

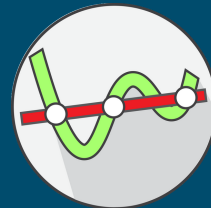


EMPOWERING INNOVATION



BARON

Branch-and-Reduce
Optimization Navigator



ALAMO

Automated Learning of
Algebraic Models



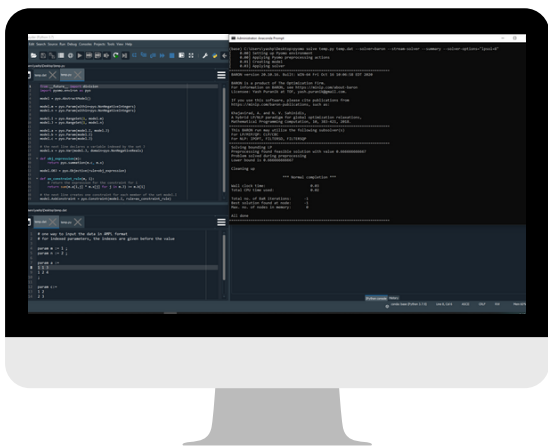
The Most Advanced Solver for Global Optimization

The BARON solver enables users to input their most difficult optimization problems as mathematical models. Proven to be the best solver for mixed-integer nonlinear programming, BARON automatically considers trillions or even infinite solution possibilities to find the best one.

Our worldwide developers have, on average, doubled MINLP performance with each major BARON release over the last 20 years. Today, more than 600 universities and 100+ companies use BARON for its' fast and accurate solutions.

Besides its robust performance, BARON comes with various familiar interfaces, including Python, Julia, MATLAB, AIMMS, AMPL, and GAMS.

BARON allows you to deploy your model wherever and however you want. One user can solve multiple models on multiple machines.



The Best Solver for Mixed-Integer Nonlinear Programming

Benchmarks consistently show that BARON is the fastest and most robust global optimization solver. A 2017 [academic study](#) found that BARON is 3-10x faster than other MINLP solvers and solves between 20% and 300% more problems. A 2021 [academic study](#) found that BARON is consistently ahead.

Advanced Algorithms

- ✓ Deterministic branch-and-reduce exploiting tight convex relaxations
- ✓ Cutting planes
- ✓ Efficient domain reduction techniques
- ✓ Parallelism and heuristics

***Learn more at minlp.com/baron-publications**

Solves All Major Problem Types

- ✓ Linear programming (LP)
- ✓ Nonlinear programming (NLP)
- ✓ Mixed-integer programming (MIP)
- ✓ Mixed-integer nonlinear programming (MINLP)

Outstanding Support

We provide direct access to PhD-level optimization experts to ensure that your needs are swiftly addressed.

Consulting Services

When needed, our developers provide model development and tuning to deliver thoughtful, efficient solutions and recommendations for your business problems using their deep expertise with the BARON solver.

Contact us at sales@minlp.com for a free initial consulting session to determine if we can help.

BARON Licenses

All BARON licenses allow unlimited simultaneous uses on any combination of MATLAB, YALMIP, JuMP, Pyomo, or BARON's native modeling language. All users can run BARON on any number of computers, jobs, and operating systems.

Please email sales@minlp.com for your licensing or consulting needs.

Academic Licenses	Price (USD)
Single-user license	\$250 monthly, \$500 annual, \$700 perpetual
Ten-user license	\$750 monthly, \$1,500 annual, \$2,100 perpetual
Department license	\$1,500 monthly, \$3,000 annual, \$4,200 perpetual
Campus license	\$3,000 monthly, \$6,000 annual, \$8,400 perpetual

Commercial Licenses	Price (USD)
Single-user license	\$875 monthly, \$1,750 annual, \$3,500 perpetual
Ten-user license	\$2,625 monthly, \$5,250 annual, \$10,500 perpetual
Enterprise (company-wide) license	\$26,250 monthly, \$52,500 annual, \$105,000 perpetual

Multi-user licenses: Multi-user licenses are required if more than one person will use the code at a time.

Free licenses: Licenses are free for the DOE, CAPD, or individuals affiliated with Carnegie Mellon University, the University of Illinois at Urbana-Champaign, or the University System of Georgia with a valid corresponding institutional email address.

Perpetual Licenses: Perpetual licenses do not expire and include Maintenance and Support for the first year after the purchase of the software. After the first year, the optional annual fee for Maintenance and Support is 20% of the list price for all licenses.

License Agreement: The [BARON End-User License Agreement](#) governs our licenses.

BARON Applications

BARON has helped optimize various business functions, including production, finance, marketing, innovation, and human resources.

Optimizing portfolios

Cui, X., Zhu, S., Sun, X., & Li, D. (2013). Nonlinear portfolio selection using approximate parametric Value-at-Risk. *Journal of Banking & Finance*, 37(6), 2124-2139.

Value-at-Risk (VaR) is an important risk measure in portfolio selection. The VaR of a portfolio is, in general, nonconvex and results in multiple local optima in the problem of minimizing the VaR of portfolios. Researchers used BARON to solve a nonconvex polynomial program to help generate solutions for an optimal portfolio.

Covid-19 management

Péni, T., Csutak, B., Szederkényi, G., & Röst, G. (2020). Nonlinear model predictive control with logic constraints for COVID-19 management. *Nonlinear Dynamics*, 1-30.

Researchers modeled the current problem of Covid-19 management as a nonlinear model predictive control problem. This control problem is an optimization problem that seeks the best cost-effective interventions to suppress the disease. BARON helped solve this optimization problem in detailed simulation studies to provide insights and validate actual government responses.

Solar power

Peng, X., Root, T.W., Maravelias, C.T. (2019) Optimization-based process synthesis under seasonal and daily variability: Application to concentrating solar power. *AIChE Journal*. 16458.

Engineers developed an optimization-based framework for process synthesis and used it to help design concentrated solar power plants with thermochemical energy storage. The main challenge with modeling the synthesis of flexible chemical processes is that as the number of possible scenarios increases, the models quickly become challenging. BARON solved an MINLP optimization model that helped engineers formulate a computationally efficient model and discover a better design.



Among the currently available solvers, BARON is the fastest and most robust one.

Mathematical Programming

BARON Version 23.5.23



BARON continues to push solver performance with expanded capabilities, new features, and impressive speedups in version 23.5.23.

Performance improvements

- ✓ Enhanced facilities for quadratic programs
- ✓ Enhanced facilities for integer presolve
- ✓ Now available for Mac OSX ARM processors (with continued support for Intel processors on Windows, Linux, and Mac OSX)

```
BARON version 23.5.23. Built: WIN-64 Tue May 23 18:09:39
BARON is a product of The Optimization Firm.
For information on BARON, see https://minlp.com/about-ba
No BARON license file found in user PATH. Continuing in
Model size is allowable within BARON demo size.

If you use this software, please cite publications from
https://minlp.com/baron-publications, such as:

Khajavirad, A. and N. V. Sahinidis,
A hybrid LP/NLP paradigm for global optimization relaxat
Mathematical Programming Computation, 10, 383-421, 2018.
=====
This BARON run may utilize the following subsolver(s)
For LP/MIP/QP: CLP/CBC
For NLP: IPOPT, FILTERSQP
=====
Starting solution is feasible with a value of -3.00000
Doing local search
Preprocessing found feasible solution with value -6.6666
Solving bounding LP
Problem solved during preprocessing
Lower bound is -6.66667

calculating duals

*** Normal completion ***
```

Download

You can download BARON Version 23.5.23 from minlp.com/baron-downloads.



ALAMO

A Novel Machine Learning Software

ALAMO (Automated Learning of Algebraic Models) allows anyone to build algebraic models from data and first principles while ensuring that those models are accurate and as simple as possible.

ALAMO is the only software capable of imposing physical constraints on machine learning models, enabling users to build accurate models from small datasets. ALAMO was the focus of a \$100 million DOE program that involved five DOE national labs and won a 2016 R&D 100 Award.

Users from 200+ universities and 50+ companies are turning data into real insights with ALAMO. To date, ALAMO has been used by hundreds of engineers and data scientists in industries, including automation, chemicals, and pharmaceuticals.



Powerful Black-Box Modeling

Results show that the ALAMO methodology is superior to other competing methods like the LASSO and ordinary regression. A 2015 academic study comparing ALAMO models to LASSO models shows, on average, that ALAMO models are simpler while maintaining a higher accuracy.

Novel Algorithms

- ✓ Constrained regression
- ✓ Adaptive Sampling
- ✓ Low discrepancy initialization

***Learn more at minlp.com/alamo-publications**

Meaningful Models

- ✓ Simple models
- ✓ Minimal data
- ✓ Accurate predictions
- ✓ Real insights

Ease of Use

ALAMO allows you to build your model with unlimited problem size and unlimited simultaneous users. Run ALAMO on any hardware configuration, operating system, or cluster. Technical support included.

Common Applications

ALAMO has been used to model industrial processes, including optimal syngas production, learning steam properties, and production of H₂ and methanol.

Try ALAMO

Get a month-to-month license to try ALAMO for minimal cost on your PC or Mac.

Visit www.minlp.com/alamo-licenses to get your license.

ALAMO Applications

ALAMO is a powerful machine learning software used by over 600 engineers and data scientists in industries including automation, chemicals, pharmaceuticals, computer software, and manufacturing.

Waste tire system design

Subramanian, A. S., Gundersen, T., & Adams II, T. A. (2021). Optimal design and operation of a waste tire feedstock polygeneration system. *Energy*, 119990.

Researchers presented the optimal design and operating conditions for a polygeneration system that produces electricity, fuels, and chemicals from waste tires. ALAMO generated the surrogate models as algebraic functions that related the state variables of the unit operation (i.e., mass, heat, and work-flow rates) to key decision variables. The models provided insights into how to adjust operating conditions in the design of waste tire systems to maximize profitability.

Refinery planning

Zhang, L., Yuan, Z., Chen. (2021). Refinery-wide planning operations under uncertainty via robust optimization approach coupled with global optimization. *Computers and Chemical Engineering*, 107205.

Engineers used ALAMO to generate explicit low-complexity and accurate surrogate models from industrial and simulation data sets that optimized refinery-wide planning operations under product demand and pricing uncertainties. ALAMO efficiently simplified the overall optimization model while guaranteeing accuracy and boosting overall profit.

Ethylene and propylene plants

Pedrozoa, H.A., Rodriguez Reartes, S.B., Vecchiotti, A.R., Diaz, M.S., Grossmann, I.E. (2021). Optimal design of ethylene and propylene coproduction plants with generalized disjunctive programming and state equipment network models. *Computers and Chemical Engineering*, 107295.

Chemical engineers proposed a superstructure optimization approach for designing an ethylene and propylene coproduction plant. They used ALAMO to develop a surrogate model for a reactor based on a rigorous model. ALAMO's surrogate model proved accurate and agreed well with data from the rigorous model in this application.

ALAMO Licenses

All users can run ALAMO on any number of computers, jobs, and operating systems. There are no limits on data size.

Note to academics: all academics with an existing university email address get free licenses for research and educational use.

Please email sales@minlp.com for your licensing or consulting needs.

Commercial Licenses	Price (USD)
Single-user license	\$200 monthly, \$1,000 annual, \$5,000 perpetual
Ten-user license	\$600 monthly, \$3,000 annual, \$15,000 perpetual
Site license (unlimited users)	\$2,000 monthly, \$10,000 annual, \$50,000 perpetual

Multi-user licenses: Multi-user licenses are required if more than one person will use the code at a time.

Free licenses: Licenses are free for all academics, CAPD members, and the U.S. Department of Energy with a valid corresponding institutional email address.

Academic licenses: Academic licenses can only be used at universities or other educational institutions for research purposes, not commercial applications. The email address of the end-user needs to show evidence of academic affiliation.

Perpetual Licenses: Perpetual licenses do not expire and include Maintenance and Support for the first year after the purchase of the software. After the first year, the optional annual fee for Maintenance and Support is 20% of the list price for all licenses.

Delivery: We deliver the license files via email. You can download the software itself from our ALAMO Downloads page.

License Agreement: The [ALAMO End-User License Agreement](#) governs our licenses.

EMPOWERING INNOVATION



www.minlp.com > sales@minlp.com