Gurobi 10.0 Overview

GUROBI OPTIMIZATION

Gurobi 10.0 – Timeline

GUROBI OPTIMIZATION

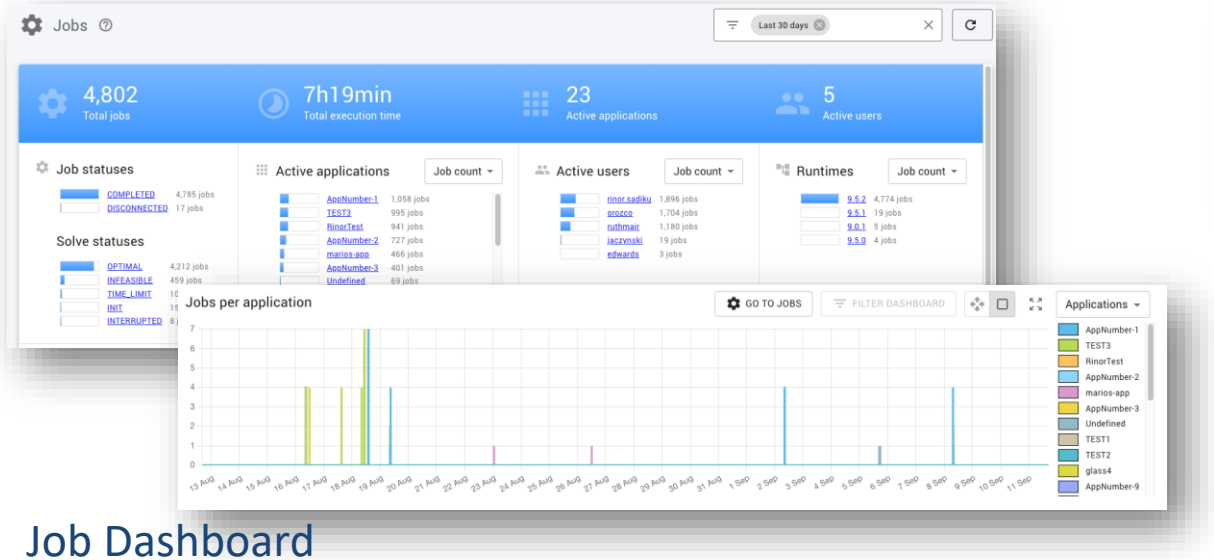
- Beta period started October 4
- Release date: November 9, 2022

- External open-source GitHub packages
  - Will be released shortly after
  - Some may take a few more weeks

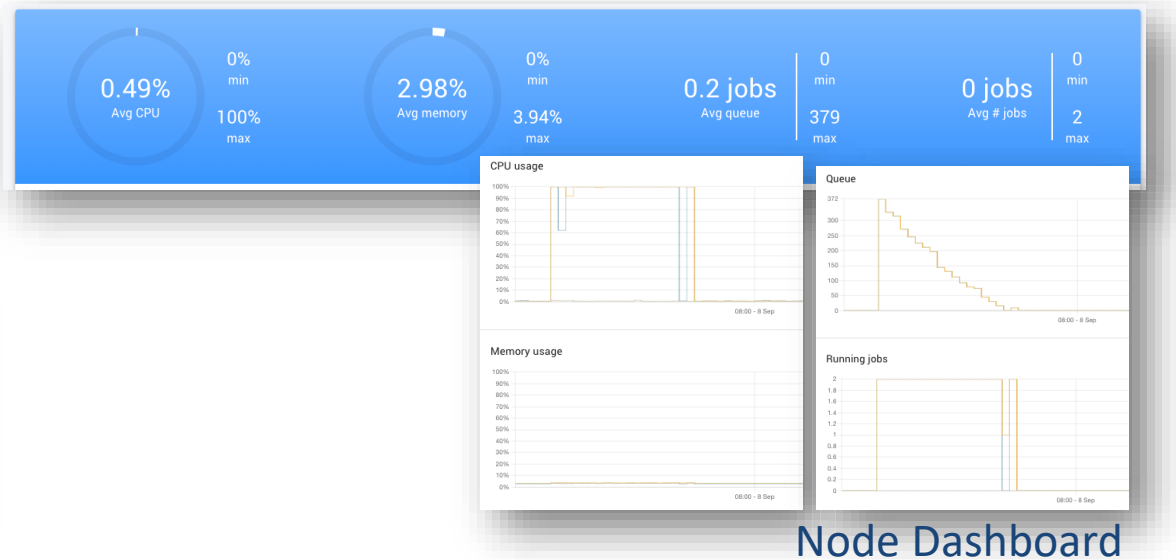

Platform

Gurobi 10.0 – Platform

- The Cluster Manager provides two new dashboards:
  - The job dashboard: e.g., job statuses, solves statuses, applications, users
  - The node dashboard: e.g., CPU usage, memory usage, jobs in queue
- Both dashboards let the user monitor the metrics over time and drill down to the actual activity to better understand the cluster usage and the behavior of the applications.



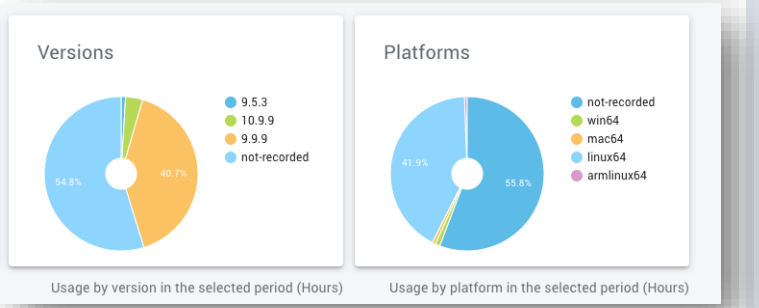
Job Dashboard

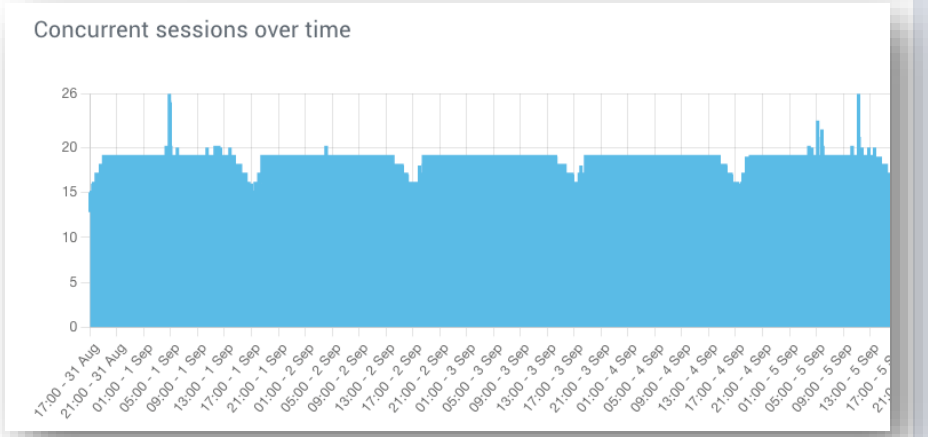


Node Dashboard

Gurobi 10.0 – Web License Service

- Supported on more platforms:
  - In addition to Docker and Kubernetes platforms, other containerized environments such as Google Cloud Run
    - Makes Gurobi available on basically all current and future container platforms
  - Regular machines on Linux, Mac and Windows
    - Offers many additional ways for our sales team to structure deals
  - Allows to use Gurobi in any deployment scenario with just one license
- New features:
  - The WLS manager reports new metrics such as the platforms and the versions used
    - Allows us to better monitor WLS license usage
  - Explicit user control on token refreshed intervals
    - Helps the user to detect and react on network outages earlier






Ease of Use

Gurobi 10.0 – Engine

Ease of Use – Product Features

GUROBI OPTIMIZATION

- Greatly improved matrix-friendly API of gurobipy
  - All modeling objects now support multiple dimensions
  - Dimension handling leans consistently on NumPy, including broadcasting
- New logistic general constraint
  - Makes it easy to incorporate a constraint in MIP that models the logistic function
  - Logistic function has various applications, including ecology, statistics, machine learning, medicine, chemistry, and others
  - See https://en.wikipedia.org/wiki/Logistic_function
- NuGet package for .NET
  - Allows .NET users to download Gurobi directly from NuGet server (similar to “pip install” for Python)
- Memory limit parameter that allows graceful exit
  - User can set a memory limit and still get best solution and resume optimization after limit was hit

Gurobipy

Other new matrix-friendly features/methods

GUROBI OPTIMIZATION

- General
  - Shape of operation resultants now consistent with analogous ndarray operations
  - Elementwise multiplication works across all matrix-friendly objects and ndarray
- MVar
  - Extract a diagonal from an MVar X : X.diagonal(offset).
  - Convert a list of Var objects to an MVar: x = MVar.fromlist(varlist)
  - Sum along an axis of an MVar X: X.sum(axis=…)
  - Elementwise squaring of an Mvar X: pow(X, 2), X**2
- MLinExpr
  - All-zero expression: MLinExpr.zeros(shape)
  - Sum along an axis of an MLinExpr mle: mle.sum(axis=…)
- New class MQuadExpr
  - For modeling multidimensional quadratic constraints
  - Similar features/methods as MLinExpr
- New class MQConstr
  - Multi-dimensional constraint handle returned from model.addConstr(…) for quadratic expressions
  - Similar features/methods as MConstr

Gurobi 10.0 – Engine

Ease of Use – External Open-Source GitHub Packages

GUROBI OPTIMIZATION

- Gurobi Machine Learning
  - Allows users to add a trained machine learning model as constraint to a MIP
    - e.g., from scikit-learn, TensorFlow/Keras, or XGBoost
  - Real-world system is captured by training a machine learning model
  - Using ML model in a MIP allows to optimize controls on that system
- Gurobipy accessors for pandas
  - Enables convenient gurobipy model building patterns with pandas
  - Specialized global methods, and object accessors for Index, Series and DataFrame objects
- Gurobi model collection*
  - Collection of ready-to-be-used functions to optimize specific problem classes
    - Start with a few problem types (from machine learning, OR, graph problems); extend over time
  - Very easy data I/O interface
  - Targets new users of math modeling with pre built code
- Numerical issues assessment tool*
  - Allows users to analyze models with numerical issues to find out root cause of such issues
  - Targets expert users that deal with numerically very challenging optimization models

*final name to be determined, may not be ready at release


Performance

Gurobi 10.0 – Engine

Performance Features

GUROBI OPTIMIZATION

- New network simplex algorithm
  - Greatly speeds up solving LPs with a network structure
- Added another heuristic for QUBO
  - Improves Gurobi's ability to quickly find good feasible solutions for quadratic unconstrained Boolean optimization problems
  - QUBO is one computational model for quantum optimization
- Significant performance gains on models that contain machine learning models
  - Very important for making our external GitHub “Gurobi Machine Learning” package more useful in practice
- General performance improvements for all problem classes

GUROBI OPTIMIZATION

Gurobi 10.0 beta

Performance Summary

Performance improvements compared to Gurobi 9.5

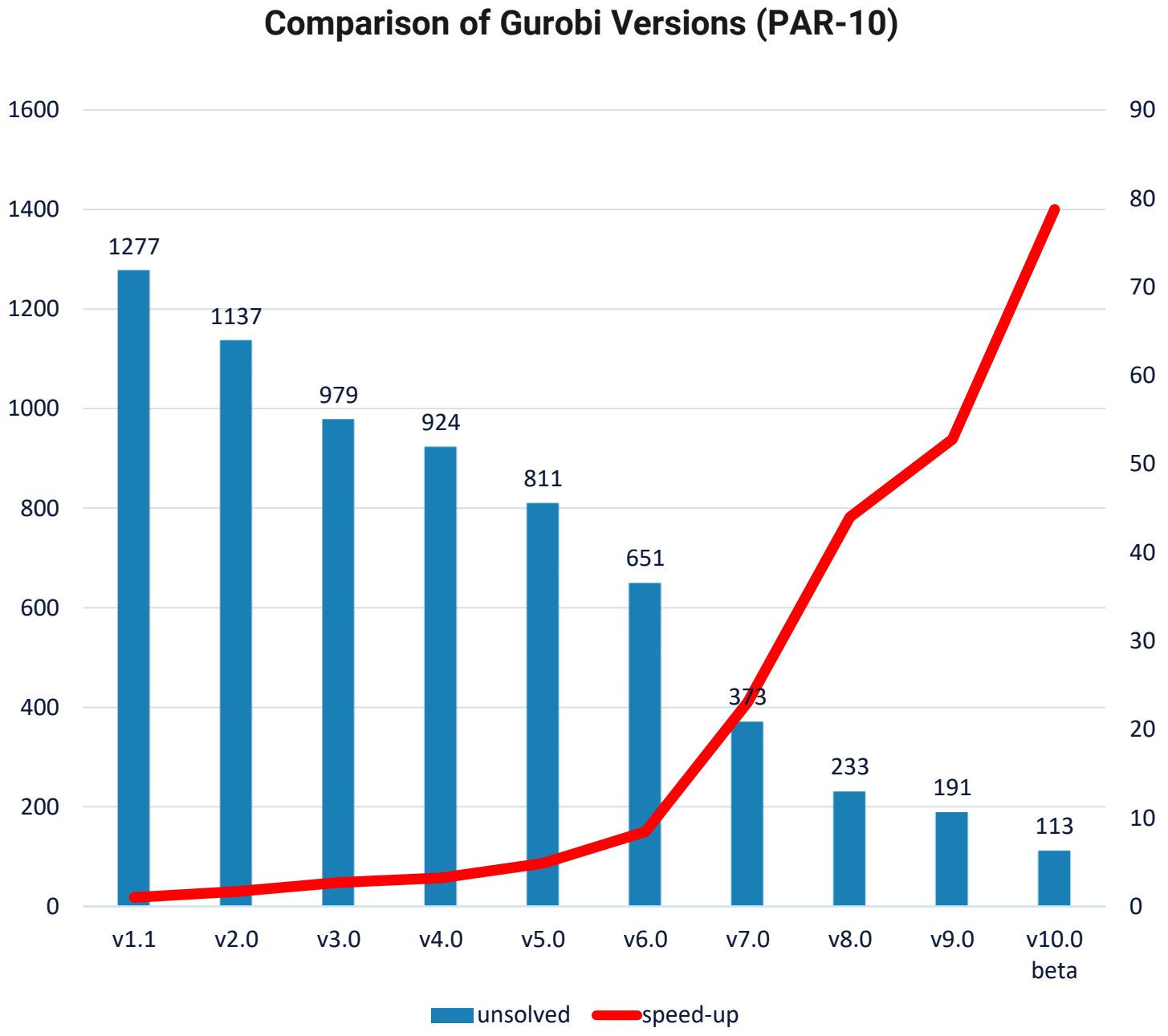
Algorithm	Overall speed-up	On >100sec models
Concurrent LP	8%	20%
MILP	12%	20%
Convex MIQP	47%	2.1x*
Convex MIQCP	14%	33%*
Non-convex MIQCP	59%	3.0x

* MIQP and MIQCP hard model tests set too small to give reliable benchmark results

GUROBI OPTIMIZATION

MILP

Performance Evolution



GUROBI OPTIMIZATION

Thank You

Watch for 10.0 webinars for more details

