

Editor's note: This is another in a series of articles profiling members of the INFORMS Roundtable.

Gurobi Optimization

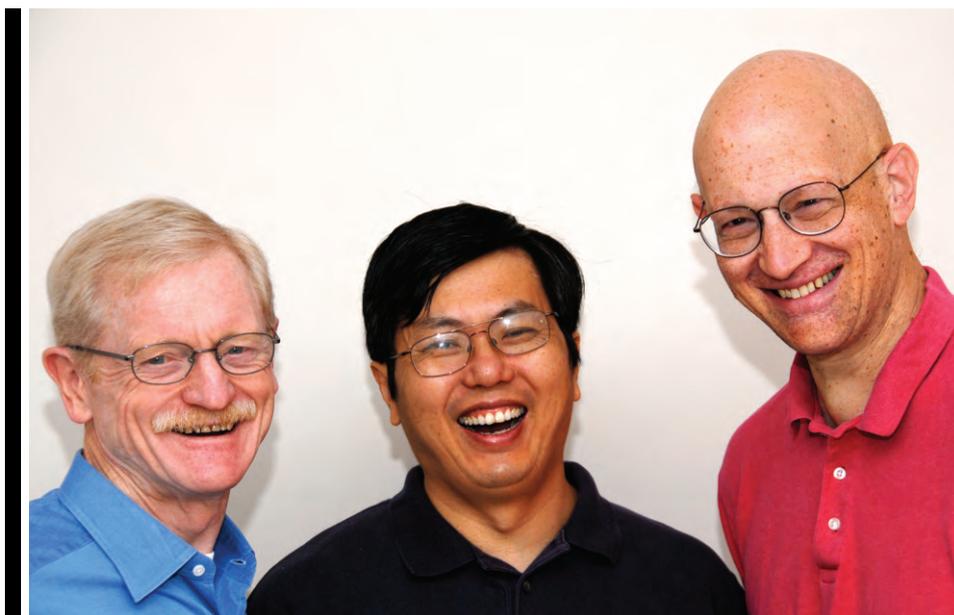
Three founders strive to build a different kind of optimization software company.

It is often said that the more focused a company is on doing one thing really well, the better it will be at doing it. That is especially true in the optimization space, given the highly technical math and programming skills required to create and improve a world-class solver, and the specialized skill sets required to provide the sophisticated support its users sometimes require.

By building an independent company, free from competing priorities, staffed by recognized experts in the industry, and focused squarely on helping users succeed with optimization, Gurobi has gone from being the new company in the industry to being a recognized leader in just five years.

Bob Bixby, Zonghao Gu and Ed Rothberg founded Gurobi in 2008. Gurobi builds, sells and supports a math-programming engine for solving linear programming and mixed-integer programming problems. Gurobi provides the tools that do the “heavy lifting” associated with modern optimization applications. In case you were wondering, the company name is derived from the first two letters of the founders’ last names (gu-ro-bi).

In the five years since the company was founded, Gurobi has grown from three founders with a vision for a better way to sell optimization software into an international business. In addition to its U.S. operation based in Houston, the company has a German subsidiary that serves the German-speaking countries of Europe, as well as exclusive distributors in Japan and Korea. Gurobi customers now span the globe, with users on every continent.



Gurobi founding fathers: Bob Bixby, Zonghao Gu and Ed Rothberg (l-r).

The Founders

The three Gurobi founders have extensive track records in the field of computational optimization. With more than 50 years of combined experience, they’ve built the optimization products that power the vast majority of commercial applications that use linear and mixed-integer programming.

Robert Bixby has a Ph.D. in operations research from Cornell University. He co-founded CPLEX Optimization in 1988 and developed the initial versions himself, and subsequently built and led the team that produced the technology and market leader in the optimization software space. CPLEX was purchased by ILOG in 1997, and Bixby stayed on at ILOG in the role of CPLEX Development Team manager,

president of the ILOG Technical Advisory Board and finally general manager of ILOG’s Semiconductor Business Division.

Zonghao Gu has a Ph.D. in industrial engineering from the Georgia Institute of Technology. He is one of the world’s leading experts in the field of computational optimization, and is particularly well known for his expertise in the area of cutting planes for mixed-integer programming. He has extensive experience in the commercial solver business. He worked for LINDO Systems from

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All About the Roundtable

1995 to 1998, and joined the CPLEX R&D team in 1998. He led the CPLEX R&D team from 2005 through 2008.

Edward Rothberg has a Ph.D. in computer science from Stanford University. He is one of the world's leading experts in the field of computational optimization, and is particularly known for his expertise in the areas of sparse linear algebra and mixed-integer programming heuristics. He joined the CPLEX Development Team in 1997, and subsequently led the team as senior director of CPLEX R&D from 1998 through 2005.

Founding Principles

As noted earlier, Gurobi Optimization was founded on the principle that a company that is focused on the business of optimization can do a better job of serving the needs of optimization users. This principle has served to define the Gurobi business model in a number of different ways.

First, the Gurobi founders believed that even though optimization technology had made remarkable progress in performance and robustness over the past decade, there was still plenty of room for additional improvements, and that such improvements would enable new applications of the technology. From the day the company was founded, solver performance has remained a focus. The product took a performance leadership position with its initial release and has retained that leadership position ever since.

Second, the founders believed that support is a crucial piece of the optimization software business. Optimization isn't rocket science – it's often a lot more complicated. When customers are building a complex optimization model, they often have questions that can only be answered by an expert. Gurobi gives users immediate access to support engineers with Ph.D.s in optimization, people who can give them the answers they need in hours, not days.

Third, the founders believed that the optimization software market was in need of more transparency in pricing and licensing. Incredibly, Gurobi was the first high-end optimization software company to provide a published price

The Roundtable consists of the institutional members of INFORMS with member company representatives typically the overall leader of O.R. activity. The Roundtable is composed of about 50 organizations that have demonstrated leadership in the application of O.R. and advanced analytics. The Roundtable culture is peer-to-peer, encouraging networking and sharing lessons learned among members.

The Roundtable meets three times a year. Roundtable goals are to improve member organizations' OR/MS practice, help Roundtable representatives grow professionally and help the OR/MS profession to thrive. Further information is available at <http://roundtable.informs.org>.

The Roundtable also has an advisory responsibility to INFORMS. According to its bylaws, "The Roundtable shall regularly share with INFORMS leadership and advise the INFORMS Board on its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities." The Roundtable meets with the INFORMS president-elect each spring to discuss practice-related topics of interest to him or her, and with the entire INFORMS Board each fall to discuss topics of mutual concern.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today.

list, with clear statements of the costs and capabilities of the available software licenses. This enabled customers to understand and plan for the total costs associated with their optimization projects without having to worry about unpleasant surprises in the future.

Finally, the founders believed that one of the best ways to expand the overall usage of optimization was to make it more broadly available to academic users. If you study the history of a successful commercial optimization project, you'll often find that its origins can be traced to an academic project or a course taken by one of the project leaders. Exposing more students to optimization technology can only increase the number of these industrial successes. Gurobi was the first high-end solver company to offer free, self-service licenses to academic users with no strings attached. The other commercial solver vendors subsequently followed our lead, and academic users can now readily obtain free licenses.

Building a New Solver From the Ground Up

Most commercial solvers have 20-plus-year histories, with hundreds of person-years invested in their development. Being faced with a blank slate in 2008 was both a blessing and a curse for the Gurobi founders. The curse, of course, was that it would require a massive amount of work to build an entirely new solver from scratch. The blessing was that the developers would have the opportunity to completely rethink the



solver design. One thing that came from many years of experience in building solvers was an understanding of what worked well and what did not, and more importantly how a brand new design could lead to a better solver.

After an intense initial development period, the Gurobi developers produced the first version of their solver in 2009. This new solver benefitted from the ground-up redesign in a number of ways. Perhaps most importantly, it was built to exploit the characteristics of modern multi-core architectures. Benchmarks showed the clear benefits that came from this focus on parallelism; multi-core performance was much better than that of other solvers. When combined with a new software licensing model that no longer charged extra for multi-core licenses, the new Gurobi solver allowed customers to benefit from the ever-increasing numbers of cores that were being included in modern microprocessors.

The ground-up rethinking also led to other benefits, including better heuristics for finding feasible solutions to MIP models, lighter and better-performing object-oriented interfaces, a better interactive solving capability achieved through tight integration with the Python programming language, better approaches to computing inconsistent subsystems, etc. This rethinking process did not stop with the first Gurobi release,

though. Since that release, which was the state-of-the-art at the time, the performance of the Gurobi MIP solver has improved by more than a factor of 20 (when measured over a broad test set).

Commercial Clients

Gurobi can cite an impressive list of companies that rely on them as their optimization solver provider (showcase customers include FedEx, Walmart, BNY Mellon and US Airways). The Gurobi solver is used in an enormous range of high-impact applications, including scheduling of electrical power generation, creating cost-effective online ad campaigns for Web companies, optimizing professional sports league schedules, computing quality matches from online dating profiles and making high-stakes financial investment decisions. Six of the 10 largest companies in the world, measured by market capitalization, are Gurobi customers.

Pushing Boundaries

As Gurobi Optimization has evolved, the company has continued to push boundaries and take chances.

As the first major solver vendor to offer free, self-service, no-strings-attached academic licenses, Gurobi has led the way in making optimization more accessible to a new generation of users. Gurobi has given out tens of thousands of free licenses, and the majority have been given to academics who are not in O.R. programs. It will be interesting to see how these new users apply the technology once they graduate and move into the commercial world.

Gurobi was also the first solver vendor to provide a cloud offering. Gurobi Cloud allows users to rent Gurobi by the hour or by the month. Users can grab as many machines as they need, without having to worry about purchasing machines or licens-

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es. This capability has opened up several new uses of optimization technology.

The new Gurobi Compute Server product has brought client-server computing capabilities to the world of optimization. It greatly simplifies the task of integrating optimization into applications that are built for scalability or fault tolerance. It also enables distributed optimization applications, where the power of multiple machines can be brought to bear on a single difficult optimization problem. **ORMS**

Ed Rothberg is chief operating officer and co-founder of Gurobi.



The image is a promotional graphic for the IFORS 2014 conference. On the left, a dark red banner contains the text "20th CONFERENCE OF THE INTERNATIONAL FEDERATION OF OPERATIONAL RESEARCH SOCIETIES" in white. Below this is the IFORS logo, which includes a globe icon and the text "I F O R S International Federation of Operational Research Societies". Underneath the logo is the phrase "The art of modeling" in a colorful, stylized font, followed by "Barcelona" in a large, dark, gothic-style font, and the website "www.ifors2014.org" at the bottom. On the right side of the graphic, there is a photograph of a traditional Spanish paella dish in a black pan, garnished with lemon wedges. Above the paella, the text "IFORS 2014" is written in a large, bold, sans-serif font, with "13th - 18th July" underneath it. The background of the right side is a blue sky with a colorful mosaic archway.