Training Program 2022

PARIS - CHICAGO - MONTREAL - BRUSSELS

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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 a registered 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 cross-company 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
03/09/22 03/10/22	Demand Forecast with R	1400	**7**
03/16/22 03/17/22	Introduction to linear optimization	1 400	**8**
04/05/22 04/06/22	Nonlinear optimization with Artelys Knitro: from theory to practice	1 400	**15**
05/24/22	Introduction to Big Data tools and techniques	750	**12**
06/01/22 06/02/22 06/03/22	Programming with Python: Data Science Tools	1950	**13**
06/08/22 06/09/22	High performance computing and parallelization with MPI	1400	**14**
06/21/22 06/22/22	Combinatorial optimization I: integer programming	1 400	**9**
09/28/22 09/29/22	Combinatorial optimization II: constraint programming & local search	1 400	**10**
10/05/22 10/06/22	Nonlinear optimization with Artelys Knitro: from theory to practice	1 400	**15**
10/11/22 10/12/22 10/13/22	Stochastic optimization and dynamic programming: applied to energy inventory management	1950	**16**
11/02/22 11/03/22 11/04/22	Software architecture, design and integration of an optimization tool	1950	**17**
11/23/22 11/24/22	Combinatorial optimization III: relaxation & hybridization	1 400	**11**

Demand forecast models with R

Through the sales of goods or services, Demand Forecasting is one of the key challenges in operational planning and in designing facilities for the long-term. This course provides tools to master R software used in the context of demand forecasting.

Date: 03/09/2022-03/10/2022

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

- Develop skills in R software, from getting started to deploying forecasting modules.

- Gain a proven methodology for data analysis and development of a demand forecasting model.

- Learn about statistical techniques for forecasting: know the main ranges of models, their advantages and disadvantages, as well as the link with the business expertise.

Target audience

This course is intended for people who work with a set of data (e.g., business analysts) and who are looking to improve their skills with a tool that allows them to perform advanced analyses.

Presentation of trainers

The speakers are Artelys consultants with a sound knowledge of R software and issues related to demand management.

Training prerequisites

Basic knowledge of probability and statistics.

The training will be given in English.

Detailed program

Getting started with R software

- Main features and advantages.
- Description of the syntax and the most useful keywords.
- Good programming practices in R.
- Installation of the software and the working environment.

Illuminating the data and the problem

- Getting to grips with the data by visualizing the chronicles.
- From raw data to usable data (data preprocessing methods).
- Identification of the structuring characteristics of the data (numerical and graphic indicators, seasonality, explanatory factors).
- Definition of the problem, the stakes, and the quality criteria of the forecasts.

Build a relevant demand model

- Which models should be considered given the characteristics of the data? Presentation of several classical models: autoregressive models (S)AR(I)MA(X), linear models.
- Implementation of the different models with the R software.
- How to choose a good model: analysis of the quality of the forecasting results (fitting performance, generalization).

To go further

- Other types of models (frequency models).
- How to make relevant graphs (ggplot package).
- How to maintain in time your developments in R.

Introduction to linear optimization

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: 03/16/2022-03/17/2022 **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's 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: 06/21/2022-06/22/2022

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 naïve 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: 09/28/2022-09/29/2022

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

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

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 – Job shop problem.
- Cumulative scheduling – non-renewable resources.

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: 11/23/2022-11/24/2022

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, dialogue among branching schemes. Using reduced cost.
- 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.

Introduction to big Data tools and techniques

Big Data is one of the latest key issues among the challenges that face many companies. However, beyond the current trend, it is rather difficult to fully understand what Big Data is and its potential.

Dates:
05/25/2022

Location: Paris

Duration: one day training

Price: 750€ excl. taxes

Training objectives

- Understand the issues and implications of Big Data.

- Apprehend the potential applicationf of Big Data.

- Define how Big Data techniques work and how to integrate them into an existing system.

- Execute the techniques on a practical use case.

Target audience

This course is aimed at professionals conducting large databases analysis (e.g. Business Analyst), using data analysis conclusions in a decision-making context and searching for managing large-scale databases solutions.

Presentation of trainers

The speakers are Artelys Consultants with a sound knowledge of the IT and statistics techniques.

Training prerequisites

The training will be given in English.

Detailed program

Introduction
- What is Big Data? Understanding the stakes and the current context.
- History of Big Data technologies.
- Use cases.

Big Data architecture
- Challenges in choosing a Big Data architecture.
- Description of the architecture and components of the Hadoop platform. Introduction to the different types of distributed architectures.
- Introduction to the most used distributions and complementary tools (Hortonworks, Cloudera, MapR, Aster, etc.).
- How to integrate it into an existing information system.

The Big Data workflows
- Collect and import data to HDFS.
- Store / organize data (HDFS, NoSQL and SQL).
- Process data (Map Reduce, Apache Spark, PIG, ElasticSearch).
- Exploit the data

Programming with Python: Data Science Tools

Data Science is the convergence of mathematics, statistics and computer science to make the most of the information contained in data. Most Artificial Intelligence (AI) methods rely on it. Python provides the Data Scientist with all the tools needed to do scientific programming. This course places particular emphasis on the quality of the code.

Dates:
06/01/2022-06/03/2022

Location: Paris

Duration: Three-day training

Price: 1 950€ excl. taxes

Training objectives

- Understand the challenges of scientific programming

- Discover Machine Learning

- Know Python libraries for data mining and scientific computing

- Produce robust and quality Python code

Target audience

- Business Analysts
- Developers
- Statisticians

Presentation of trainers

Artelys data scientists regularly participating to customer-driven projects.

Training prerequisites

- Basic programming skills.
- Basic knowledge of data analysis and statistics.
- The training will be given in English.

Detailed program

Programming efficiently with Python

- Introduction to the language, first Python script.
- Presentation of development environments (Anaconda).
- Jupyter notebook: an efficient environment for the presentation and reproducibility of scientific results.

Fundamentals of Python programming

- Python data structures (lists, tuples, dictionaries).
- List traversal and generation (itertools, iterators, generators and comprehension lists).
- Good practices: exceptions, type checking, etc.

Code organization and quality

- Comments and cleanliness (docstring, linters, pep8, etc.).
- Modularity and reusability of code (file import, Object Oriented Programming and polymorphism).
- Algorithms and complexity.

Distribution, isolation, and package management

Introduction to scientific programming
- Scientific programming vocabulary and statistical analysis.
- Main machine learning algorithms (supervised analysis, unsupervised analysis, classification, and regression).
- The scientific stack: Numpy, Scipy, Scikit-learn, Pandas, Sympy, Matplotlib.

Descriptive statistics and data structures
- Data management with pandas: import, dataframes, slicing, mapping (reading, formats, date management).
- Visualization with Matplotlib

Machine Learning with Scikit-learn: Presentation, linear modelling and prediction, classification with Scikit-learn.

Scientific computing with Numpy: Presentation, data structure, indexing, slicing, iterating.

Scientific computing with Scipy: Overview, linear algebra, application.

The simulation of complex physical systems and large-scale problem solving require massive computing power. With the introduction of Big Data, computational performance requirement increases even more. High-Performance Computing is an essential tool for research and industry. This course will focus on cluster implementation.

Dates:
06/08/2022-06/09/2022

Location: Paris

Duration: Two-day training

Price: 1 400€ excl. taxes

Training objectives

- Introduce HPC on distributed architecture's fundamental principles and good practices.

- Master the use of MPI library.

- Practical application with well-known examples (research and industry).

Target audience

Engineers and researchers aiming to use HPC and gain initial experience.

Presentation of trainers

The speakers are Artelys engineers with in-depth expertise in using HPC.

Training prerequisites

- Basic knowledge of scientific computing, Python and computer systems.
- The training will be given in English.

Detailed program

Presentation of High-Performance Computing
- Main issues and necessity of parallelization.
- Examples of applications.
- Hardware and software components of High-Performance Computing (processors, memory, applications allowing the implementation of parallelization on the hardware).
- Measurement of computational performance and improvement techniques.
- Introduction to parallelism performance indicators.

Architecture of HPC systems

- Shared memory architecture.
- Distributed memory architecture.
- Hybrid architectures.

High-performance architecture management systems: Scheduling and Load-balancing with SGE

Implementation of parallelization
- Concepts of message exchange. Programming interfaces.
- Parallel computing in MPI (Message Passing Interface).
  - MPI-1: Number of processes, process number. Point to point communications. Collective communications. Communicators. Topologies.
  - MPI-2: Dynamic process management. Parallel I/O. Memory to memory communication.
  - Libraries and interfaces.

Nonlinear optimization with Artelys Knitro: from theory to practice

Nonlinear optimization arises in various domains such as energy, economy, finance, machine learning, model predictive 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
04/05/2022-04/06/2022
10/05/2022-10/06/2022

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.

Stochastic optimization and dynamic programming: applied to energy inventory management

Inventory and financial assets management-related decisions are closely connected. One is often seeking for balance between instant profit and future gains. This course shows how dynamic programming can model similar issues.

Dates:
10/11/2022-10/13/2022

Location: Paris

Duration: Three-day training

Price: 1 950€ excl. taxes

Training objectives

This course will include stochastic optimization problem modeling and processing with dynamic programming and derivative techniques.

Target audience

Anyone aiming to discover stochastic optimization through dynamic programming.

Presentation of trainers

The speakers are Artelys consultants with in-depth expertise in industrial problem-solving and teaching at universities and schools.

Training prerequisites

- Basic knowledge in optimization.

- The training will be given in English.

Detailed program

Deterministic Dynamic Programming

- Introduction.
- Deterministic dynamic programming: principles. Transition equation, state, Bellman values. Shortest path problems. Management of production unit start-ups.
- Bellman values and dual variables. Economical interpretation of Bellman values. Inventory management case. Link with dual variables.

Stochastic dynamic programming

- From deterministic to stochastic. Modeling a dynamic stochastic optimization problem. Non-Anticipativity constraints. Dynamic programming on scenario trees. Application to option pricing.
- Dynamic stochastic programming. State definition and probabilistic structure. Examples of modeling. Bellman values economic interpretation. Valuation of future contracts.

Stochastic dynamic programming (continued)

- Inventory management and dynamic programming: some examples. Modeling and effects on Bellman functions.
- Large dynamic problems. Limits of dynamic programming for large problems.
- Decomposition methods: dual dynamic programming, scenario decomposition, scenario tree method.
- Processing large dynamic problems: application to annual electricity production planning. Dynamic management modeling of interconnected systems in the energy sector. Resolution by decomposition. Solving by dual dynamic programming.
- Links with reinforcement learning.
- Sampling and generalization techniques.
- Dynamic learning and optimization schemes.

Training wrap-up

Software architecture, design and integration of an optimization tool

Technical decisions related to the development, architecture, and integration of software have a strong and lasting impact on its costs, quality, and performance. Quantitative decision support modules have specific computing features that require heavy machine resources (RAM and CPU) and complex data management. As a result, their architects require specific skills.

Dates:
11/02/2022-11/04/2022

Location: Paris

Duration: Three-day training

Price: 1950€ excl. taxes

Training objectives

- Introduce fundamental principles and good practices of HPC computation on distributed architecture.

- Understand the inherent stakes and difficulties involved in the design and integration of a decision support software through practical examples.

- Understand technologies used as well as their vocabulary.

Target audience

- Architects, project managers, or technical experts aiming to grasp the specificities of quantitative computational function-based solutions.

- Decision support engineers aiming to expand their skills in computer science and software integration.

- Any developers involved in working on complex IT development projects.

Presentation of trainers

Artelys engineers specialized in the implementation of operational solutions for quantitative decision support and experts in IT and software design.

Training prerequisites

The training will be given in English.

Detailed program

Software Design
- Software quality factors.
- Code maintenance and maintainability.
- Unit tests and Test-Driven Development method.

Design Patterns
- General introduction.
- Gang of Four Design patterns in-depth study.
- Anti-Patterns.

Data structure options
- Introduction to computational complexity.
- Data collection and linkage structures

Introduction to development tools
- Version control system, code review (examples: Git, Gerrit, Sonar).
- Continuous integration platform (Jenkins).
- Software integrator (Maven).
- Project manager (Redmine).
- Be able to use your IDE.
- Additional tools (Meld, unix/grep, etc.).

Designing an integrated decision support solution
- Fundamentals and issues.
- Technology options.
- Notion of highly cohesive low coupling.

Foundations and technologies of software architecture
- Architecture, SaaS solutions, remote computing.
- Data exchange methods and dedicated tools.
- Technical base of solutions, application containers, hosting.
- Interfacing a calculation engine in synchronous, asynchronous or hybrid mode.
- Achieve a downgraded mode.

Approach to conduct these projects
- V-cycle, agility, spiral or iterative development.
- Standard solutions, examples of architectures, and critical analyses.

Training on Economic optimization of energy systems

Artelys offers on-demand training sessions on economic optimization of energy systems based on the experience of our consultants.

  ✓   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

Energy systems economics

The European electricity sector has undergone significant and drastic changes for several years. These changes include evolving consumption patterns, growth of peak electricity demand, dramatic decline of the costs of renewable power plants, increasingly ambitious CO2 emission reduction targets, sector integration strategies, ambitious development plans for electrolytic hydrogen, etc. We offer a tailored training course on these evolutions in the energy sector and present the avenues proposed by national and European public institutions to tackle them: reform of support mechanisms for renewable energies, integration of markets (day ahead, capacity, CO2 quotas) at European level and strengthening of interconnections between countries.

Electricity market organization in Europe

The electricity markets address needs that correspond to specific time horizons: long-term via OTC, reserve and capacity markets, at the daily level for day-ahead markets and some reserve markets, on the same day for intraday markets, in real-time for balancing markets. We offer a training course that gives an overview of these different markets and an understanding of their relevance for the electricity system. We offer a focus on the way they are organized in Europe (by presenting the case of European market coupling and European balancing platforms). Practical work will be carried out in order to illustrate the economic and legal descriptions, by studying in particular what the expected valuation by a producer on each of the markets in France can be.

Energy transition and Smart Grids

The energy transition will transform the way the electricity system is operated. The traditional situation that consists in electricity flowing from large generation groups to end-users is profoundly evolving due to decentralized production and new consumption practices (electric vehicles, load shedding, etc.). We propose a training course which focuses first on energy markets, operation of the transmission and distribution networks, principles of frequency and voltage control. A second part will

then be devoted to the future challenges that can be tackled with smart grids, with particular emphasis on the case of self-consumption and the local challenges of managing flexibilities (via technological and market design solutions).

Risk management and energy systems

The key topics include forecasting and risk issues specific to the energy sector, as well as the most suitable methods for dealing with such risks. This training course introduces the general concepts of risk management (e.g. Value-at-Risk, Stress-Testing) and its application to the specific case of energy systems, by recalling in particular certain risk hedging tools (long-term contracts, options, etc.). It also provides details on the various aspects of rigorous stochastic modeling and methodological approaches that facilitate the estimation and reduction of risk in an uncertain environment. Concrete examples from real-world problems encountered by practitioners in the energy world will facilitate the understanding and assimilation of the concepts.

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 Suite 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, CO_2 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 knowledge, 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 as well as in strategic planning.

Artelys

OPTIMIZATION SOLUTIONS