CONSORTIUM

PROJECT PARTNERS

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany (Coordinator)

Centrum Wiskunde & Informatica (CWI), the national research institute for mathematics and computer science in the Netherlands

Compagnie IBM France

French National Center for Scientific Research (CNRS), France

Heidelberg University, Germany

Italian National Research Council (CNR-IASI), Italy

Management Artificial Intelligence Operations Research (M.A.I.O.R.), Italy

Technical University of Dortmund, Germany

Tilburg University, The Netherlands

University of Bologna, Italy

University of Cologne, Germany

University of Klagenfurt, Austria

ASSOCIATED PARTNERS

Bavarian Research Alliance GmbH, Germany

CRAY Computer GmbH, Switzerland

Optit srl, Italy

ORTEC bv, The Netherlands

Sapienza University of Rome, Italy

Siemens AG, Germany

University of Paris Saclay, France

University of Pisa, Italy

PROJECT PROFILE

PROJECT
MINOA (Mixed-Integer Non-Linear Optimisation: Algorithms and Applications)

FUNDING PROGRAMME
Horizon 2020,
Marie Skłodowska-Curie Innovative Training Network

GRANT AGREEMENT NO.
764759

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MINOA

MIXED-INTEGER NON-LINEAR OPTIMISATION: ALGORITHMS AND APPLICATIONS

NEW ALGORITHMS TO CONTROL COMPLEX SYSTEMS MORE EFFECTIVELY

INNOVATIVE TRAINING NETWORK ON MATHEMATICAL OPTIMISATION

Whether in logistics or in energy management – extremely short-term decisions are seldomly made by humans today. Highly intelligent machines that can control processes and systems in real time take care of this instead. The underlying software determines the best possible results in fractions of seconds by using complex mathematical calculations. Finding out how to achieve this is the task of mathematical optimisation. Optimising a system can be extremely challenging, for example if the system has to be described by complex physics laws, potentially combined with decisions such as whether the system requests the installation of a new power plant or not. It gets even more challenging if uncertainties come into play, for example due to future projections or because of seasonally varying requirements. This kind of situation frequently arises in practice, but because of its enormous complexity, it often cannot be handled by currently existing solution methods. While tremendous progress has been made for optimising simplified situations, limited problem classes or at a theoretical level, practically efficient implementation and successful application of new mathematical findings to real-life problems is still in its infancy.

The MINOA (Mixed-Integer Non-Linear Optimisation: Algorithms and Applications) Network intends to develop new and effective algorithms which can be integrated into numerous applications from the energy, logistics, engineering, natural sciences and data analytics sectors.
It will also train the next generation of highly skilled researchers and managers in applied mathematics, operations research and computer science, who will be able to use these new methodologies and technologies and make a tremendous contribution to science, industry and society.

PROJECT OBJECTIVES

As a European Innovative Training Network (ITN), MINOA's mission is on the one hand to gain new insights into the field of applied mathematics. On the other hand, the MINOA network focuses on training a total of twelve early-stage researchers from the fields of applied mathematics, optimisation and computer sciences. The twelve related research projects are pursued in joint supervision between experienced practitioners from leading European companies and optimisation experts, covering a wide range of scientific fields (from mathematics to algorithms and real-world applications) in order to gain new competences and improved insights.

MINOA'S SPECIFIC OBJECTIVES ARE

- to push forward the scientific frontiers by solving mixed-integer non-linear optimisation (MINO) applications in energy, logistics, natural sciences, engineering, data analytics, as well as in combinatorial optimisation;
- to develop software for the solution of MINO applications, to validate it for the applications, and to give recommendations for their effective use;
- to train highly skilled researchers and managers with optimisation and problem-solving expertise;
- to help satisfy the increasing demand for these specialized researchers and managers in Europe;
- to enhance the knowledge transfer between academia and industry in the field of optimisation;
- to increase the employability of scientists in the field of optimisation;
- to consolidate and expand the network of collaborations in this field in Europe.

BENEFITS FOR THE SOCIETY

The MINOA team will focus on specific challenges which can be found in large systems that are subject to uncertainty and in real-time applications. The transport and energy sectors offer some good examples for such extremely challenging conditions and how they can benefit from MINOA's findings. Every day in Europe alone, more than 20,000 aircraft must be routed in such a way as to ensure on the one hand that safety distances are maintained and, on the other hand, that airspace is used optimally. Changing weather conditions is a factor that makes planning more difficult and requires a rapid response in order to determine the optimum route for each individual aircraft and thus minimise delays and kerosene consumption.
In the energy sector, system operators are faced with the challenge of managing energy supply from various sources and have to make sure that electricity networks are able to cope in real-time with fluctuating supplies from solar or wind energy sources.
Such extremely short-term decisions are made by high-performance computers based on complex mathematical calculations. The MINOA experts aim to develop new algorithms which will allow to enhance the decision quality in such situations. This will, in turn, make public services safer, faster and more efficient.
Finally, the objective is also to be able to apply the MINOA methodology and findings to other fields in the future as well.