Artelys | OPTIMIZATION SOLUTIONS

Training Program 2021

PARIS - CHICAGO - MONTREAL - BRUSSELS

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https://www.artelys.com/training/

EDITORIAL

Artelys
OPTIMIZATION SOLUTIONS

The sharing of our skills is a founding element of our company.

At Artelys, we are committed to delivering outstanding training courses.

The strong growth of our activities over the past 20 years has always been accompanied with particular attention paid to our training offer. Our training program is a way of sharing the most advanced and up-to-date knowledge, enabling our customers, partners and employees to acquire and strengthen their skills in our areas of expertise, which are focused on quantitative optimization.

We have developed our training sessions around three main themes:

- Optimization and Data Science
- Economic optimization of energy systems
- Digital components and optimization tools

Noteworthy among the new features is the fact that the Optimization and Data Science theme has been designed as a Master's level degree course.

These training courses are as always based on the skills and experience acquired by Artelys consultants and researchers in the realization of analysis models and the implementation of operational solutions in companies. They are pragmatic and practice-oriented, without dodging fundamental technical difficulties.

We look forward to welcoming you to our training courses, with a new program and a stronger ambition that will meet your expectations.

Artelys | OPTIMIZATION SOLUTIONS

Artelys is specialized in the modeling of complex systems, notably energy systems, and their optimization. It develops the associated IT tools based on the most suitable numerical technologies and an intensive use of quantitative methods combining statistics and numerical optimization, adapted to the business context of its clients.

Artelys is an approved training institution by the French Ministry of National Education (Training Organization n°11754066975). Artelys consultants, who regularly provide training sessions in numerical optimization techniques, statistical calculation and energy system management, thus have a solid pedagogical experience.

CROSS COMPANY TRAINING

- Analyzing the current state of affairs together
- Deciphering cutting-edge technology topics
- Supporting you in your professional development

INTRA-COMPANY OR CUSTOMIZED TRAINING

- Training programs tailored to your needs
- All courses in the catalog are scheduled on dates of your choice.
- The training organization in your premises everywhere in Metropolitan France and overseas.

Our training courses take place in our premises, 81 rue Saint-Lazare, 75009 Paris, France. They are situated 5 minutes' walk from the Saint-Lazare train station and 2 minutes from the Trinité d'Estienne d'Orves station (metro line 12).

Depending on the health context, we may choose to provide these training courses remotely.

5 REASONS TO CHOOSE US

- Artelys is a **European leader** in optimization and statistical analysis, energy system optimization and IT tools for decision support.
- Artelys **has more than 20 years of experience** in the organization and realization of professional training.
- **A strong commitment** of the company to the quality of the training courses delivered and the adequacy with the expectations of the participants.
- Competitive rates: our rates are degressive from the 2nd attendee of the same company.
- A special attention is paid to the comfort of our trainees: we provide binders with training material, USB key, coffee breaks, lunch

TRAINING ON OPTIMIZATION AND DATA SCIENCE

Operations Research represents one of the major fields of implementation of mathematical optimization techniques and computer science in industry. It is primarily based on the analysis of data and the search for optimal solutions to complex decision-making problems. This area plays a key role in maintaining industrial competitiveness and has made great advances in recent years. The training courses offered here in optimization and data science enable to gain and/or update the mastery of theoretical and practical tools in this field. These trainings are devoted to learning statistical analysis and data processing techniques, modeling and solving complex optimization problems (combinatorial, linear, nonlinear and stochastic) and to the design and practical implementation of adapted technologies and computer tools.

Registrations and detailed programs on: https://www.artelys.com/training/

TRAINING SCHEDULE

DATES	TITLE OF THE COURSE	PRICE € VAT EXCL.	PAGE
03/17/21 03/18/21	Introduction to linear programming	1 400	**7**
03/31/21 04/01/21	Nonlinear optimization	1 400	11
06/16/21 06/17/21	Combinatorial optimization I: integer programming	1 400	8
09/29/21 09/30/21	Combinatorial optimization II: constraint programming & local search	1 400	9
10/06/21 10/07/21	Nonlinear optimization	1 400	11
11/24/21 11/25/21	Combinatorial optimization III: relaxation & hybridization	1 400	10

Introduction to linear programming

Linear programming is an extremely powerful tool to rationalize the use of resources in increasingly complex economic systems. Recent advances in linear programming solvers allow scientists and economists to quickly implement these techniques in a large number of operational and strategic problems. The success of such approaches depends, above all, on the choices made during the modeling phase. This course will allow you to understand the principles behind linear optimization algorithms and to adopt the most efficient modeling approach.

Date: 03/17/2021-03/18/2021

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

Ability to model decision problems through linear programming and interpreting results.

Target audience

Engineers, economists, scientists and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport and logistics.

Training prerequisites

Basic skills in linear algebra (vector spaces, linear mapping, matrix operations, basic notions in affine geometry).

The training will be given in English.

Detailed program

Introduction to linear programming

- Introduction: history, set-up.
- Linear programming terminology: definitions, linear program formulation and graphical illustrations, classical reformulations.
- Notion of convexity.

Simplex algorithm

- Simplex method: principle, dictionary form, tabular form, non-degeneration and cycling, initial base. Implementation through simple examples.
- Applying linear programming to scheduling problems. Illustrating the impact of modeling on solver results.

Duality

- Duality: building a dual program, fundamental results (equality constraints and Lagrange multipliers, inequality constraints and Farkas' lemma, KKT conditions, weak duality).
- Economic interpretation of dual variables. Using dual variables to handle transportation and stock management problems.
- Post-optimality and sensitivity analysis.
- Variants of the simplex method: revised form, dual simplex.

Interior-point methods

- Interior-point methods: quality of nonlinear approaches, Karmarkar' algorithm, primal-dual interior algorithm, affine algorithm, complexity and polynomial convergence.

Using a solver

- Taking advantage of a linear programming solver: tips and tricks, and good practices (illustrations with FICO Xpress).

Combinatorial optimization I: integer programming

The discrete nature of many decision problems can lead to a so-called combinatorial explosion. Whenever avoiding such phenomena (e.g. by relaxing integrity constraints) proves to be impossible, integer programming (IP) allows to tackle a great number of combinatorial optimization problems such as those found in the domain of logistics, production management or scheduling.

Date: 06/16/2021-06/17/2021

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

Handle the discrete aspects of a decision problem with the help of integer programming (IP).

Target audience

Engineers, economists, scientists and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport and logistics.

Training prerequisites

Contents of the course 'Introduction to linear optimization'.

The training will be given in English.

Detailed program

Integer Linear Programming (ILP)

- A brief reminder of linear programming.
- Formulations: What is an integer program? Formulation of an integer linear program. Combinatorial explosion. IP formulations. Alternatives formulations.
- Optimality, relaxation and bounds: optimality and relaxation, linear relaxations, combinatorial relaxations, lagrangian relaxation, duality, primal bounds.
- Modeling techniques and illustrations.
- Solving integer linear programs with branch-and-nound.
- Principles of cutting methods and branch-and-cut. Numerical examples.

Application

- Introducing, modeling and solving a travelling salesman problem with the FICO Xpress solver.
- Introducing, modeling and solving an industrial problem with FICO Xpress.
- Comparison between a naive formulation of the problem and a formulation including cuts.

Introduction to decomposition techniques

- Introduction to decomposition techniques: illustration of the interest of column generation.
- Principles and practical interest of column generation techniques.
- Presentation of an industrial application.

Combinatorial optimization II: constraint programming & local search

Whenever integer programming (IP) turns out to be unfit for treating a combinatorial optimization problem, it might be necessary to use the problem's attributes in order to overcome it. Based on this concept, constraint programming and local search provide a formal framework for solving difficult combinatorial problems.

Date: 09/29/2021-09/30/2021

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

Treating difficult combinatorial optimization problems with the help of constraint programming and local search techniques.

Target audience

Engineers, economists, scientists and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport and logistics.

Training prerequisites

Contents of the courses:

- 'Introduction to linear optimization'
- 'Combinatorial optimization I: integer programming'

The training will be given in English.

Detailed program

Constraint programming

- Constraint programming: principles and applications.
- Presentation of a constraint programming solver: Xpress- Kalis.

Practical applications of constraint programming

- A simple staff scheduling example.
- Solving a movie scenes allocation problem.
- Solving a frequency assignment problem.
- Enumeration configuration – Branching strategies – Definition of search strategies for an advanced user.

Local Search

- Intuition (n-queens) - Neighborhood (car-sequencing, magic square) - Optimization (warehouse location) - 2-opt, k-opt
- Optimality vs. Feasibility (graph coloring) – Complex neighborhood (sport scheduling) – Escaping from local minima, connectivity.
- Formalization, heuristics – Introduction to metaheuristics: Variable neighborhood search, Simulated annealing, Tabu search.

Scheduling problems and resource management

- Introduction to scheduling problems.
- Disjunctive scheduling – application to the construction of a sports stadium.
- Multi-machines disjunctive scheduling – Jobshop problem.
- Cumulative scheduling – non-renewable resources.

Combinatorial optimization III: relaxation & hybridization

Aside from the attributes, it is possible to get around a problem by using its structure. In such a case, rather than solving a large-scale problem subject to combinatorial explosion, it is better to solve several small problems in a coordinated way: this is the principle of decomposition. In some cases, it may even be advantageous to combine combinatorial optimization techniques (IP, CP, local search) to overcome a problem particularly difficult to solve. This is the principle of hybridization.

Date: 11/24/2021-11/25/2021

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

Mastering the principles of hybridization and decomposition methods in order to solve difficult large-scale problems.

Target audience

Engineers, economists, scientists and developers interested in modeling decision problems and implementing optimization algorithms.

Presentation of trainers

Artelys consultants specialized in modeling and solving large scale optimization models applied to the domains of energy, transport and logistics.

Training prerequisites

Contents of the courses:

- ' Introduction to linear optimization'
- 'Combinatorial optimization I: integer programming'
- 'Combinatorial optimization II: constraint programming and local search'

The training will be given in English.

Detailed program

Hybridization techniques

- Linear programming / Constraint programming hybridization. Mixed modeling, common search trees, dialogueamongbranchingschemes.Usingreducedcost.
- Constraint programming / Local search hybridization. Description of neighborhoods as constrained neighborhoods. Under constraints' neighborhood exploration.

Decomposition techniques

- Principles of price decomposition and resource decomposition. Types of information exchanges. Elementary examples.
- Lagrangian. Duality. Definition and economic interpretation of the dual function. Duality gap. Convex and non-convex cases.
- Price decomposition: coordination algorithms and non-differentiable optimization.
- Benders decomposition: principles and implementation.

Applications

- Joint gas and electricity assets optimization: introduction, Benders and price decomposition.
- Example of constraint programming and local search hybridization: timetables scheduling, frequency assignment.
- Decomposition and hybridization for maintenance scheduling.

Nonlinear optimization

Nonlinear optimization arises in various domains such as energy, economy, finance, machine learning, model predictive model control. This training will enable participants to understand and practice the basics and subtleties of nonlinear optimization and to model and solve problems efficiently.

Dates: 2 sessions
03/31/2021-04/01/2021
10/06/2021-10/07/2021

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

Whichever is your application domain, this training will provide you with an introduction to the field of nonlinear optimization and will teach you how to apply nonlinear modeling techniques to industrial applications using Artelys Knitro.

Target audience

Scientists and developers interested in modeling and solving nonlinear programs using Artelys Knitro.

Presentation of trainers

Professional consultants and software developers from Artelys with years of experience in solving large-scale nonlinear problems using Artelys Knitro.

Training prerequisites

Basic knowledge in operations research and programming.

The training will be given in English.

Detailed program

Nonlinear programming (NLP)

- Introduction, presentation of the training.
- Problem statement and optimality conditions.
- Newton method for unconstrained optimization. Globalization techniques.
- Interior-point and active-set methods for constrained optimization.

Solving nonlinear problems with programmatic interfaces

- Presentation, modeling and solving a nonlinear model with Artelys Knitro in Python™.
- Impact of exact versus approximate derivatives. Quasi- Newton method.
- Using Artelys Knitro in R/MATLAB®: a nonlinear least square minimization application.

Solving nonlinear problems with modeling interfaces

- Using Artelys Knitro in AMPL: modeling syntax, automatic differentiation, examples.
- Good practices in nonlinear modeling. Tips and tricks.
- Fine-tuning Artelys Knitro parameters.
- Global optimization using parallel multi-start.

Solving nonlinear models with special features

- Mixed-integer nonlinear programming (MINLP) methods. Practical example.
- Mathematical programming with equilibrium constraints (MPEC). Application to computational economics and game theory.
- Convex non-smooth models.

TRAINING ON NUMERICAL COMPONENTS AND OPTIMIZATION TOOLS

Artelys offers on-demand training sessions on the numerical software solutions and optimization tools that its consultants use daily to solve complex issues.

- ✓ A training program tailored to your needs.
- ✓ Possibility of specific lectures during conferences and seminars.

To program an on-demand training on one of our tools or numerical software solutions described below, please contact us at training@artelys.com

1 NUMERICAL SOFTWARE SOLUTIONS

Artelys Knitro

Artelys Knitro is a numerical software component that implements advanced nonlinear optimization techniques. Its four algorithms and its numerous options allow it to offer excellent performance and great robustness when solving a variety of optimization problems. We offer on-demand training sessions that will allow you to learn how to solve nonlinear optimization problems, such as portfolio optimization, optimal network power flow, nonlinear predictive control, or Nash equilibrium models. Trusting its efficiency and robustness, hundreds of institutions worldwide have chosen Artelys Knitro to solve highly complex problems.

Artelys Kalis

Artelys Kalis is a software component for modeling and solving large scale combinatorial problems through hybrid constraint programming and mathematical programming techniques. We offer on-demand training sessions that will present the principles of constraint programming and a rapid and efficient implementation of combinatorial problems of different types: tasks and timetable scheduling, resource allocation, equipment or network configuration.

FICO® Xpress Optimization Suite

FICO® Xpress Optimization offers a complete range of modeling and numerical optimization tools. These solutions can be quickly integrated into business problems in order to provide decision-support insights into complex problems. The following are some examples of on-demand courses that we can offer:

- Logistics – Defining master plans in sectors such as transport, manufacturing, etc.
- Personnel planning – Timetabling in sectors such as aeronautics, medical, public transportation and distribution.
- Networks – Defining investment strategies in sectors such as telecommunications or electricity networks, and establishing a medium-term strategy.

AMPL

AMPL is a complete and powerful algebraic modeling language for solving linear and nonlinear problems with discrete or continuous variables. We offer on-demand training sessions that will teach you how to use generic notation and familiar concepts necessary to formulate optimization problems and to examine the possible solutions. The flexibility and the ease of use of AMPL allow for a very fast prototyping and development of models, whereas its speed and options control make it a very efficient tool for repeated use in production.

2 ARTELYS CRYSTAL SUITE

Artelys Crystal City

Today used for the elaboration of the Energy Master Plans of the Metropolises of Lyon, Grenoble, Lille, Poitiers, Metz, Tours, Orléans, Toulouse Métropole, Artelys Crystal City provides full support to territorial authorities in evaluating, monitoring and communicating their local multi-energy development plans. At the time of the energy transition, local decision-makers are confronted with new territory planning issues where the energy dimension is a key factor in the decision-making process. We offer on-demand training sessions based on the tool Artelys Crystal City allowing to treat a variety of challenges related to topics such as energy consumption, CO2 emissions reduction, coordinating the development of distribution networks and valuating local renewable production potential.

Artelys Crystal Super Grid

The energy sector of most countries is currently undergoing a rapid and deep mutation: the development of renewable energy generation technologies, interconnections, energy storage and demand-side response represents at the same time a challenge and an opportunity to rethink the way energy systems are operated and how we plan their evolution. Whether they are energy regulators, network operators, assets owners, researchers, all the actors have to evaluate the impacts of strategic choices that integrate this new energy reality. We offer on-demand training sessions based on Artelys Crystal Super Grid, providing quantitative elements to assess the costs and benefits of adding interconnection capacity between two countries or to optimize a national energy strategy using the investment planning module of Artelys Crystal Super Grid.

Artelys Crystal Forecast

In a world in constant and rapid evolution, forecasters are increasingly requested to bring to light the future and to reinforce the understanding of the business activities. Based on our expertise in data analysis and statistical modeling, our business expertise, as well as the innovative and adaptive

technologies of the suite Artelys Crystal, we offer on-demand training sessions based on the tool Artelys Crystal Forecast, in order to develop skills that will allow you to generate valuable forecasts and scenarios on short-, medium- and long-term time horizons. This training will prove especially useful in the sector of operational management and as well as in strategic planning.

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Further information and registration

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