sincerely,
Marco A. Lopez, Chair of EUROPT

Words from the organizers of EUROPT Workshop on Advances in Continuous Optimization in Remagen, Germany

On 3-4 July 2009, the 7th EUROPT Workshop on Advances in Continuous Optimization took place in the German city of Remagen, as a satellite event to the EURO XXIII conference in Bonn: <http://www.rheinahrcampus.de/europt2009>

In Remagen, EUROPT enjoyed the hospitality of the **RheinAhrCampus Remagen**, a small but successful University of Applied Sciences, and benefited from their excellent facilities.

The two-day scientific program comprised two plenary talks, four semiplenary and 84 talks in parallel sessions. The plenaries and semiplenaries were given by *Yurii Nesterov*, *Sven Leyffer*, *Philippe Toint*, *Leonidas Sakalauskas*, *Amir Beck*, and *Juan Parra*. The contributed talks were organized in a couple of invited sessions as well as in contributed sessions. Due to the large number of contributed talks, they had to be scheduled in five parallel sessions.

The social program consisted of a welcome evening at the courtyard of the RheinAhrCampus and a conference dinner during a boat trip on the river Rhine, during which the EUROPT Fellow 2009, *Adil Bagirov*, was presented.

The organizers would like to thank everybody who contributed to the success of this event. A more detailed report on the workshop will soon be posted on the EUROPT website: <http://www.iam.metu.edu.tr/EUROPT/>

On behalf of the Organizing Committee, *Mirjam Dur* and *Oliver Stein*

Forthcoming Events

- **International Energy Week 09**
November 3-5, 2009
Kuching, Sarawak, Malaysia

<http://www.iew.my>

The Sarawak Government will host the International Energy Week 09 (IEW 09) from 3 to 5 November 2009 at the brand new Borneo Convention Centre, Kuching that will bring together key decision makers and industry players from across the region. IEW 09 will be the first major international event held in the energy rich state of Sarawak that will incorporate 2 International Expos, 2 International Conferences, Over 30 Technology Symposiums , CEOs Summit, Business Matchings Networking.

The staging of IEW 09 is in support of the Malaysian Government's initiative in harnessing the tremendous opportunities in the energy sector through the Sarawak Corridor On Renewable Energy (SCORE). It will provide the platform for power producers, oil gas producers, technology suppliers, regulators, consultants and investors to explore new technologies, introduce new initiatives, develop new partnerships and enhance cooperation.

IEW'09 Secretariat: AMB Exhibitions Sdn Bhd Suite 1701, 17th Floor Plaza Permata (IGB Plaza) 6, Jalan Kampar, Off Jalan Tun Razak, 50400 Kuala Lumpur, Malaysia

Contact: Phone: (603) 4045 4993, Fax: (603) 4045 4989

E-mail: rina@ambexpo.com, zahir@ambexpo.com

Person in-charge: Ms Rina (Petroleum Asia '09), Mr Zahir (Electropower Asia '09)

- **Global Conference on Power Control Optimization**

February 2-4, 2010
Marriott Hotel, Gold Coast Australia

www.engedu2.net

The third Global Conference on Power Control and Optimization PCO 2010, which will be held in Marriott hotel, Gold Coast, Australia from 2 to 4 February 2010. The Conference is technically sponsored by IOI Press, AIP, Springerlink TF and professional Engineering publisher and organized by the Technion Israel Institute of Technology and Curtin University of Technology, Malaysia.

Organizing Committee:

Nader Barsoum, Malaysia;

Pandian Vasant, Malaysia;

Liron Yedidsion, Israel;

Rabi W Yousif, Malaysia;

Jeffrey Webb, Malaysia

Steering Committee:

Kenneth Adan, Malaysia; Sermsak Uatrongjit, Thailand; Fernando Jimenez, Spain; Youssef Attallah, Lebanon; Dvir Shabtay, Israel; Cevetco Andreeski, Macedonia; Andrew Kusiak, USA; Wei Xu, UK

International Program Committee:

Terry Williams, UK; David A. Pelta, Ireland; Janos Sebstyen, Hungary; Sankar Pal, India; Didier Dubois, France; Xiao-Zhi, Finland; John Mellor, UK; Jeng-Shyang, Taiwan; Praveen Jain, Canada; Frede Blaabjerg, Denmark; Christoph Meyer, Germany; Nicola Femia, Italy; Nikhil Ranjan Pal, Taiwan; Henry Nuttle, USA; Gerhard Wilhelm Weber, Turkey; Fernando Gomide, Brazil; Moti Henig, Israel; Sergey Kryzhevich, Russia; Gianfranco Rizzo, Italy

The scope of the conference is contemporary and original research and educational development in the area of electrical power engineering, control systems and methods of optimization. The scope of the conference includes, but not limited to, the following topics:

Hybrid renewable energy and energy saving; Power systems, protection and reliability; Controllers, drives and machine design; Smart system and dynamic robust system; Mechatronics and nano physics; NEMS and MEMS; Simulators and software engineering; Soft computing and computational intelligent; Bioinformatics and body sensors; Fuzzy and hybrid optimization; Queuing theory and game theory; MRP, ERP, Inventory project management; Artificial immune systems; Evolutionary algorithms; Ant colony; Genetic and swarm optimization; Probabilistic possibilistic optimization; Production design and rough set; Line, pattern searches and decision making; Scheduling and assignment problems; Continuous and combinatorial operation; Graph theory and supply chain management; Micro transportation; Network communication and wireless sensor; Condition monitoring and instruments

Papers submission: Prospective authors from universities or institutes and industries are invited to submit the full paper by email before the deadline. Paper should be submitted electronically, formatted in MSWord, as per PCO guideline. All papers will be peer reviewed by independent specialists as per IEEE guide. PCO-10 proceeding will be published online by AIP. Selected papers will be published in Elsevier, Springer, Inderscience, Professional Engineering, and other Journals.

Sessions: Proposal for holding special sessions, tutorial and workshop are invited from prospective authors, industrial bodies and academicians, and should be addressed to the Chair. The program committee is currently looking for speakers and financial sponsors from industry, academics, and professional bodies.

Contact: All correspondence should be addressed to the conference secretariat: Tel: 605 3711416, 6085 443821
Email: icpco.20@gmail.com

IMPORTANT DAYS

Submission of Full Papers: October 1, 2009
Notification with Peer Review: November 1, 2009
Camera-ready Paper: December 15, 2009
Registration with Full Payment: December 15, 2009

- **International Conference on Statistics, Probability, Operations Research, Computer Science and Allied Areas**
January 4-8, 2010
Adhra University, Visakhapatnam, India
www.andhrauniversity.info

In conjunction with VIII International Indian Statistical Association Joint Statistical Meeting and XXIX Annual Convention of Indian Society for Probability and Statistics.

Objective: to assess recent developments in the fields of Statistics, Probability, Operations Research and Computer Science and to discuss future directions in terms of theory, practice and education. One of the primary goals is to foster international collaboration in these related areas through the exchange of ideas and experiences to enhance other technology transfer activities. Reform needed in statistical education and training in order to meet the changing needs of the industry and government will receive special attention. The program of the conference will include several invited sessions, contributed sessions as well as workshops. English is the official language for all conference materials and presentations. The conference will be held at Andhra University in Visakhapatnam.

Topics: The Conference will feature topics including

Applied probability, Random Walks, Bayes Inference, Bio-statistics and Bio.informatics, Communication Networks and Security, Data Mining, Design of Experiments, Directional Data Analysis, Distribution Theory, Econometrics, Markov Processes and Markov Decision Theory, Mathematical Finance, Multivariate Analysis, Nonparametric Inference, Operations Research, Queues and Inventories, Pattern Recognition and Image Processing, Probability Theory, Limit Theorems, Statistical Education, Statistical Quality Control and Reliability, Stochastic Modeling, Stochastic Processes, Stochastic Calculus and Control, Survey Sampling, Survival Analysis, Time Series Analysis

International Organizing Committee:

Chair S.Rao Jammalamadaka, UCSB, USA

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Programm Committee:

For IISA Sessions:

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Hira Koul, USA
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For ISPS Sessions:

Chair: C.Uma Shankar
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P.G.Khot
K.R.M. Nair
R.R.L.Kantam

Contacts: Prof K.Srinivasa Rao, Department of Statistics, Andhra University, Visakhapatnam - 530 003, Andhra Pradesh, India
Ph: 91-891-2844650, 91-891-2844647 (Off) ; 91-891-2560761 (Resi); 91-994-9659959 (Mob)
e-mail:ksraoau@yahoo.co.in, ksraoau@gmail.com

• **ALIO/INFORMS Joint International Meeting**

June 6-9, 2010

Buenos Aires, Argentina

<http://meetings.informs.org/BuenosAires2010/> meetings@informs.org

We invite members of ALIO, INFORMS and the worldwide OR/MS community to join us in Buenos Aires in June 2010 for the ALIO-INFORMS International Meeting. This joint conference consists of the INFORMS International Conference and XV CLAIO, the biannual conference organized by ALIO.

Since their inception, Operations Research/Management Science tools have helped solve problems in many industries, yet OR/MS has much more to offer society in its efforts to sustain economic growth while using resources efficiently. There are always new challenges for using OR/MS techniques in non-traditional domains.

At ALIO-INFORMS 2010, attendees will exchange ideas on topics such as services, logistics and transportation, manufacturing, supply chain management, environment, natural

resources, biotechnology, and healthcare. The meeting intends also to emphasize the importance of the relationship between basic research and the practice of OR/MS.

The academic program will consist of plenary talks, tutorials, and parallel sessions, covering many aspects of OR/MS and it will offer a forum for intellectual exchange between participants of all the countries of Latin and North America, as well as from other regions around the world.

Co-Sponsored by: Association of Latin-Iberoamerican Operational Research Societies www.dc.uba.ar/alio, Institute for Operations Research and the Management Sciences www.informs.org

Local Host: SADIO, Sociedad Argentina de Informática e Investigación Operativa

Organizing Committee:

General Chair: Irene Loiseau, Universidad de Buenos Aires, Argentina

Co-chair: Ben Lev, University of Michigan-Dearborn, USA

Plenary Co-chairs: Nelson Maculan, Universidade Federal de Rio de Janeiro, Brasil; Andrés Weintraub, Universidad de Chile, Chile

Tutorials Chair: Celso Ribeiro, Universidade Federal Fluminense, Brasil

Practice Program Co-chairs: Rafael Epstein, Universidad de Chile, Chile Bjarni Kristjansen, Maximal Software, USA

Sponsored Sessions Chair: Nérida Echebest, Universidad Nacional de La Plata, Argentina

Publications Co-chairs: Lorena Pradenas Rojas, Universidad de Concepción, Chile, María Urquhart, Universidad de La República, Uruguay

ALIO Liason Héctor Cancela, ALIO President, Universidad de La República, Uruguay

Meeting Committee:

Victor Albornoz, Universidad Técnica Federico Santa María, Chile

Gulnara Baldoquin de La Peña, Instituto Politécnico José A. Echeverría, Cuba

Carlos Brizuela, CICESE, México

Ramiro Cáceres, Universidad Nacional de León, Nicaragua

Carlos Coelho Coelho, CINVESTAV-IPN, México

Alexandre Cunha, Universidade Federal de Minas Gerais, Brasil

Rosa Delgadillo, Universidad Mayor de San Marcos, Perú

Belarmino Adenso Díaz, Universidad de Oviedo, España

Laureano Escudero, Universidad Rey Juan Carlos, España

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Luis Gouveia, Universidade de Lisboa, Portugal

José Hernández, Universidad Metropolitana, Venezuela

Alfredo Iusem, IMPA, Brasil

Zhixin Liu, University of Michigan- Dearborn, USA

José Mario Martínez, UNICAMP, Brasil
Isabel Méndez Díaz, Universidad de Buenos Aires, Argentina
Oscar Meza, Universidad Simón Bolívar, Venezuela
Graciela Nasini, Universidad Nacional de Rosario, Argentina
Carlos Paternina, Universidad del Norte, Colombia
Eduardo Pizza, Universidad de Costa Rica, Costa Rica
Roger Ríos, Universidad Autónoma de Nuevo León, México
Wilfredo Sosa Sandoval, Universidad Nacional de Ingeniería, Perú
Carlos Vidal, Universidad del Valle, Colombia
Yoshiko Wakabayashi, Universidad de Sao Paulo, Brasil

Teaching Effectiveness Colloquium Co-chairs: James Cochran, Louisiana Tech University, USA, Marcela González, Universidad de Talca, Chile

Venue: The conference will be held at the Law School of Buenos Aires University (Facultad de Derecho de la Universidad de Buenos Aires).

IMPORTANT DAYS

Abstract Submission opens: August 15, 2009

Abstract Submission deadline: February 1, 2010

Authors Deadline for Final Abstract Changes: April 26, 2010

Registration Deadline: May 7, 2010

• **EngOpt 2010**
2nd International Conference on Engineering Optimization
September 6-9, 2010
Technical University of Lisbon, Portugal

<http://www.engopt.org> (in construction)

(PRELIMINARY ANNOUNCEMENT)

Scope of the conference EngOpt is a forum for Engineers, Mathematicians and Computer Scientists to share research and innovations, promoting interdisciplinary activities in all fields of Engineering Optimization.

Objectives The main objective of the EngOpt conferences is to periodically bring together engineers, applied mathematicians and computer scientists working on research, development and practical application of optimization methods applied to all engineering disciplines or developing basic techniques in this field. Prospective authors are invited to submit abstracts on optimization and its application in all areas of engineering and industry.

Main Topics: Engineering Design Optimization, MDO - Multidisciplinary Design Optimization, Inverse problems, Engineering Simulation Involving Optimization Techniques,

Basic Numerical Techniques, Interdisciplinarity in Engineering Optimization, Efficient Analysis and Reanalysis Techniques.

Contacts: EngOpt 2010 Secretariat Centre for Mechanical Design Mechanical Engineering Department Instituto Superior Técnico Av. Rovisco Pais, 1049-001 Lisboa, Portugal,
Ph: +351 218417280 , Fax: +351 218417915
Email: engopt2010@dem.ist.utl.pt

IMPORTANT DAYS

Abstract Submission: March 30, 2010
Notification of acceptance: April 15, 2010
Full Paper Submission: May 30, 2010

- **21st International Conference on Multiple Criteria Decision Making**
June 13-17, 2011
Jyväskylä, Finland

www.jyu.fi/mcdm2011

(By Prof. Kaisa Miettinen Chair of the Conference)

Welcome to the land of Midsummer Sun and University of Jyväskylä in June when the days are the longest: the sun shines about 21 hours a day with a few hours of twilight in between. This gives conference participants an opportunity to enjoy the unique northern nature and life style during the outing and even after the conference days.

We expect an active participation, because of easy access to Finland. We expect some 200 participants from all over the world. We are planning to have maximum 4 parallel sessions. Finland has a strong MCDM community, with lots of respect for the Societys traditions.

The general chair for the Conference will be Professor Kaisa Miettinen, University of Jyväskylä and the program co-chairs Professors Pekka Korhonen and Jyrki Wallenius, Helsinki School of Economics.

If you wish to be informed of calls for proposals and papers etc., contact us at mcdm2011@mcidsociety.org.

Further information: <http://www.jyu.fi/mcdm2011>.

• **IFORS 2011**
**19th Triennial Conference of the International Federation of
Operational Research Societies**
July 10-15, 2011
Melbourne, Australia

<http://www.ifors2011.org/>

(SECOND ANNOUNCEMENT)

Conference Organizing Committee:

Chair: Dr Patrick Tobin, School of Arts and Sciences (Vic), Australian Catholic University, Melbourne Campus (St Patrick's)

e.mail: Patrick.Tobin@acu.edu.au

Phone: +61 3 9953 3199, Fax: +61 3 9495 6141

Secretary: Kaye Marion, Senior lecturer in Operations Research and Statistics School of Mathematical and Geospatial Sciences, RMIT University e.mail: k.marion@rmit.edu.au

Phone: +61 3 9925 3162

Treasurer: Assoc Prof Paul Lochert,

e.mail: plochert@bigpond.net.au

Phone: +61 3 9802 4628

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- Prof Natasha Boland, School of Mathematical and Physical Sciences, University of Newcastle,
e.mail: Natashia.Boland@newcastle.edu.au
Phone: +61 2 4921 6717, Fax: +61 2 4921 6898

Conference Program Committee Chair:

Prof May Yee (Janny) Leung, Department of Systems Engineering and Engineering Management, The Chinese University of Hong Kong Office: Room 509, William M.W. Mong Engineering Building Phone: (852) 2609-8238

e.mail: janny@se.cuhk.edu.hk

Second announcement on postdoctoral positions in University of Waterloo, Canada

Applications are invited for one or more postdoctoral positions to carry out research in the development of novel optimization methodologies for solving hard combinatorial problems arising in real-world applications.

The positions may be based at either the University of Waterloo (<http://www.uwaterloo.ca>) or the University of Guelph (<http://www.uoguelph.ca>).

The **lead investigators** are Professors Miguel Anjos (Waterloo, Management Sciences), Anthony Vannelli (Guelph, Engineering), Stephen Vavasis (Waterloo, Combinatorics Optimization), and Henry Wolkowicz (Waterloo, Combinatorics Optimization).

The successful applicant will have completed (or be very near completion of) a PhD in Operations Research, Electrical Engineering, Computer Science, or a related field. Preference will be given to candidates with documented expertise in mathematical programming techniques.

The starting date will be determined by mutual agreement. The initial contract will be for 6 to 12 months, with a possibility of extensions up to a maximum of 2 years in total.

Applicants should send a CV and list of referees to Professor Miguel Anjos (manjos@uwaterloo.ca) as a PDF (preferred) or Word file. Applications will be accepted until all positions are filled.

Further information can be obtained from Professor Miguel Anjos, tel. +1-519-888-4567 ext 32521, manjos@uwaterloo.ca <http://mfa.uwaterloo.ca>

Teaching activities

"Quadratic Internal Model Principle in Mathematical Programming"

by Neculai Andrei, nandrei@ici.ro

Research Institute for Informatics, Center for Advanced Modeling and Optimization, 8-10, Averescu Avenue, Bucharest 1, Romania;
Member of Academy of Romanian Scientists, 54, Splaiul Independentei, Bucharest 5, Romania.

1. Introduction. Starting with an initial point x_0 , every algorithm for solving the general nonlinear optimization problem

$$\begin{aligned} & \min f(x) \\ & \text{subject to } h(x) = 0, \end{aligned} \tag{1}$$

where $f : \mathbb{R}^n \rightarrow \mathbb{R}$ and $h : \mathbb{R}^n \rightarrow \mathbb{R}^m$, can be considered as a generator of a sequence of points $\{x_k\}$ which satisfy the constraints of the problem in such a way that $f(x_k) \rightarrow f(x^*)$,

where x^* is a local solution of the problem. The *line search methods* are characterized by two main actions. At the iteration k a search direction d_k is generated and then a suitable point $x_k + \alpha_k d_k$ is computed by a step length α_k so that a reduction of the minimizing function or of a merit function (a penalty function) is obtained. The main action in any optimization algorithm is the design of the generator of directions d_k . The steplength is computed using the standard procedures of Armijo or of Wolfe in order to reduce the values of the function f or of a merit function. Plenty of nonlinear optimization algorithms are known and there are a lot of papers and books presenting them from the viewpoint of theoretical and computational aspects.

To solve problem (1), or a more general version of it with inequality constraints, each optimization algorithm must "understand" it. There is a large diversity of optimization algorithms. Many of them solve a constrained optimization problem by converting it to a sequence of unconstrained problems via Lagrangian multipliers or via penalty or barrier functions. Another class of methods solves nonlinear programming problems by moving from a feasible point to a new improved one along a feasible direction. However, every optimization algorithm, in one way or another, is based on the Karush-Kuhn-Tucker optimality conditions. Generally, these conditions are expressed as a nonlinear algebraic system. In the framework of the Newton machine this nonlinear system is reduced to a sequence of linear algebraic systems, which is equivalent to a sequence of quadratic programming problems. The quadratic internal model principle in mathematical programming states that "*an optimization algorithm must encapsulate implicitly or explicitly a quadratic internal model of the problem to be solved*". Every optimization algorithm uses its own quadratic internal model which takes into account the main ingredients defining the algorithm. This is the minimal part that must be encapsulated by the algorithm in order to solve the problem.

The philosophical motivation behind the quadratic internal model principle in mathematical programming is as follows. As known, the mathematical model of a physical reality is based on the conservation laws. In physics, a conservation law states that a particular measurable property of an isolated system does not change while the system evolves. Any particular conservation law is a mathematical identity to certain symmetry of a physical system. For systems which obey the principle of the least action and therefore have a Lagrangian [Lagrange, 1797], [Fourier, 1798] the Noether's theorem [Noether, 1971] expresses the equivalence between conservation laws and the invariance of physical laws with respect to certain transformations called symmetries. The behavior of a physical system can often be expressed in terms of a specific function of the system variables, called Lagrangian. The system follows a path through the phase space such that the integral of the Lagrangian is stationary. For a system with Lagrangian L of the variables q and $\dot{q} = dq/dt$ the equation of motion is

$$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{q}} \right) = \frac{\partial L}{\partial q}.$$

From this equation Noether specified that if the quantity on the right hand term is zero (meaning that L is symmetrical over q), then the rate of change of the quantity in parentheses on the left side is also zero, i.e. it is a conserved quantity. Generally, any symmetry of the Lagrangian function corresponds to a conserved quantity, and vice versa. It seems that at the fundamentals of our cognoscible universe lies the concept of symmetry. But,

mathematically symmetries are expressed by quadratic forms - a homogeneous polynomial of degree two in a number of variables. It is worth saying that the quadratic forms are central objects in mathematics and they are ubiquitous in physics and chemistry. Quadratic forms occur in number theory, Riemannian geometry, Lie theory and they always express energy of a system, particularly in relation to the L^2 norm, which leads us to the use of the concept of Hilbert spaces. Therefore, it is quite natural to see that at the heart of every mathematical model is a quadratic form. This quadratic form must be replicated in an optimization algorithm in order to get a solution of the corresponding problem.

2. Quadratic Internal Model Principle. In his synthesis, Yuan [2003] has shown that using the Newton machine for every method for solving a constrained optimization problem a linear algebraic system can be associated in a most natural way. All the linear systems corresponding to different methods are similar in form and can be expressed as:

$$\begin{bmatrix} W(x_k, \lambda^k) + T_k & -\nabla h(x_k)^T \\ \nabla h(x_k) & S_k \end{bmatrix} \begin{bmatrix} d \\ \eta \end{bmatrix} = - \begin{bmatrix} \nabla f(x_k) + \varepsilon_1 \\ h(x_k) + \varepsilon_2 \end{bmatrix}, \quad (2)$$

where $W(x_k, \lambda^k) = \nabla^2 f(x_k) - \sum_{i=1}^m \lambda_i^k \nabla^2 h_i(x_k)$ is the Hessian matrix of the Lagrange function $L(x, \lambda) = f(x) - \lambda^T h(x)$, $T_k \in \mathbb{R}^{n \times n}$ is a symmetric matrix, $S_k \in \mathbb{R}^{m \times m}$ is a null or a diagonal matrix whose elements are nonpositive, $\varepsilon_1 \in \mathbb{R}^n$ and $\varepsilon_2 \in \mathbb{R}^m$ are two vectors. In (2), d is the searching direction and η is an auxiliary vector which for some methods could be the Lagrange multiplier. In the following we shall consider two cases.

1) Let us assume that $S_k = 0$. Therefore, from (2), we get

$$\begin{bmatrix} W(x_k, \lambda^k) + T_k & -\nabla h(x_k)^T \\ \nabla h(x_k) & 0 \end{bmatrix} \begin{bmatrix} d \\ \eta \end{bmatrix} = - \begin{bmatrix} \nabla f(x_k) + \varepsilon_1 \\ h(x_k) + \varepsilon_2 \end{bmatrix}. \quad (3)$$

It is easy to see that the system (3) corresponds to the Newton method for optimization with equality nonlinear constraints or to the sequential quadratic programming method. The augmented system (3) can be considered as the necessary condition for d to be a solution of the following quadratic programming problem:

$$\begin{aligned} \min & \frac{1}{2} d^T (W(x_k, \lambda^k) + T_k) d - (\nabla f(x_k) + \varepsilon_1)^T d \\ \text{subject to} & \nabla h(x_k) d + (h(x_k) + \varepsilon_2) = 0. \end{aligned} \quad (4)$$

It is well known that if $(W(x_k, \lambda^k) + T_k)$ is positive definite on the null space of $\nabla h(x_k)$ and $\nabla h(x_k)$ is a full-rank matrix, then the quadratic problem (4) has a unique global solution d . This solution can be obtained by solving the augmented system (3), where d is the solution of the problem and η is the Lagrange multiplier associated to the equality constraint. The problem (4) is the *quadratic internal model of problem (1) associated to the methods involving the linear system (3) (with $S_k = 0$)*.

For example, the *quadratic internal model of the problem (1) corresponding to the Newton method* is:

$$\begin{aligned} & \min \frac{1}{2} d^T W(x_k, \lambda^k) d - (\nabla f(x_k) + \nabla h(x_k) \lambda^k)^T d \\ & \text{subject to } \nabla h(x_k) d + h(x_k) = 0. \end{aligned} \quad (5)$$

2) Let us suppose that $S_k \neq 0$. Normally, S_k is a diagonal matrix, whose diagonal elements are all negative. In this case it is easy to see that the system (2) corresponds to the following methods: the augmented Lagrange function, the inverse barrier function, the *log*-barrier function, the interior point algorithms, the path-following methods, the affine scaling interior point methods etc. From (2) we get:

$$\eta = -S_k^{-1} \nabla h(x_k) d - S_k^{-1} h(x_k) - S_k^{-1} \varepsilon_2. \quad (6)$$

Therefore, using (6) in (2) it follows that

$$\begin{aligned} & [W(x_k, \lambda^k) + T_k + \nabla h(x_k)^T S_k^{-1} \nabla h(x_k)] d \\ & = -\nabla h(x_k)^T S_k^{-1} h(x_k) - \nabla h(x_k)^T S_k^{-1} \varepsilon_2 - \nabla f(x_k) - \varepsilon_1. \end{aligned} \quad (7)$$

But, (7) is equivalent with the following quadratic problem:

$$\begin{aligned} & \min \frac{1}{2} d^T [W(x_k, \lambda^k) + T_k + \nabla h(x_k)^T S_k^{-1} \nabla h(x_k)] d \\ & \quad - [-\nabla h(x_k)^T S_k^{-1} h(x_k) - \nabla h(x_k)^T S_k^{-1} \varepsilon_2 - \nabla f(x_k) - \varepsilon_1]^T d, \end{aligned} \quad (8)$$

which is called *the quadratic internal model of problem (1) associated to the methods involving the linear system (2) (with $S_k \neq 0$)*.

Therefore, an optimization algorithm for solving (1) must encapsulate a procedure for solving (in an iterative way) the quadratic internal model (8), which represents the essence of the problem from the view point of the algorithm involving (2).

Observe that the quadratic internal model of (1), as expressed by (8), is dependent on the algorithm we consider for solving the problem (1). In particular, for example, the *quadratic internal model of problem (1) corresponding to the augmented Lagrange function method*, in which the augmented Lagrange function is

$$L(x, \lambda, \sigma) = f(x) + \lambda^T h(x) + \frac{1}{2} \sigma \|h(x)\|_2^2, \quad (9)$$

where $\lambda \in \mathbb{R}^m$ is the Lagrange multiplier and $\sigma > 0$ is the penalty parameter, is:

$$\begin{aligned} & \min \frac{1}{2} d^T (W(x_k, \lambda^k h(x_k)) + \sigma \nabla h(x_k)^T \nabla h(x_k)) d - \\ & \quad (-\nabla f(x_k) + \nabla h(x_k)^T (\lambda^k - \sigma h(x_k))) d. \end{aligned} \quad (10)$$

In this case $\eta \in \mathbb{R}^m$ is given by $\eta = \sigma \nabla h(x_k) d + \sigma h(x_k)$.

It is worth saying that for the unconstrained problem ($m = 0$) the Newton step can be obtained by solving the following quadratic problem

$$\min \frac{1}{2}d^T \nabla^2 f(x_k)d + \nabla f(x_k)^T d, \quad (11)$$

which is the *quadratic internal model of the problem* $\min f(x)$ corresponding to the *Newton method*. Of course, the Newton step $d = -(\nabla^2 f(x_k))^{-1} \nabla f(x_k)$ is obtained by solving the linear system $(\nabla^2 f(x_k))d = -\nabla f(x_k)$, but as we know, it comes from the quadratic problem (11). Similarly, we can say that for the unconstrained problem the quasi-Newton step can be obtained by solving the following quadratic problem:

$$\min \frac{1}{2}d^T B_k d + \nabla f(x_k)^T d, \quad (12)$$

which is the *quadratic internal model of the problem* $\min f(x)$ corresponding to the *quasi-Newton method*, where B_k is a positive definite matrix satisfying the quasi-Newton equation $B_k(x_{k+1} - x_k) = \nabla f(x_{k+1}) - \nabla f(x_k)$.

3. Conclusion. To solve a mathematical programming problem an algorithm must encapsulate in an implicitly or explicitly manner a quadratic internal model of the problem. This is the quadratic internal model principle in mathematical programming. This quadratic internal model reflects the ingredients of the algorithm and represents its essence. The philosophical support of this principle is coming from the Noether Theorem which expresses the equivalence between the conservation laws and symmetries which can be represented by quadratic forms. These quadratic forms are the fundamentals of every line search optimization algorithm.

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Editor's personal comments

The 7th EUROPT Workshop "Advances in Continuous Optimization" held in Remagen belongs already to the past, but a lot of precious moments remain in our memory. Namely, scientific presentations of a very high level, a friendly environment and a very nice atmosphere offered to all the participants. For me it was a great privilege to have the opportunity to meet in person so many friends and colleagues from whom we have received or will receive collaboration and support in edition of our Newsletters.

I must refer also that I am very thankful to my colleagues of the Managing Board for committing to me jointly with my colleague Tatiana Tchemisova, their confidence to organize the next EUROPT Workshop in Aveiro, Portugal. After seven Workshops with so many remarkable moments, like the ones lived in Remagen, we are conscious of importance is this challenge and we will do our best efforts in order to turn the 8th EUROPT Workshop is an event according to your expectations as the ten years EUROPT birthday meeting.

This issue includes a detailed information about seven forthcoming events, an announcement of postdoctoral position and the section "Problems and Teaching Activities" contains a kind contribution of Professor Neculai Andrei from Research Institute for Informatics, Center for Advanced Modeling and Optimization, Romania, with the title "Quadratic Internal Model Principle in Mathematical Programming".

On behalf of the Editorial Board of EUROPT Newsletter,

Domingos M Cardoso

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