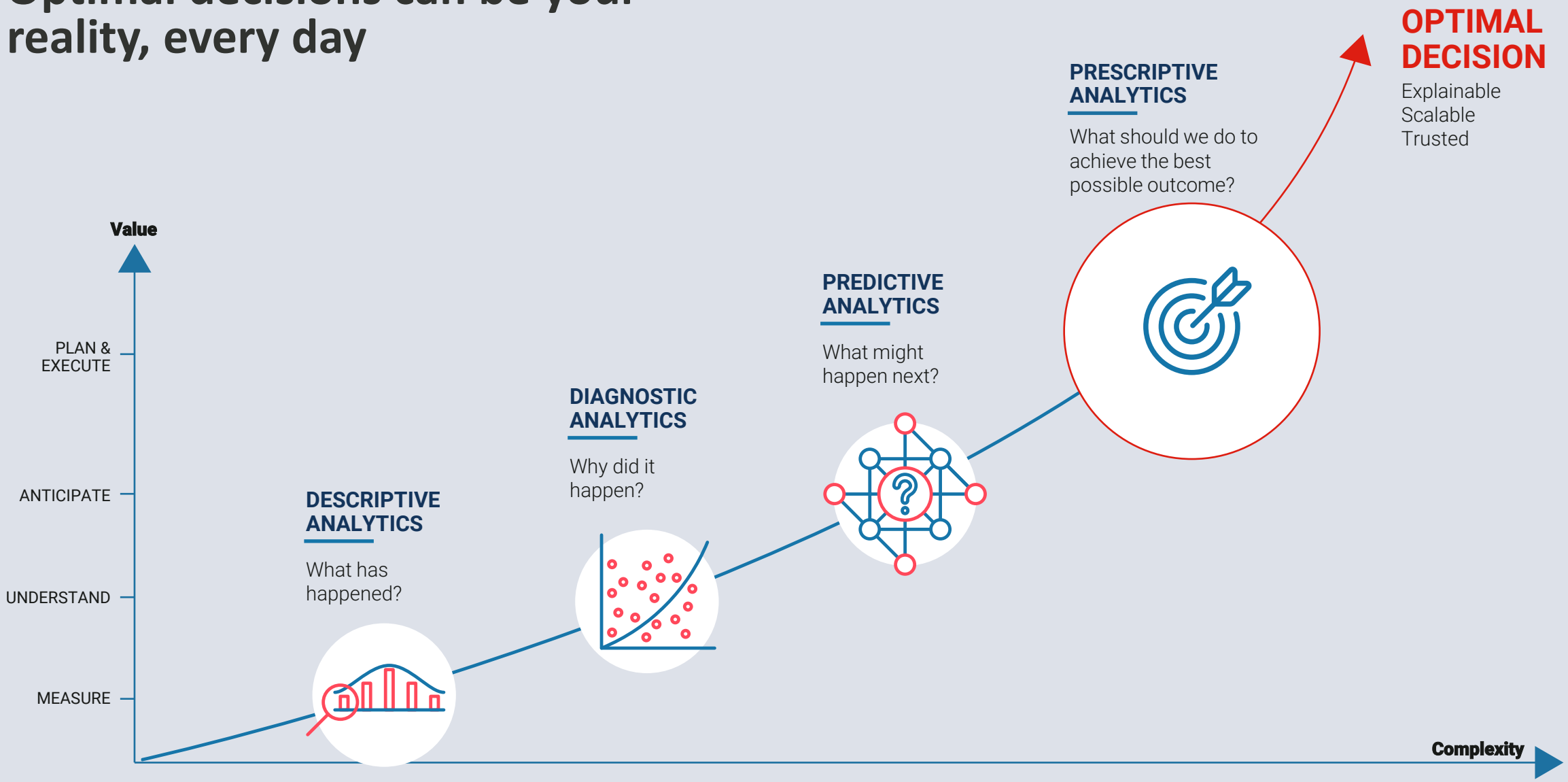
Enhance Your Supply Chain with Mathematical Optimization

Jennifer Locke
Manager, Technical Account Management, Americas

May 2023

GUROBI OPTIMIZATION

Optimal decisions can be your reality, every day



Supply Chain Optimization

The use of mathematical techniques to make the supply chain more efficient, cost-effective, and responsive.

Challenges

Globalization and Complexity

Challenging to manage diverse suppliers, transportation networks, and customs regulations

Demand Volatility

Fluctuations in customer demand, difficult to accurately forecast and plan inventory levels. Shifts in demands lead to overstocking or stockouts, impacting customer satisfaction and profitability.

Inventory Optimization

Excessive inventory ties up capital and increases storage costs, while inadequate inventory levels lead to stockouts and lost sales

Cost Pressures

Pressure to reduce costs and improve operational efficiency, such as optimizing transportation, warehousing, inventory costs, and find ways to minimize waste and streamline processes

Optimizing Your Supply Chain

Harnessing mathematical optimization for efficient planning and execution

Network Design

Optimize the location of production facilities, distribution centers, and transportation routes to minimize costs and improve customer service levels.

Inventory Management

Optimize inventory levels and replenishment policies to minimize inventory holding costs while ensuring that products are available when needed.

Production Planning

Optimize production schedules and workforce allocation to maximize production efficiency and minimize costs.

Supplier Selection

Optimize supplier selection and contracting decisions to minimize costs while ensuring quality and delivery performance.

Demand Forecasting

Optimize demand forecasting to improve inventory management and production planning

Vestel

Challenges

To increase visibility, flexibility, productivity, and profitability of a global end-to-end supply chain.

Optimized Outcomes

ICRON's new S&OP system, powered by Gurobi, revolutionized Vestel's processes, leading to a 20% improvement in planning accuracy and a 50% reduction in planning time.

"Gurobi is able to quickly conduct an analysis to determine the root cause of the infeasibility of a planning problem and run scenario analysis to explore various possible solutions."

Z. Caner Taşkın, Chief Technology Officer, ICRON

Gurobi Partner:

ICRON

VESTEL

ARAUCO

Challenges

To accurately forecast demand, manage raw material supply as well as production and distribution operations, and make integrated, optimal plans and decisions—amidst supply and demand volatility.

Optimized Outcomes

With Gurobi, ARAUCO can now minimize costs and maximize demand fulfillment, resource utilization, and revenue growth.

ARAUCO was able to swiftly and successfully build models that captured and addressed their highly complex supply chain planning problems and enabled them to rapidly generate optimal solutions.

Gurobi Partner:

aleph5

arauco

Polymathian

Challenges

To enable users to solve complex planning and scheduling problems through optimal, automated, repeatable, and auditable planning processes.

Optimized Outcomes

With their Gurobi-powered solution from Polymathian, customers have achieved a 10-30% increase in efficiency (i.e., asset utilization and throughput), with dramatically reduced planning cycle times (from days and hours to a few minutes or seconds).

"[Our customers] can get the best possible answer in the shortest possible time to make better business decisions given their role in the value chain."

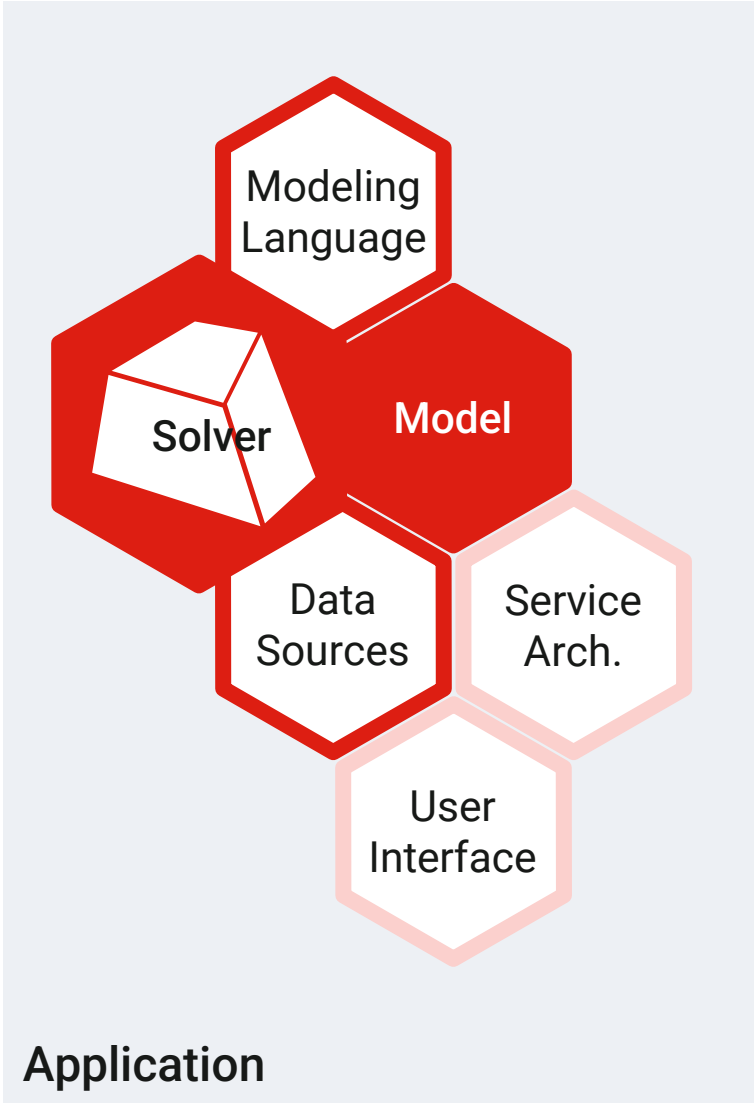
Dr. Ben Hollis, Director, Polymathian

Polymathian
Industrial Mathematics

What do I mean by optimization?

Also known as… Mathematical Programming, Decision Science, Decision Optimization, Decision Analytics, Prescriptive Analytics, Operations Research

What You Need for an Optimization Application



Modeling language
Any programming language (Python, Matlab, R, C, C++, C#, Java, …) or special math modeling language

Model
A problem statement that encompasses the necessary business requirements, such as a clearly defined objective, any applicable constraints, and the decision variables involved.

Solver
A software tool or algorithm that is designed to find the best solution to a specific optimization problem.

Data sources
Access to databases, services, etc. from the programming language API's tools

User interface (optional)

Service architecture (optional)

What *Is* an Optimization Model?

GUROBI OPTIMIZATION

Math model

$$
\begin{aligned}
\max \quad & x + y + 2z \\
\text{subject to} \quad & x + 2y + 3z \leq 4 \\
& x + y \geq 1 \\
& x, y, z \text{ are binary } (0, 1)
\end{aligned}
$$

Gurobi model in Python

```python
# Create a new model
m = gp.Model("mip1")

# Create variables
x = m.addVar(vtype=GRB.BINARY, name="x")
y = m.addVar(vtype=GRB.BINARY, name="y")
z = m.addVar(vtype=GRB.BINARY, name="z")

# Set objective
m.setObjective(x + y + 2 * z, GRB.MAXIMIZE)

# Add constraint: x + 2 y + 3 z <= 4
m.addConstr(x + 2 * y + 3 * z <= 4, "c0")

# Add constraint: x + y >= 1
m.addConstr(x + y >= 1, "c1")

# Optimize model
m.optimize()
```

GUROBI OPTIMIZATION

Demo

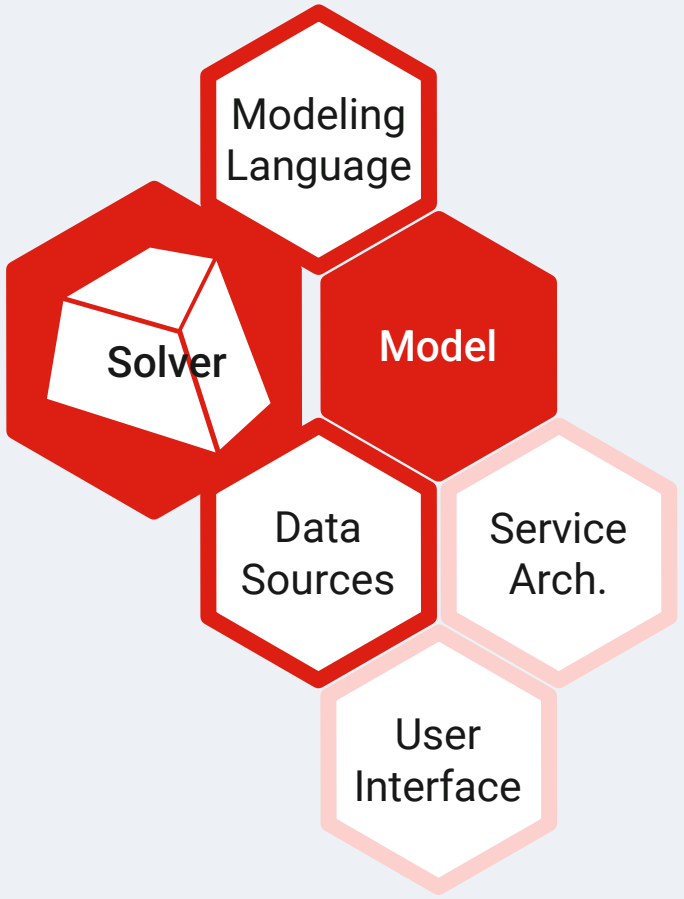
Workforce allocation

Production planning

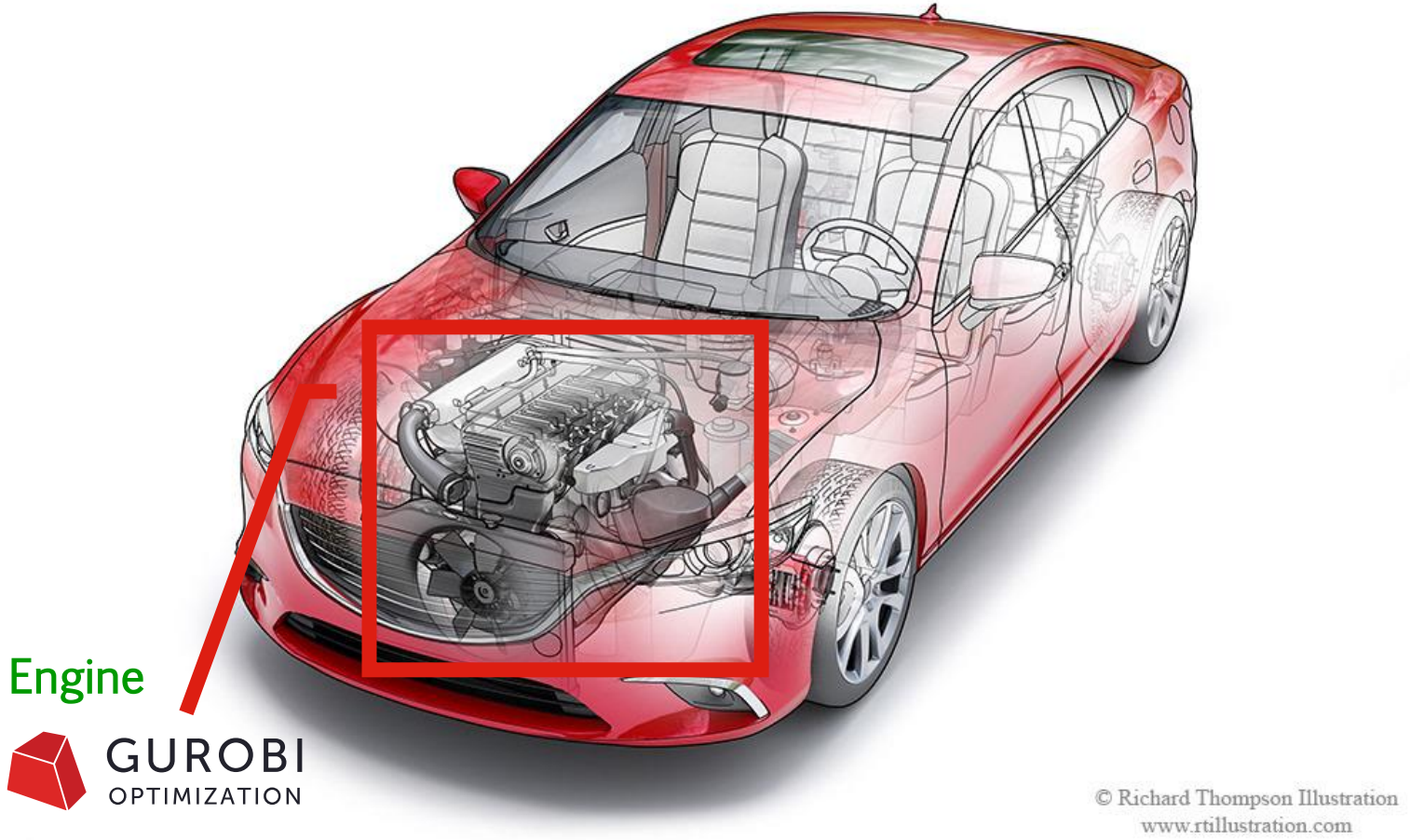
Facility location

GUROBI
OPTIMIZATION

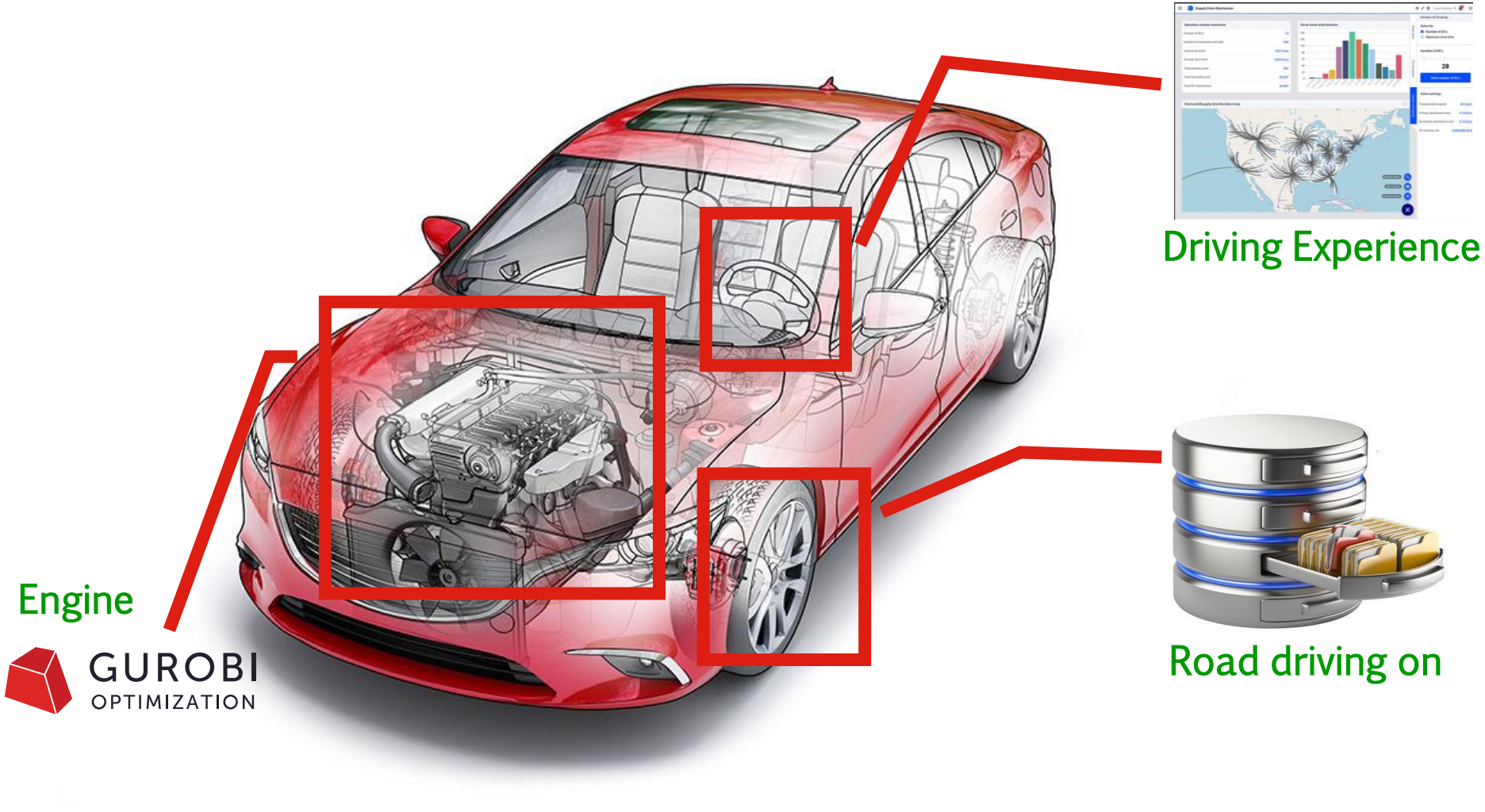
Introduction to Gurobi

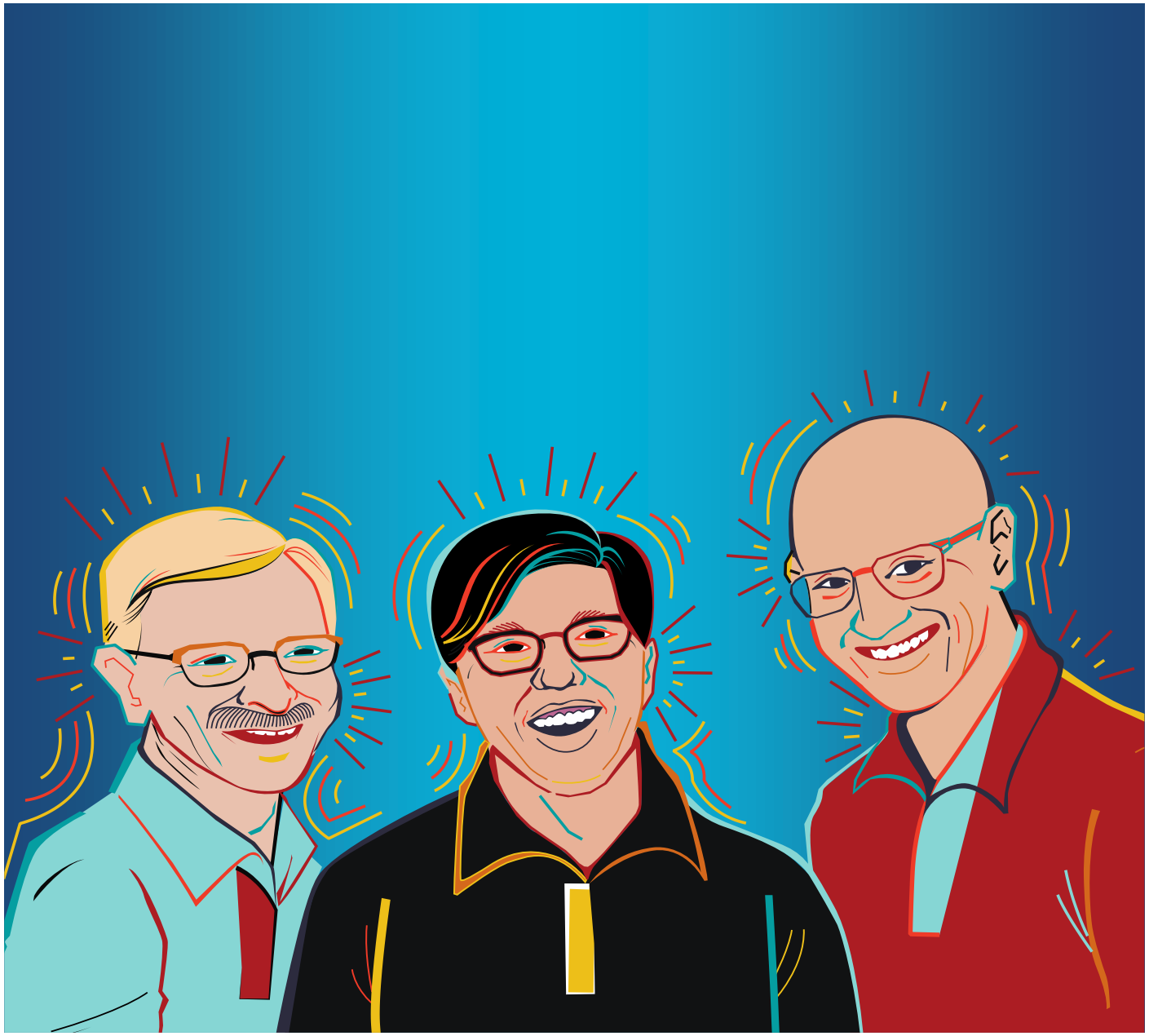


Application



How Gurobi and Aimpoint Work Together





Dr. Bob Bixby, Dr. Zonghao Gu, and Dr. Ed Rothberg

GUROBI OPTIMIZATION

A Singular Focus

In 2008, our founders created Gurobi Optimization with a single, simple vision:

To build the world's fastest and most powerful mathematical optimization solver.

And that's exactly what they did.

The World's Most-Trusted Brands Run on Gurobi

TRUSTED BY

70%
OF FORTUNE 10

70%
OF BIGGEST EUROPEAN COMPANIES (BY REVENUE)

70%
OF TOP GLOBAL TECH COMPANIES

60%
OF TOP GLOBAL FOOD PRODUCERS

"[Gurobi] has met our high expectations, and the support they provide has been fantastic."

Michael North, Sr. Director, National Football League (NFL)

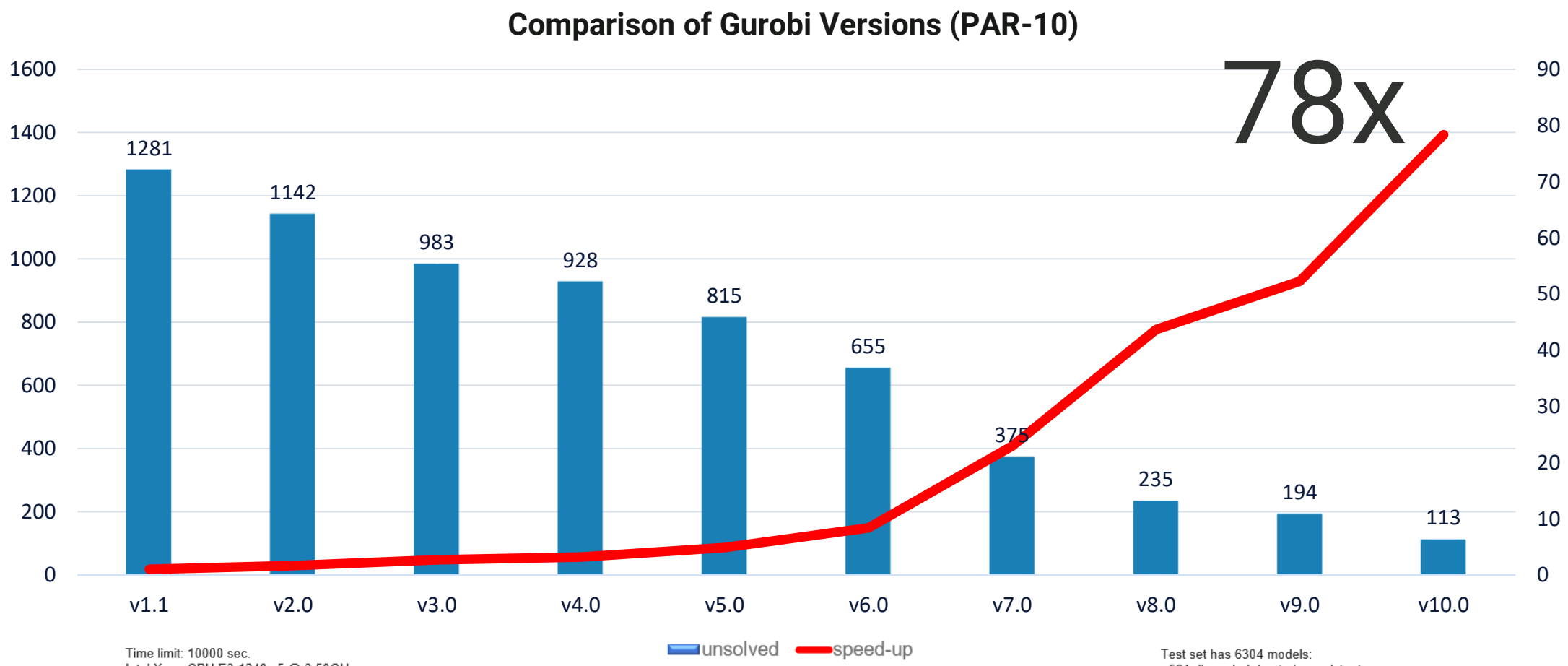
VIEW CASE STUDIES

Franz Edelman Award in Operations Research

- Annual award for the OR project with the biggest impact on society
- Measured financial impact of finalists: $257 billion
- Large fraction use LP or MIP to achieve results
  - https://www.informs.org/Recognizing-Excellence/INFORMS-Prizes/Franz-Edelman-Award

MILP Performance Evolution

Latest Version Gurobi 10.0

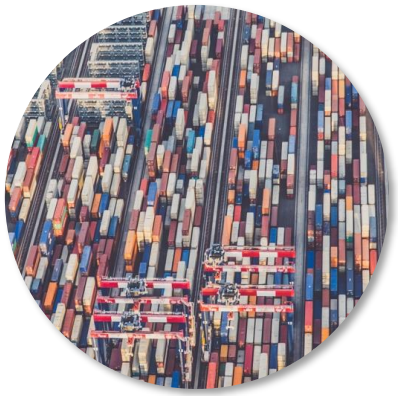


Time limit: 10000 sec.
Intel Xeon CPU E3-1240 v5 @ 3.50GHz
4 cores, 8 hyper-threads
32 GB RAM

Test set has 6304 models:
- 561 discarded due to inconsistent answers
- 1567 discarded that none of the versions can solve
- speed-up measured on >100s bracket: 2371 models

What Does a Faster Solver Buy You?

Solver performance is a combination of speed, robustness, tractability, and scalability.

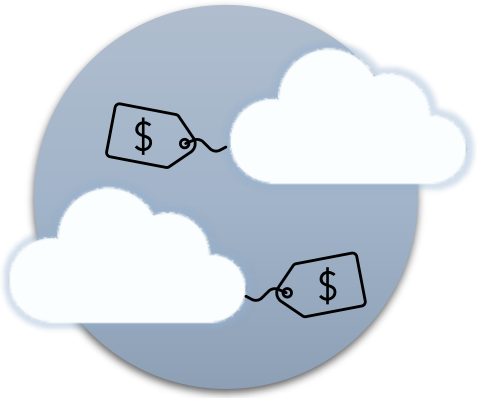


Expand the Scope

More scalable solutions can allow for considering more decisions at once

Real-Time Optimization

Faster models may mean you can set up a closed-loop system that finds and then implements results



Reduce Cloud and Compute Costs

Spending less time on optimization may reduce your cloud computing bill at the end of the month.

More Questions Answered

Answer questions as they arise. What if the price increased by X%? What constraints are holding us back right now?

Supported Model Types

Gurobi solves a broad range of problem types

LP	QP	QCP
MILP (including PWL)	MIQP	Non-Convex MIQCP
SOCP	Bi-Linear	Convex MIQCP

Summary

- Mathematical optimization
  - solve many the challenges you face today
  - Improve efficiency
  - Minimize costs
  - Maximize profits
- Always try MIP
- Gurobi and Aimpoint are here to help

Gurobi Team

Mian Qin
Account Director
Americas Northeast

Jennifer Locke
Manager, Technical
Account Management,
Americas

Tracy Pesanelli
Vice President & Americas
Senior Sales Advisor

Paul Charchaflian
Director Alliances & Partners

GUROBI
OPTIMIZATION

GUROBI OPTIMIZATION

Thank You

For more information: gurobi.com

Jennifer Locke
Manager, Technical Account Management, Americas

locke@gurobi.com | +1 (346) 348-0579

