

Gurobi 5.5 Performance Benchmarks



GUROBI
OPTIMIZATION

Thank You for Your Interest in Gurobi

The Gurobi Optimizer was designed from the ground up to be the fastest, most powerful solver available for your LP, QP, QCP, and MIP (MILP, MIQP, and MIQCP) problems.

- ▶ In industry standard public benchmark tests¹ Gurobi has the...
 - Fastest overall solve times for LP models
 - Fastest overall solve times to optimality for MIP/MIQP models
 - Fastest overall solve times to feasibility for MIP/MIQP models
 - Fastest times for detecting infeasibility
 - Fastest overall solve times for QP models

And, as problems get harder, our relative performance gets even better.

¹Industry standard public benchmarks maintained by [Hans Mittelmann](#) at Arizona State University

Two Types of Benchmark Testing

Internal

- ▶ Primary Objectives
 - Robustness testing
 - Compare version-to-version improvements
- ▶ Test Bank
 - Internal library of over 8,000 models from industry and academia

Public

- ▶ Primary Objective
 - Competitive benchmarks against other solvers
- ▶ Test Bank
 - Maintained by Hans Mittelmann
 - <http://plato.la.asu.edu/bench.html>
 - Based upon MIPLIB 2010

- On the next slides we'll share some specific results as well as results from our own internal testing.
- Of course, every model is different so we invite you to [try Gurobi for yourself](#) or [contact us](#) with any questions.

Dedicated to Continued Improvements

- ▶ Geometric mean runtime on ~1000 models in our internal model set where at least one of the solvers takes more than 100s to solve
- ▶ Version-to-version improvement for major releases:
 - LP Models
 - Concurrent: Gurobi 4.0 → 5.0: 1.2X
 - Barrier: Gurobi 3.0 → 5.0: 1.5X
 - Primal Simplex: Gurobi 1.1 → 5.0: 2.7X
 - Dual Simplex: Gurobi 1.1 → 5.0: 4.9X
 - MIP Models
 - Gurobi 1.0 → 2.0: 2.4X
 - Gurobi 2.0 → 3.0: 2.2X (5.1X)
 - Gurobi 3.0 → 4.0: 1.3X (6.6X)
 - Gurobi 4.0 → 5.0: 2.0X (12.8X)

Performance Improvements since v5.0

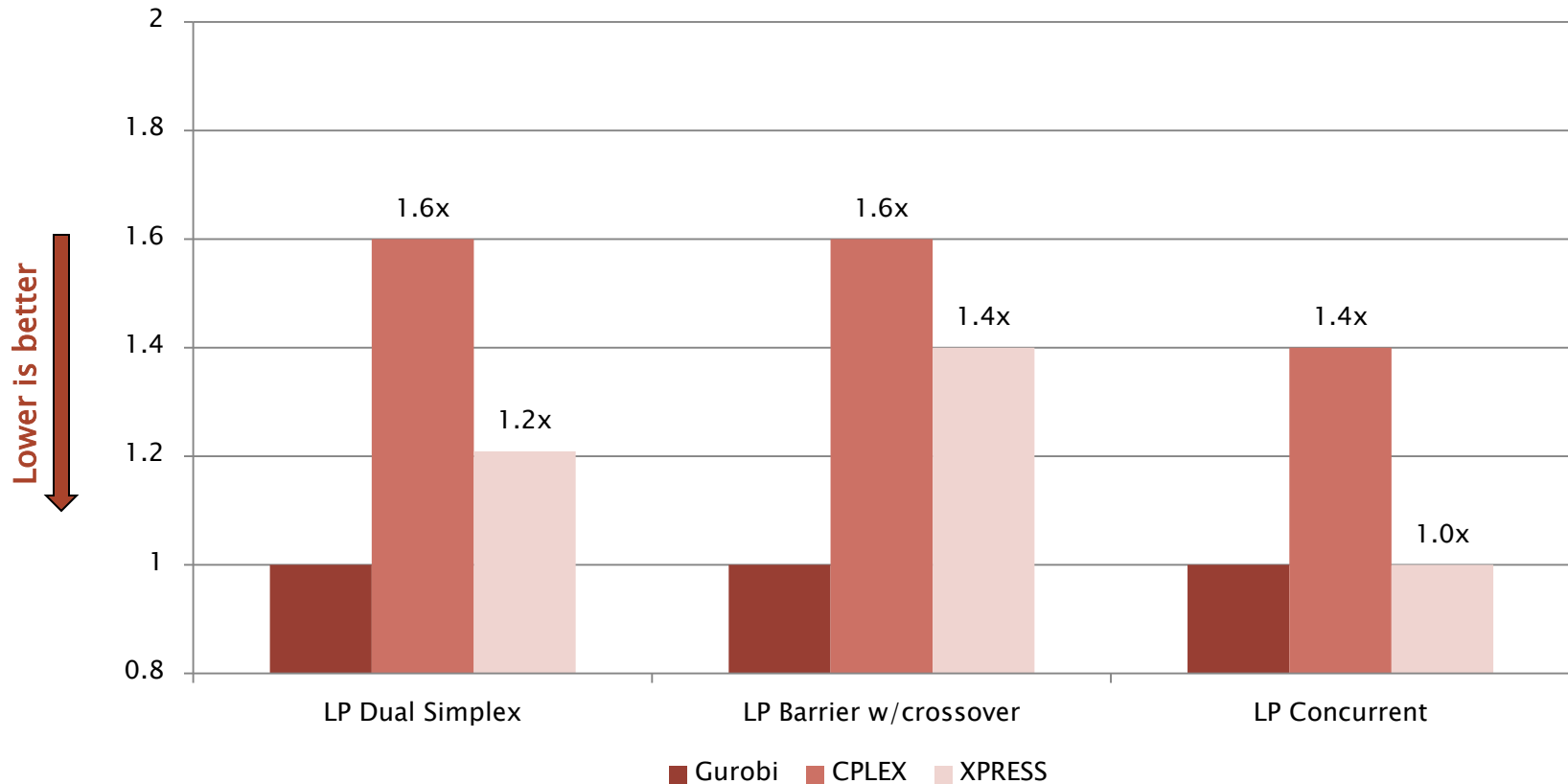
- ▶ Releases include significant MIP performance improvements
 - 5.4X mean improvement in time to first solution
 - 15% mean improvement in time to proven optimality overall
 - 40% improvement in time to optimality on the hardest models
 - (those which take over 1000 seconds to solve)

LP Competitive Benchmarks

Gurobi 5.5 vs. CPLEX™ 12.5 vs. XPRESS™ 7.5
(Maintained by Hans Mittelmann)

Gurobi Has The Fastest Solve Times

Gurobi is Overall the Fastest LP Solver

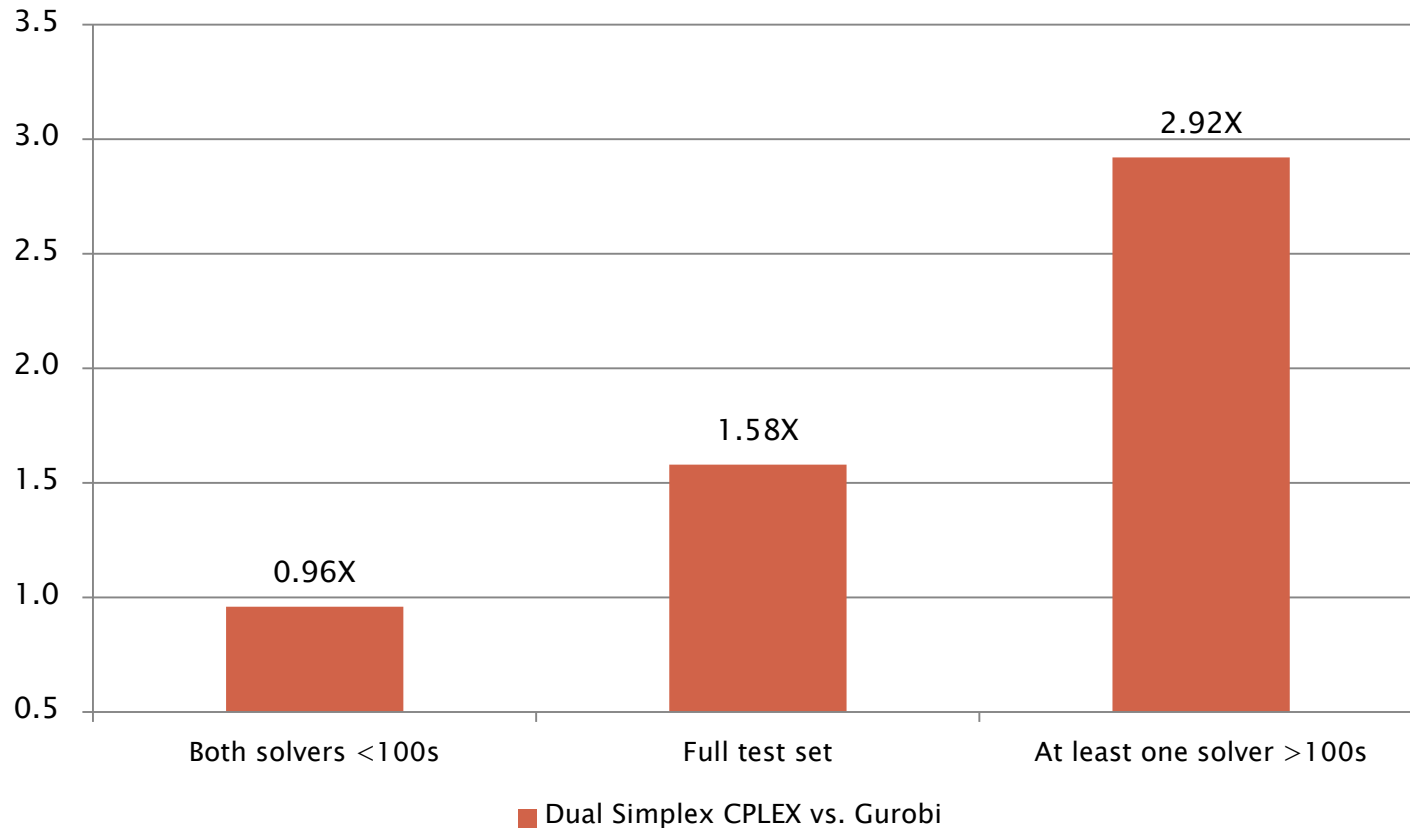


Notes:

- Relative speed calculated using geometric means of ratios of runtimes across the 40 models for that algorithm
- For example: CPLEX 12.5 is overall ~60% slower using Dual Simplex on the 40 LP test models
- Complete test data available here: <http://plato.asu.edu/ftp/lpcom.html>



Gurobi Is ~60% Faster Overall and Nearly 3X Faster on the Hardest Models



Make sure to not just test us *on* easy test models. Our best performance will *likely* be *on* your real-world, hardest, models.

MILP Competitive Benchmarks

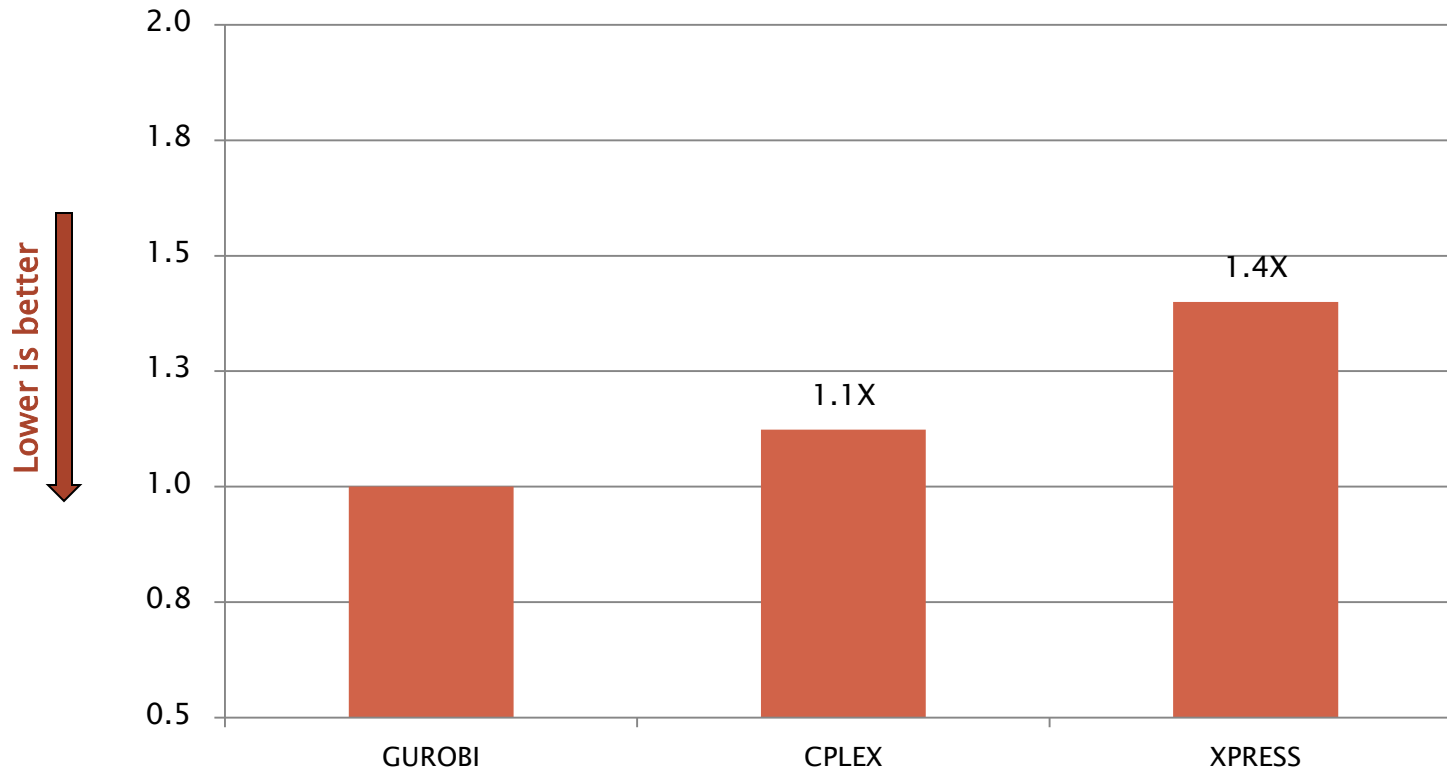
Gurobi 5.1 vs. CPLEX 12.5 vs. XPRESS 7.5
(Maintained by Hans Mittelmann)

Fastest to Optimality

Fastest to Feasibility

Fastest to Detect Infeasibility

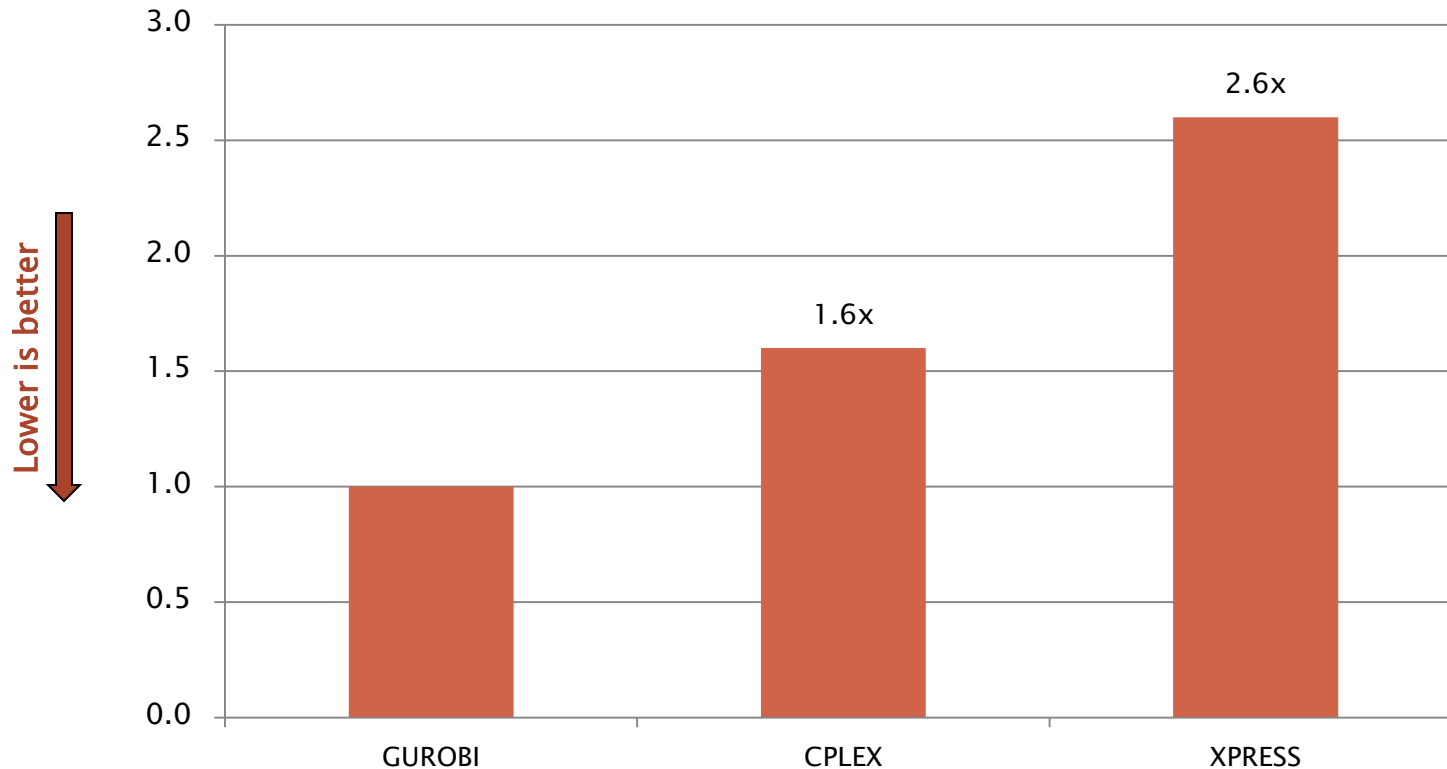
Gurobi is Fastest Overall to Optimality



► Notes:

- Relative speed calculated using geometric mean runtimes across 1, 4, and 12 thread tests
- Complete test data available here: <http://plato.asu.edu/ftp/milpc.html>

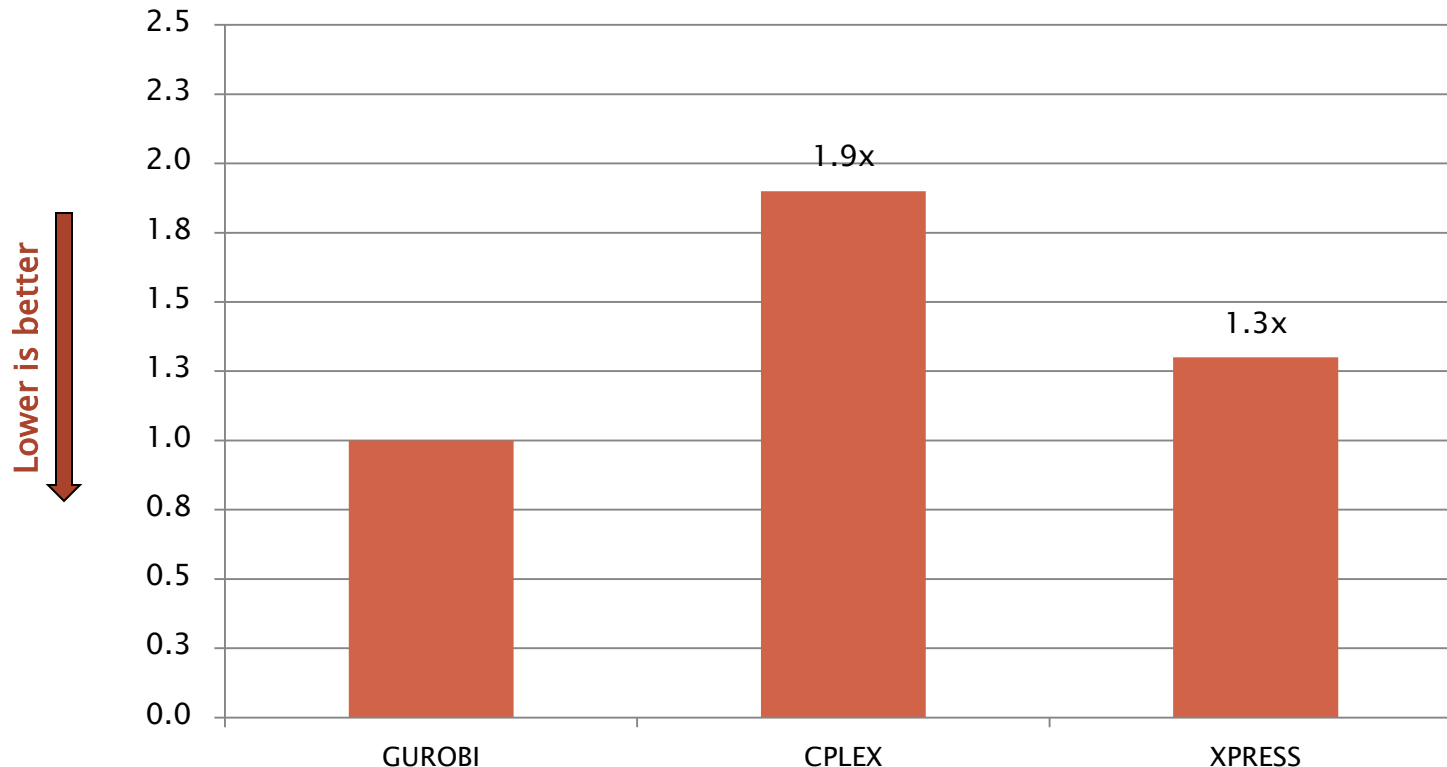
Gurobi is Fastest Overall to Feasibility



► Notes:

- Relative time to feasibility
- Results comparing geometric mean runtimes of the 30 models used in the benchmark
- Complete test data available here: http://plato.asu.edu/ftp/feas_bench.html

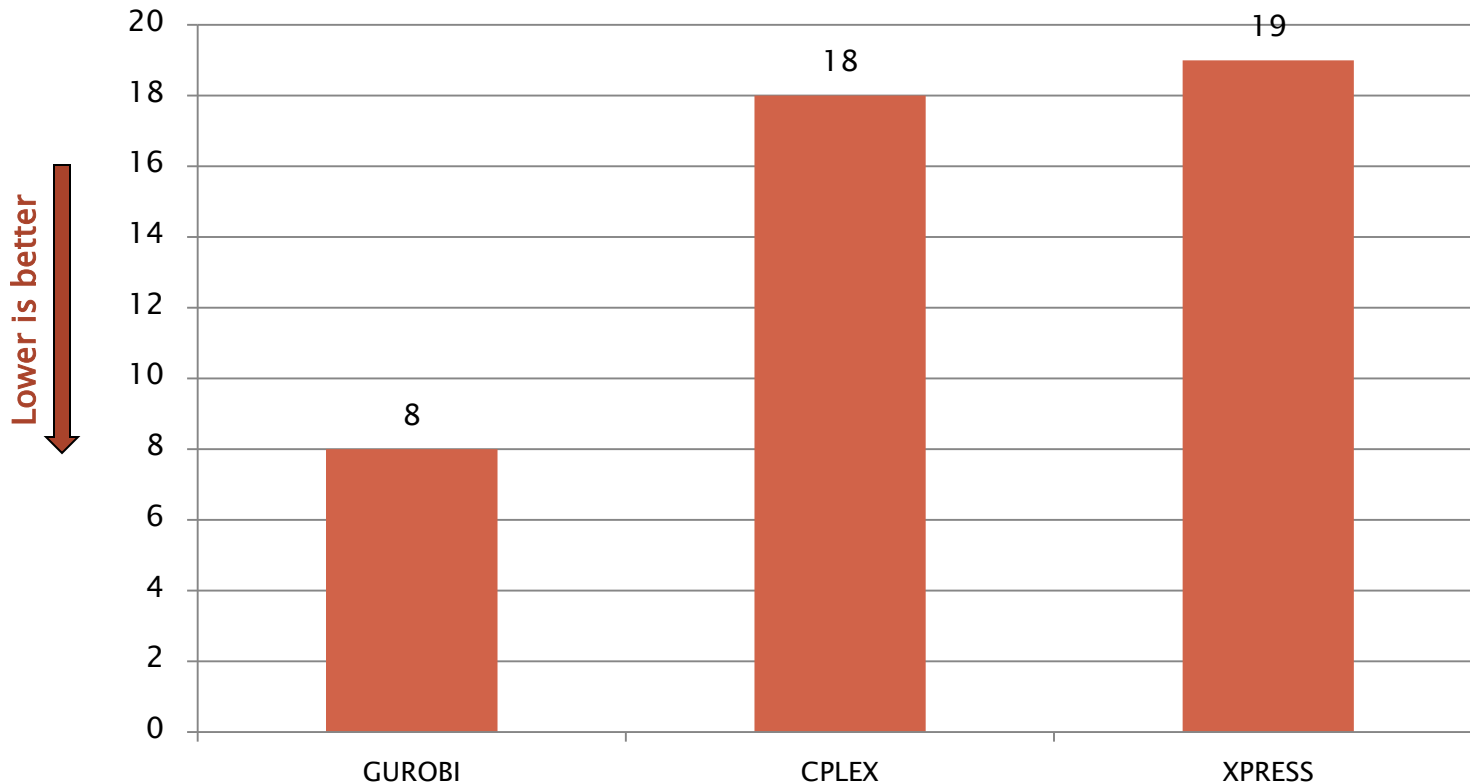
Gurobi is Fastest Overall to Detect Infeasibility



► Notes:

- Relative time to infeasibility for MILP models
- Results comparing geometric mean runtimes of the 19 models used in the benchmark
- Complete test data available here: <http://plato.asu.edu/ftp/infeas.html>

Gurobi's overall performance is even better than the ratios indicate...



- ▶ Number of problems not solved to optimality* within time limits
- ▶ Time limits cap the ratios used in the geometric means.

*Optimality Benchmark

QP Competitive Benchmarks

Gurobi 5.1 vs. CPLEX 12.5 vs. XPRESS 7.4 vs. MOSEK™ 6.0
(Maintained by Hans Mittelmann)

Gurobi beats the recognized leaders across QP,
MIQP, SOCP, and MIQCP benchmarks

Gurobi is Fastest Across All QP Benchmarks

(> 1.0 means Gurobi is faster)

| Benchmark | CPLEX | XPRESS | MOSEK |
|-------------------|-------|--------|-------|
| | P=4 | P=4 | P=4 |
| QP (continuous) | 1.3X | 0.8X | 6.4X |
| MIQP | 6.1X | 2.5X | – |
| SOCP (continuous) | 11.0X | – | 1.5X |
| MIQCP | 10.2X | 4.7X | – |

► Notes:

- Relative runtimes
- Results comparing geometric mean runtimes of the models in each benchmark
- Results with a “–” indicate no test data available for that combination
- Complete test data available here: <http://plato.asu.edu/ftp/miqp.html>

Benchmarks vs. Open Source Solvers

Benchmarks – Open Source MIP

- ▶ Mittelmann MIPLIB2010 tests, P=1 (>1X means Gurobi wins):

| | January 2012 | January 2013 |
|---------|--------------|--------------|
| CBC | 10X | 13X |
| SCIP | 6X | 7X |
| GLPK | 22X | 27X |
| LPSOLVE | 19X | 24X |

- ▶ Feasibility (CBC): 51X slower in January 2012, 293X slower in January 2013
- ▶ Open source MIP solvers continue falling further behind

MIPLIB 2010 News!

Gurobi Solves 11 previously unsolved models

- ▶ Tested against the MIPLIB 2010 Challenge Set in 2012
 - Models previously unsolved by any commercial or academic code
 - More at: <http://miplib.zib.de>

| | | |
|----------------------------------|---|--------------------------------|
| b2c1s1 | maxgasflow | opm2-z10-s2 |
| opm2-z11-s8 | opm2-z12-s14 | opm2-z12-s7 |
| rmatr200-p10 | satellites3-40-fs | satellites3-40 |
| wnq-n100-mw99-14 | transportmoment (only 36s!) | |

- ▶ Application domains
 - Lot sizing, Gas network transport, Mining, Satellite scheduling, p-Median problem, Weighted n-Queens

Isn't it time you considered upgrading to Gurobi?

1. You can download a free trial on www.gurobi.com.
2. We are also happy to discuss providing a free, no size limit, evaluation copy. Simply contact us at: info@gurobi.com.

