WHITE PAPER

A Need for Speed: Why Optimization Solver Speed Matters

Make fast, confident decisions at the speed of business.

Contributed by Ed Klotz, PhD

When choosing between the various open-source and commercial solvers available on the market, speed is often the most important factor for users. In fact, around 80% of users who switched from another solver to Gurobi report that speed was the main motivation behind their decision to switch.

Not surprisingly, speed has been an intense focus among mathematical optimization software developers ever since mathematical optimization technologies were introduced over 70 years ago—and amazing progress has been made. For example, some mathematical optimization problems that can be solved in one second today would have taken 55 years to solve in 1991.

Although mathematical optimization technologies have made tremendous strides over the years—with dramatic improvements in speed, accuracy, and robustness—performance remains a constant challenge. This is because, even though solvers keep getting faster and more powerful, the size and complexity of business problems continue to increase.

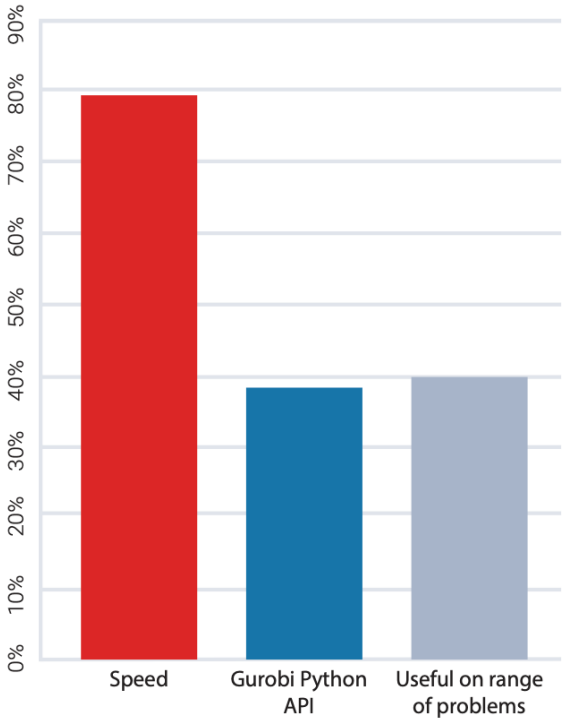
And so the quest to reach higher and higher peaks of performance continues, and speed remains a top priority among solver software developers (who continually strive to raise the bar and set new standards) and users (who are constantly looking to solve harder problems, faster).

But why does mathematical optimization solver speed matter? While winning benchmarks is nice, what is the value proposition for software users? In this article, I will discuss three key reasons why solver speed is critical for businesses today.

Users Switch Solvers for Speed

In our 2023 State of Optimization Report, two-thirds of survey respondents reported switching to Gurobi from another commercial or open-source solver. The reasons behind their switch included: speed (80%); usefulness on a wide range of problems, including LP, MIP, MIQP, MIQCP, and non-convex problems (41%); the Gurobi Python API (38%); and Gurobi's expert support (36%).

Survey Question: What are the top 3 reasons you switched to Gurobi?



#1: Real-Time Decision Making

The business world today is characterized by complexity and constant change. To survive and thrive, companies must be able to make real-time, data-driven decisions on how to most efficiently utilize their resources. And mathematical optimization empowers them to do exactly that.

One industry where mathematical optimization is used extensively in real-time applications is electric power. To manage the flow of energy across their electrical grids and keep supply and demand in balance, transmission and distribution system operators must have the capability to generate plans every 20 or 30 minutes and make real-time decisions on which sources of power to use to satisfy demand in the most efficient and profitable way. In this situation, having a solver that functions with the utmost speed is vital—as this enables electric power providers to rapidly generate plans as supply and demand dynamics shift, and make real-time decisions on how to best deploy their assets.

There are many other industries—including logistics and manufacturing—where mathematical optimization is widely used in real-time applications, and many companies in these industries rely on mathematical optimization solvers to consistently deliver fast and accurate solutions that enable optimal, real-time decision-making.

When using mathematical optimization to facilitate or even automate real-time decision-making, the speed of the solver really matters—as companies can't afford to wait for their applications to generate solutions to their pressing, day-to-day business problems.

#2: Disruption Management

Another reason why having a high-speed solver is so pivotal is that it enables companies to handle disruptions more effectively.

Many businesses today must cope with severe disruption. For example, manufacturing and aviation industries must deal with disruptions regularly—caused by unexpected events such as extreme weather, natural disasters, and machine breakdowns—on a daily basis.

> **“ Companies can't afford to wait for [their solver] to generate solutions to their pressing, day-to-day business problems.”**

When facing disruption, companies must strive to get their operations back on track as soon as possible—and every second counts, as the sooner things can be restored to normal, the fewer costs will be incurred.

As a prescriptive analytics technology, mathematical optimization automatically delivers solutions—based on the latest available data—that prescribe the best course of action to handle a disruptive event. Armed with these solutions, companies can quickly make real-time decisions on how to respond to disruptions and redeploy their resources.

In these time-sensitive situations, the faster the solver, the better—as the longer it takes to get operations running smoothly again, the higher operating costs will be.

#3: Robust Scenario Analysis

Another area where the speed of the solver is critical is in conducting scenario analysis.

Mathematical optimization technologies enable users to generate numerous what-if scenarios, evaluate and compare their potential impact on business operations and objectives, and determine the best courses of action.

Simply put, a faster solver gives users the capability to run more scenarios in a shorter amount of time—and this has tremendous business value.

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One good example of this is the National Football League (NFL), which uses mathematical optimization to automatically create and analyze 50,000+ possible scheduling scenarios. With Gurobi, the NFL—which has a finite period of time to examine various possible schedules and select the best one—can generate a huge pool of high-quality candidate schedules to choose from.

A high-speed solver enables companies to conduct rapid, robust what-if analyses—so that they can explore and evaluate many different scenarios and make the best strategic decisions.

Full Speed Ahead

I predict that in the coming years, solver speed will continue to be a key consideration for buyers, a critical capability for users, and a chief focus of developers.

Indeed, as the problems in the business world become progressively more complex, the need for faster and better mathematical optimization solver performance will persist—and companies like Gurobi will continue to innovate and improve their technology to meet the challenges of the day.

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