



SAS/OR® Software

Optimize business processes and address management science challenges with enhanced operations research methods

What does SAS/OR® software do?

SAS/OR software provides a powerful array of optimization, project scheduling and simulation techniques to identify the actions that will produce the best results, while operating within resource limitations and other relevant restrictions.

Why is SAS/OR® important?

SAS/OR enables organizations to consider more alternative actions and scenarios, and determine the best allocation of resources and the best plans for accomplishing goals. Incorporating operations research analytics not only adds structure and repeatability to decision-making processes, but also better utilizes your BI investments and delivers a competitive edge.

For whom is SAS/OR® designed?

SAS/OR is designed for people in any industry with operations research or management science experience who build decision-guidance models by applying operations research techniques to solve real-world problems.

Choosing the actions that produce the best outcomes requires the ability to create, consider and evaluate alternate scenarios. SAS/OR software helps model, solve and communicate the best solutions to complex planning problems more quickly and more easily than ever before.

SAS/OR brings together essential optimization, scheduling, simulation and related modeling and solution capabilities in an integrated and adaptable environment. These capabilities are supported and complemented by the strengths of SAS® in data access and integration, analytics and reporting.

Customers worldwide use SAS/OR software to solve planning problems and address business challenges such as:

- Resource allocation and management.
- Production and inventory planning.
- Product mix and blending.
- Staffing allocations.
- Distribution, routing, scheduling and traffic flow.
- Supply chain management and optimization.
- Capital budgeting, asset allocation and portfolio selection.

Key benefits

- **Unparalleled breadth of operations research capabilities.** SAS/OR offers the broadest available spectrum of operations research modeling and solution techniques, and includes state-of-the-art advancements in mathematical optimization. The depth of detail and realism in SAS/OR software's modeling capabilities, control of optimization and scheduling processes, and integrated approach to data access and information delivery enable organizations to identify and distribute the best answers to complex planning problems.
- **An interactive modeling and solution environment.** SAS/OR lets you build models interactively, modifying constraints or variables and experimenting easily with the effects of changes to underlying data. In mathematical optimization, a specialized modeling language enables you to work transparently and directly with symbolic problem formulations, and an appropriate solution method for the business scenario can be automatically chosen. This allows problems to be formulated and solved intuitively and efficiently whether they are linear, nonlinear or quadratic.
- **Incorporate more data, more easily.** With SAS/OR it is easy to indicate where and how input data will be used in a model. Data/model separation is maintained, which is critical when reusing models or model components. Users can select the aspects of the solution to be reported and can control the form in which they are reported.
- **Faster response times for large, complex models.** Accelerated solution methods with faster solvers generate quicker answers to large, real-world problems.



Product overview

With SAS/OR, modelers transform real-world scenarios into mathematical expressions. When altering models to better reflect the key elements of business problems, they can consider various options, leveraging essential modeling, optimization and scheduling capabilities from within the SAS Enterprise Intelligence Platform.

All SAS/OR capabilities are surfaced within a common language and use a common data format, which allows analysts to seamlessly utilize data mining, data cleansing, forecasting, experimental design, Monte Carlo simulation or any of the hundreds of statistical functions offered by SAS Analytics, and avoid the hassles of dealing with multiple niche software packages.

Operations research is never performed in isolation; it is part of a continuum that begins with data integration, grows by

informing decision makers with descriptive and predictive analytics, and builds on those analyses to deliver proactive decision guidance.

Mathematical optimization

SAS/OR contains sophisticated mathematical programming techniques that can help determine the best use of limited resources to achieve objectives. It provides:

- Algebraic, symbolic optimization modeling that transparently represents model formulations.
- A single modeling language for linear, integer, mixed-integer, nonlinear and quadratic programming.
- Powerful optimization solvers and presolvers.
- An interactive mathematical modeling and solution environment.

Algebraic, symbolic optimization modeling language

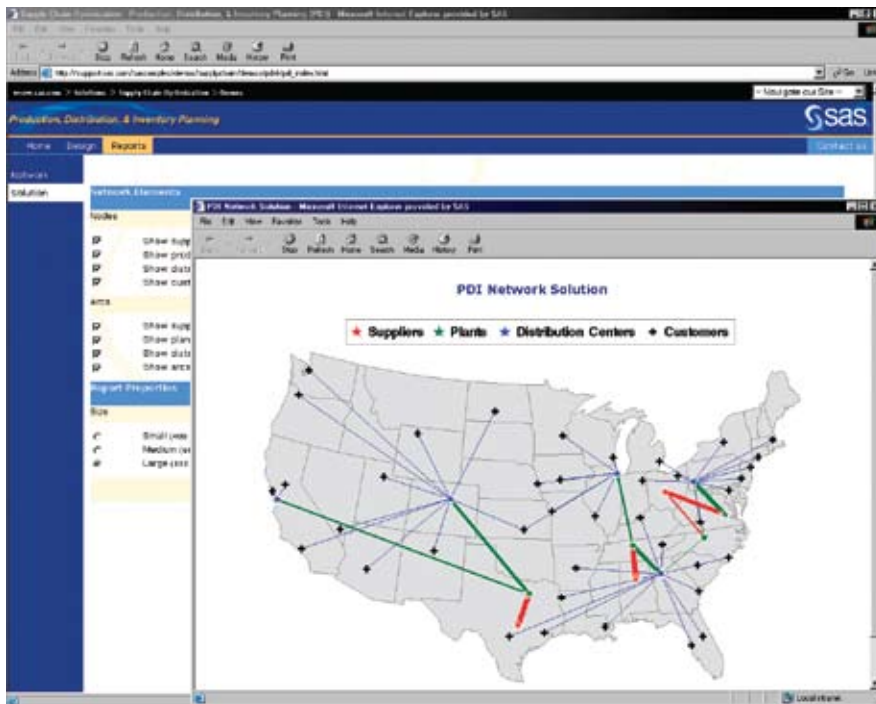
SAS/OR offers a new OPTMODEL procedure that provides a rich optimization modeling language with specialized syntax and constructs that enable formulated problems to be represented directly and efficiently in SAS. This makes it easier to review models for initial validation, make subsequent adjustments or run models with new data. This portability is critical if optimization models are to be distributed for use across many departments or divisions, or if senior analysts retire or are reassigned and must pass planning models to their junior counterparts to carry on with implementation and/or adaptation for future scenarios.

Linear, integer, mixed-integer, nonlinear and quadratic programming

SAS/OR users need to learn only one set of commands to build and solve a wide range of optimization models. Optimization models often evolve during the implementation process, and as analysts adjust their formulations to address slightly different business cases, constraints and/or the objectives can change from linear to nonlinear expressions and vice versa. With SAS/OR, users don't have to worry about switching modeling environments or calling different procedures to use appropriate solution algorithms.

Powerful optimization solvers and presolvers

Completely new solvers have been developed, streamlined for simplicity and tuned for quantum reductions in the time needed to find optimal solutions. This enables you to tackle even larger enterprise and resource planning problems and solve them more quickly. High-performance solvers include primal simplex, dual simplex, and interior-point algorithms, as well as mixed-integer and quadratic programming solvers.



SAS/OR software's powerful production and distribution optimization capabilities are displayed in a Web-based demonstration.

Interactive modeling and solution environment

In the OPTMODEL language you can modify your optimization model interactively, dropping or restoring constraints, fixing or unfixing decision variables at specified values, or altering the underlying data. This enables you to try out different versions of the same model and experiment easily with the effects of changes. Intermediate solutions can be saved for use in future optimizations. All aspects of intermediate and optimal solutions are fully accessible for examination, analysis and reporting.

Network flow optimization

Constrained network flow models are used in a variety of settings, including production, distribution and financial applications. SAS/OR enables organizations to solve problems such as determining minimum-cost or maximum-cost flow, shortest or longest path, or maximum flow through a network. Network models are common in supply chain manufacturing and transportation situations with a node and arc structure. Nodes represent physical/temporal locations, and arcs denote the transfer of key commodities between nodes (between physical locations and/or between time periods). With SAS/OR, extremely complex network flows can be modeled to represent supply, demand, inventory and transshipment scenarios.

Project and resource scheduling

SAS/OR software's project management capabilities give you the flexibility to plan, manage and track project and resource schedules through a single integrated system. The software is adept at handling complicated situations involving multiple project record keeping, resource priorities, complex project and resource calendars, substitutable resources with skill pools, multiple and nonstandard precedence relationships, and activity

deadlines. Single- and multi-project schedules can be easily created and updated, incorporating structural, time and resource constraints. Inputs to the scheduling process include hierarchical project structures, resource requirements, and work shift/calendar/holiday information for activities and resources. Both replenishable and consumable resources are supported, and resources can be assigned in teams as needed. Extensive control over the scheduling process is provided. Output includes detailed project schedules and profiles of resource usage and availability across project time lines. Graphics include Gantt charts and network diagrams.

Earned Value Management analysis

SAS/OR includes new Earned Value Management capabilities that enable you to track, analyze and predict the cost and schedule performance of projects in progress. By comparing actual vs. scheduled work and expenses, SAS computes metrics describing the budget impacts of current deviations from original plans and generates insightful projections of final costs.

Decision analysis

Decision trees help structure decision-making processes under uncertain conditions by enabling you to examine and compare all possible outcomes. In input data sets you describe the problem structure, the probabilities of various outcomes and the associated payoffs. SAS/OR analyzes the decision problem, incorporates your attitude toward risk and utility, and identifies an optimal decision strategy.

Bill of materials processing

Bills of materials are used in production environments to detail the relationships linking parts and materials, subassemblies, assemblies and finished products. SAS/OR performs bill of material processing, reading product and compo-

nent structure data and composing the information into single-level, multi-level and indented bills of materials. Summarized reports show quantities of all items needed to fill orders for finished goods. These capabilities can work in conjunction with SAS/OR software's project scheduling features to determine the impact of parts availability on production and delivery schedules.

Discrete event simulation

SAS/OR provides a graphical modeling environment for discrete event simulation, which is used to model, study, plan and improve systems where random events play a significant role. The QSIM application features prebuilt sampling, queuing and timing components that speed the process of building accurate, detailed simulation models. Built-in animation helps with monitoring and debugging as you explore a range of "what if" scenarios. The new, experimental SAS Simulation Studio application expands these abilities with the addition of a new graphical modeling interface, organized methods for exploring the effects of parameters on system performance and many other improvements.

Genetic algorithms and constraint programming

SAS/OR includes two new options for those eager to try new approaches to tough problems. Genetic algorithms apply principles of natural selection and evolution in working with groups of solutions to optimization problems. Constraint programming builds solutions to constraint satisfaction problems—constraints only, with no objective—by choosing values for individual solution elements and tracking each choice's effect on allowable values for the remaining elements.

SAS/OR® Software Technical Requirements

Supported platforms

- AIX: Version 5.3 and Version 6.1 on POWER architectures
- HP-UX PA-RISC:
HP-UX 11iv2 (11.23), 11iv3 (11.31)
- HP-UX Itanium: HP-UX 11iv2 (11.23), 11iv3 (11.31)
- Linux for x86 (x86-32): RHEL 4 and 5, SuSE SLES 9 and 10
- Linux for x64 (EM64T/AMD64):
RHEL 4 and 5, SuSE SLES 9 and 10
- Microsoft Windows (x86-32):
Windows XP Professional, Windows Vista*, Windows Server 2003 family
- Microsoft Windows on x64 (EM64T/AMD64):
Windows XP Professional for x64, Windows Vista* for x64, Windows Server 2003 for x64
- Microsoft Windows (on Itanium):
Windows Server 2003 for Itanium-based systems
- OpenVMS for HP Integrity Servers (Itanium): 8.3
- Solaris on SPARC: Version 9, 10
- Solaris on x64: Version 10
- z/OS: V1R7, V1R8, V1R9 and higher

* NOTE: Windows Vista Editions that are supported include Enterprise, Business and Ultimate.

Required software

- Base SAS®
- SAS/GRAPH® for Gantt charts, network diagrams and decision trees

Key Features

Mathematical optimization

- New OPTMODEL family of procedures provides:
 - Use of industry-standard MPS/QPS format input data sets.
 - Flexible syntax for intuitive model formulation.
 - Support for the transparent use of standard SAS functions.
 - Direct invocation of linear, nonlinear, quadratic and mixed-integer solvers.
 - Support for the rapid prototyping of customized optimization algorithms.
- Aggressive presolvers to reduce effective problem size.
- Linear programming solvers:
 - Primal simplex and dual simplex.
 - Iterative interior-point.
- New branch-and-bound integer and mixed-integer programming solver with cutting planes and primal heuristics.
- Continued support for the original LP (linear and mixed-integer programming) procedure.
- General nonlinear programming solvers:
 - Unconstrained: LBFGS, Fletcher-Reeves, Polak-Ribiere.
 - Constrained: conjugate gradient, Newton-Raphson, trust region.
 - Nonlinearly constrained: SQP.
- Quadratic programming with state-of-the-art solver tailored for large-scale optimization.
- Network flow optimization: shortest path, maximum flow, minimum cost flow.
- Genetic algorithms for local search optimization.

Project and resource scheduling

- Critical Path Method and CPM-based resource-constrained scheduling.
- Calendars, work shifts and holidays for determining resource availability and schedules.
- Full support for nonstandard precedence relationships.
- Ability to include PERT estimates of duration.
- Versatile reporting, customizable Gantt charts and project network diagrams.
- New Earned Value Management analysis.
- Decision analysis:
 - Create, analyze and interactively modify decision tree models.
 - Customize utility functions, including risk aversion/tolerance.
 - Calculate Value of Perfect Information (VPI) and Value of Perfect Control (VPC).
- Bill of materials (BOM) processing:
 - Reads from standard product structure data files and part master files, or combined file.
 - Accounts for lead times, lead time offsets, scrap factors, quantities on hand.
 - Produces single- or multi-level bills of material, including indented and summarized BOM.
 - Produces summarized parts, listing items and quantities required to meet the specified plan.
- New constraint programming capabilities*.

Discrete event simulation

- Versatile, graphical modeling capabilities; create and save custom components.
- Model animation for validation and debugging.
- Ability to save models as SAS data sets.
- Wide variety of sampling distributions.

* Denotes experimental status with SAS/OR 9.2. The experimental capability designation refers to a preliminary version that is released in order to get user feedback. It has not received the level of testing that SAS deems necessary for software to be called "production."



THE
POWER
TO KNOW.

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