



# GAMS

## Benchmarking & Quality Assurance

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GAMS Development Corporation / GAMS Software GmbH



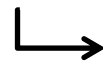


# Agenda

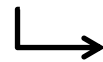
GAMS

Benchmarking - Challenges

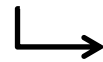
Benchmarking - Perspectives



User



Solver Developer



GAMS – Software Quality Assurance

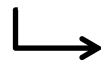


# Agenda

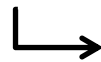
GAMS

Benchmarking - Challenges

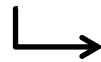
Benchmarking - Perspectives



User



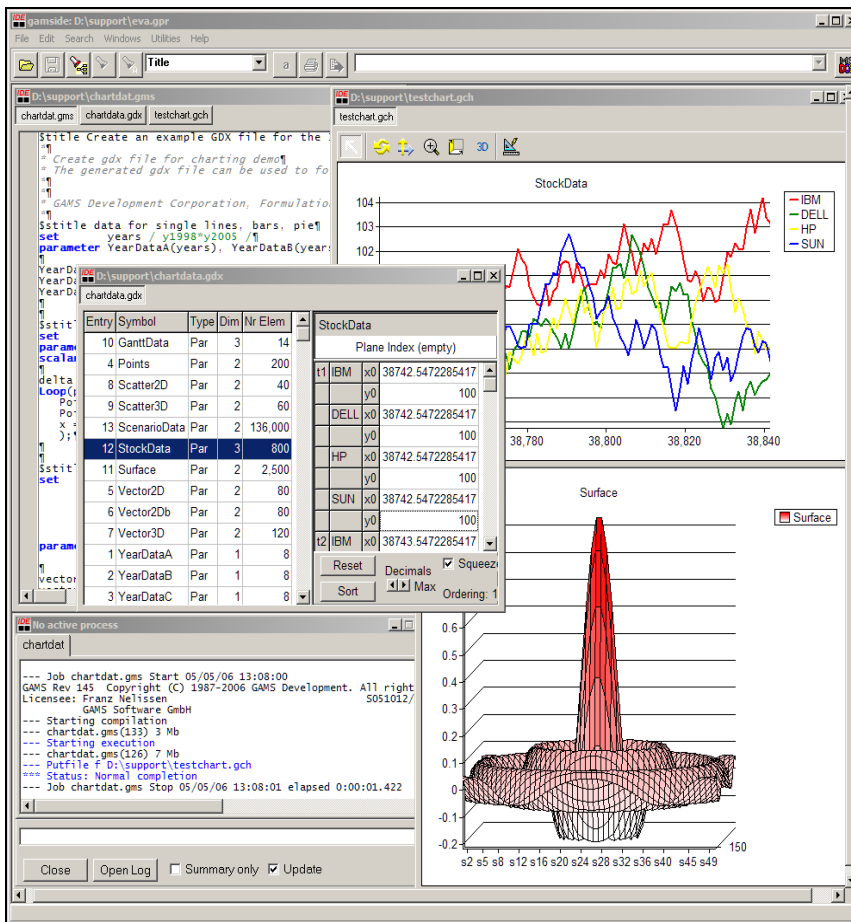
Solver Developer



GAMS – Software Quality Assurance



# GAMS at a Glance

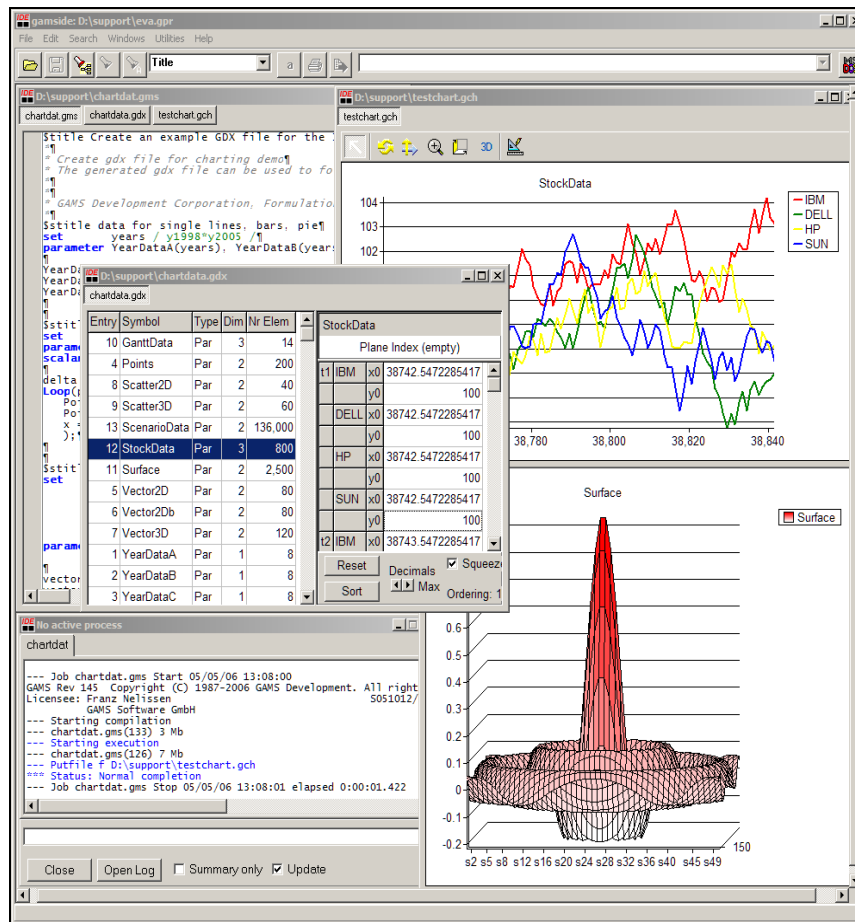


## Algebraic Modeling System

- Facilitates to formulate mathematical optimization problems similar to algebraic notation
  - Simplified model building
- Provides links to appropriate state-of-the-art external algorithms
  - Efficient solution process

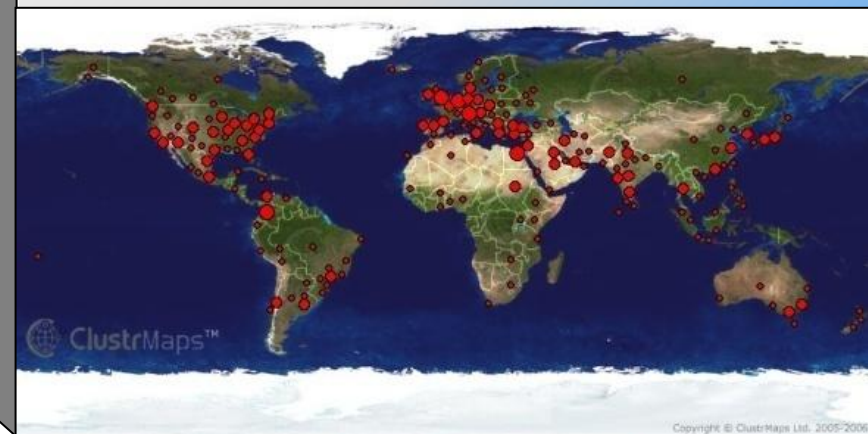


# GAMS at a Glance



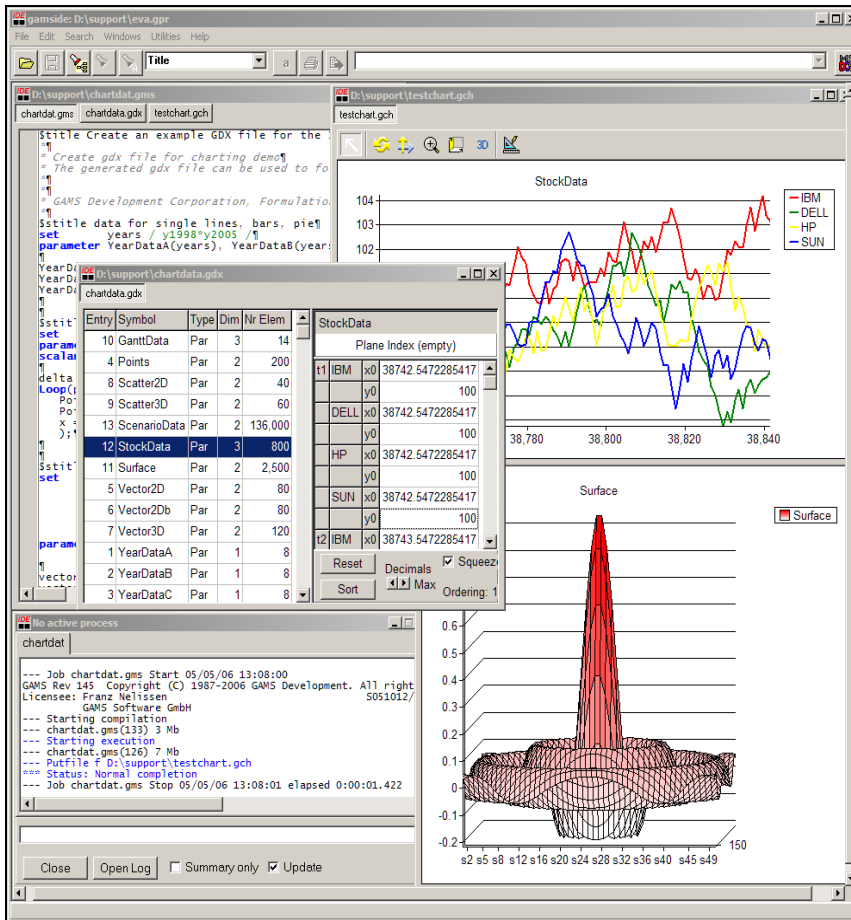
## General Algebraic Modeling System

- Roots: World Bank, 1976
- Went commercial in 1987
- GAMS Development Corp.
- GAMS Software GmbH
- Broad academic & commercial user community and network





# GAMS at a Glance

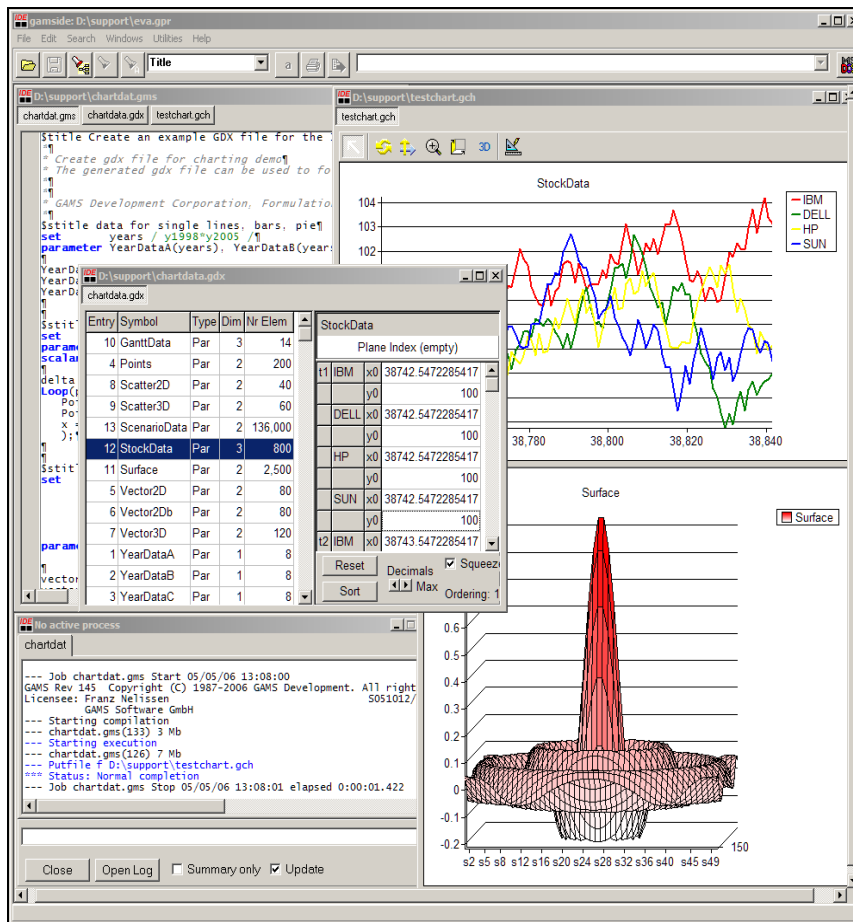


## General Algebraic Modeling System

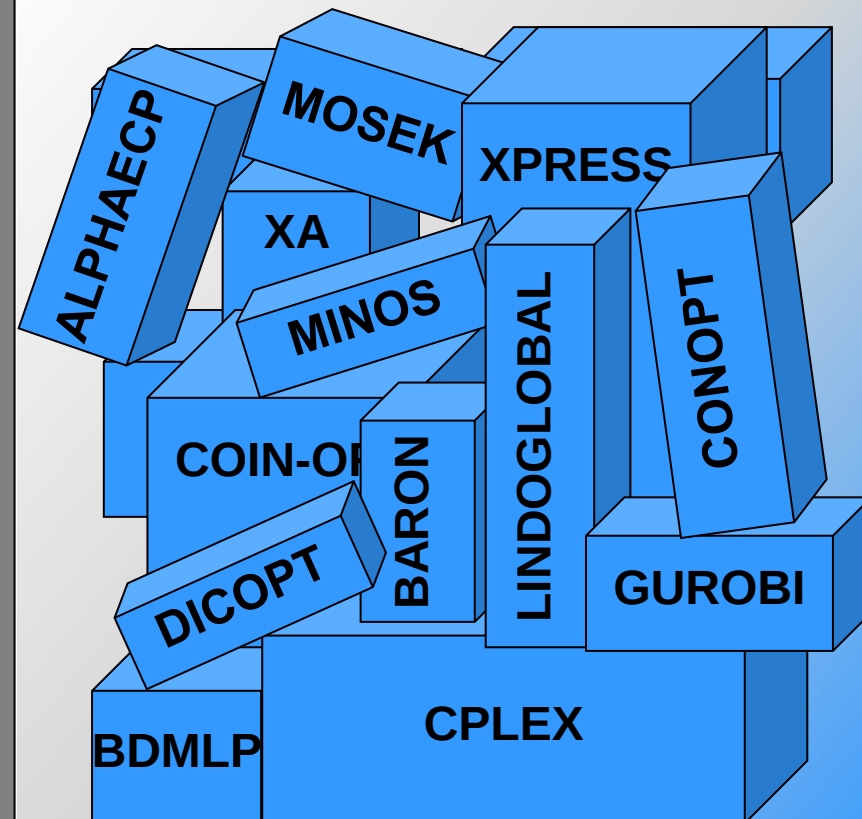
- Algebraic Modeling Language
- 25+ Integrated Solvers
- 10+ Supported MP classes
- 10+ Supported Platforms
- Connectivity- & Productivity Tools
  - IDE
  - Model Libraries
  - GDX, Interfaces & Tools
  - Grid Computing
  - Benchmarking
  - Compression & Encryption
  - Deployment System
  - ...



# GAMS at a Glance

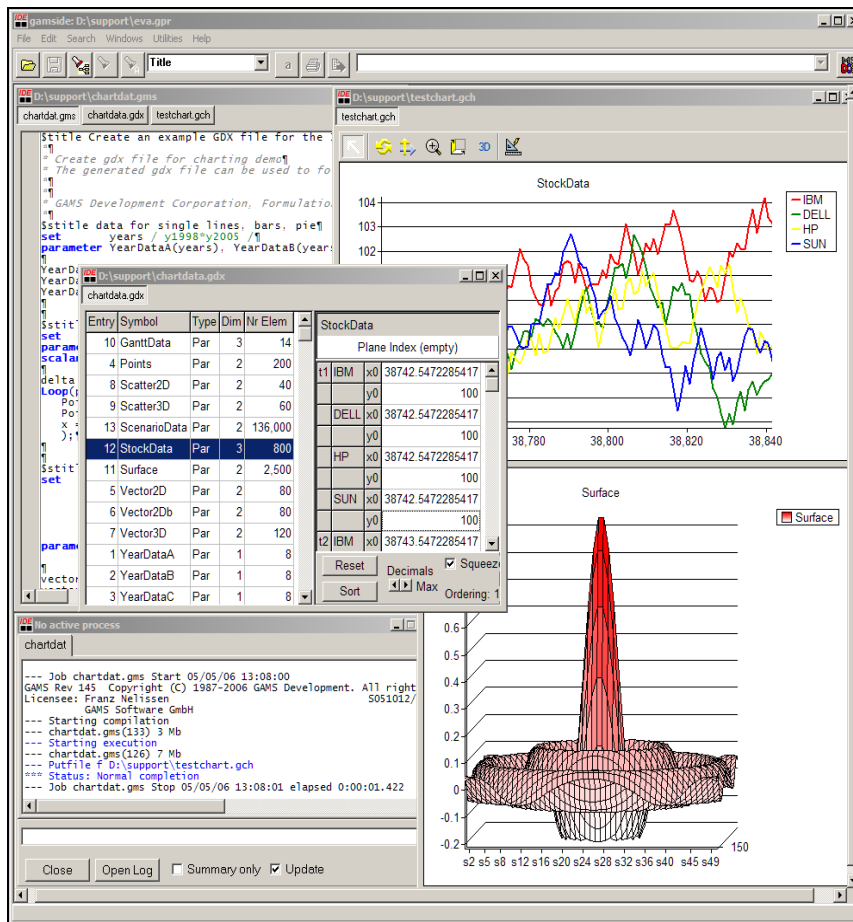


25+ Integrated Solvers

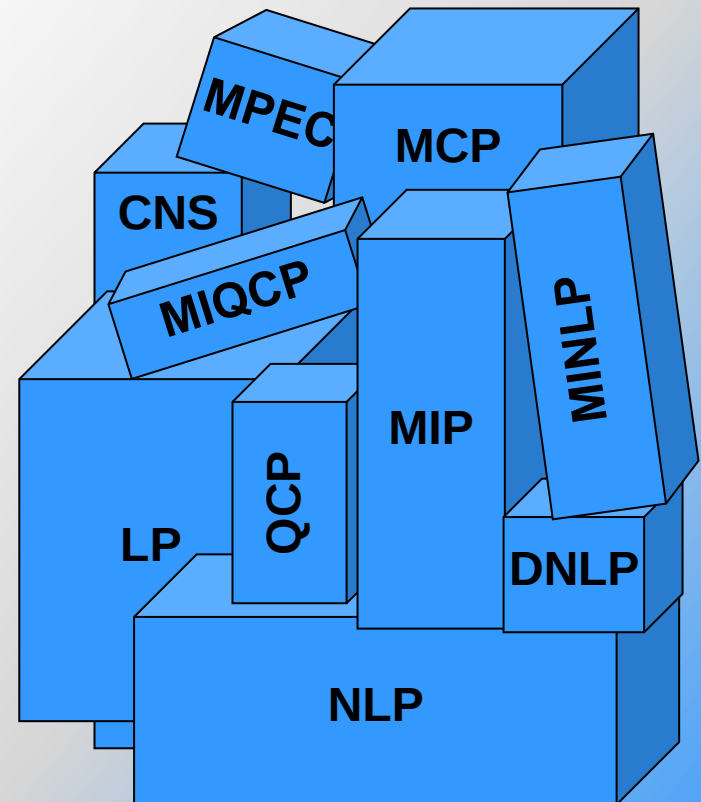




# GAMS at a Glance

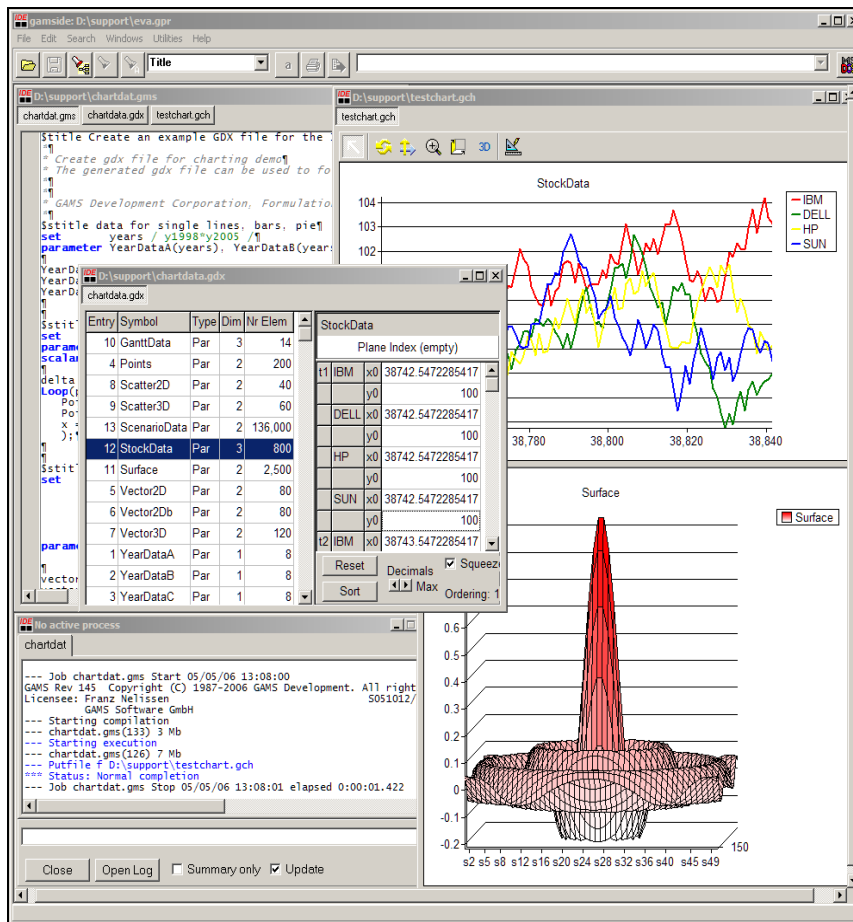


10+ Supported MP classes

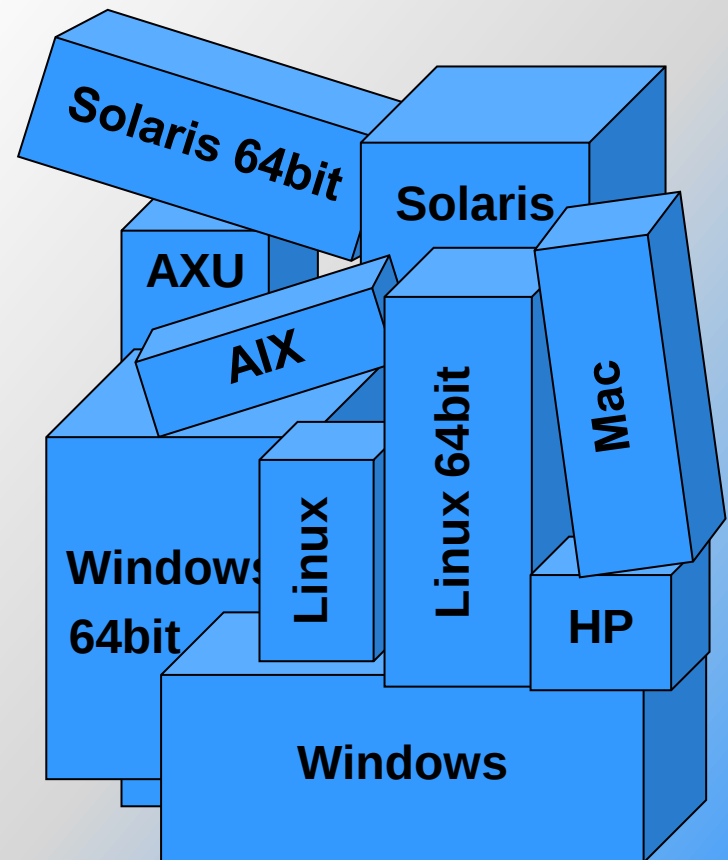




# GAMS at a Glance



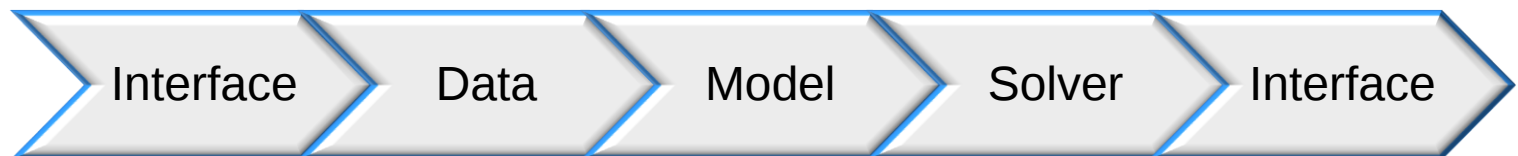
10+ Supported Platforms





# GAMS' Fundamental concepts

- **Platform independence**
- **Open architecture and interfaces to other systems**
- **Balanced mix of declarative and procedural elements**
  - Declaration of Sets, Parameters, Variables, Equations, Models,
  - Procedural Elements like loops, if-then-else, ...
- **Layers of separation**





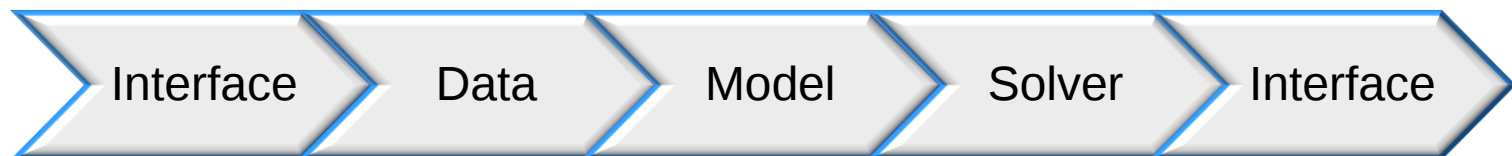
# GAMS' Fundamental concepts

- **Different layers with separation of**

- model and data
- model and solution methods
- model and operating system
- model and interface

→ **Models benefit from**

- advancing hardware
- enhanced / new solver technology
- improved / upcoming interfaces to other systems



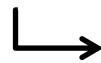


# Agenda

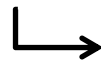
GAMS

Benchmarking - Challenges

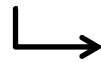
Benchmarking - Perspectives



User



Solver Developer



GAMS – Software Quality Assurance



# Challenges

Benchmarking is not glamorous –  
where's the novelty & publications?

- *Make the tools used public - “open-source” them*
- *Make it a group project with high priority*



## Challenges cont'd

Benchmarking is time-consuming

- *Create standard libraries of test problems, categorized for convenient access*
- *Automate*
  - *the creation of test scripts*
  - *the collection of data*
  - *the creation and display of statistics*



## Challenges cont'd

Benchmark results can be subjective, misleading, or hard to believe – conclusions can be hard to draw.

- *One can always make a certain solver look best. Choices: Models and solver options?*
- *Test libraries and automation reduce subjective element and make benchmarks reproducible, hence believable*
- *Automate the creation and display of statistics*



## Challenges cont'd

The political baggage – domination vs. balance

- *Interesting benchmarks show dominance and therefore might discredit products*
- *Benchmarks showing balanced results are less interesting*



# Agenda

GAMS

Benchmarking - Challenges

Benchmarking - Perspectives

└─ User

└─ Solver Developer

└─ GAMS – Software Quality Assurance

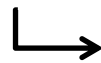


# Agenda

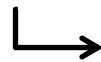
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Benchmarking - Challenges

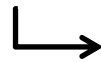
Benchmarking - Perspectives



User



Solver Developer



GAMS – Software Quality Assurance



# Perspectives

## GAMS User

- *Which solver is the best for **my** model?*
- *Which solver shall I license?*
- *Is the solution returned by the solver indeed correct?*



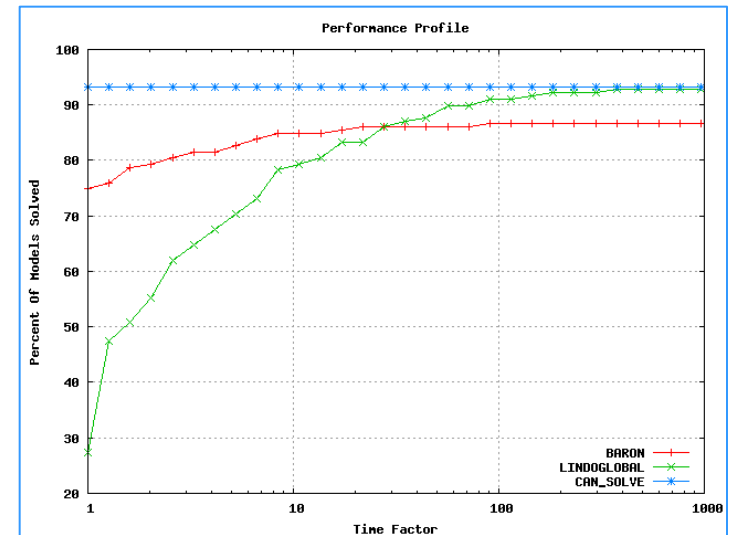
# Which Solver?

| Solver/Model type availability - 23.4 May 24, 2010 |    |     |     |     |      |     |      |       |     |       |        |        |
|----------------------------------------------------|----|-----|-----|-----|------|-----|------|-------|-----|-------|--------|--------|
|                                                    | LP | MIP | NLP | MCP | MPEC | CNS | DNLP | MINLP | QCP | MIQCP | Stoch. | Global |
| ALPHAECIP                                          |    |     |     |     |      |     |      | ✓     |     | ✓     |        |        |
| BARON 9.0                                          | ✓  | ✓   | ✓   |     |      |     | ✓    | ✓     | ✓   | ✓     |        | ✓      |
| BDMLP                                              | ✓  | ✓   |     |     |      |     |      |       |     |       |        |        |
| COIN-OR                                            | ✓  | ✓   | ✓   |     |      |     | ✓    | ✓     | ✓   | ✓     |        | ✓      |
| CONOPT 3                                           | ✓  |     | ✓   |     |      | ✓   | ✓    |       | ✓   | ✓     |        |        |
| CPLEX 12.1                                         | ✓  | ✓   |     |     |      |     |      |       | ✓   | ✓     |        |        |
| DECIS                                              | ✓  |     |     |     |      |     |      |       |     |       | ✓      |        |
| DICOPT                                             |    |     |     |     |      |     |      | ✓     |     | ✓     |        |        |
| GUROBI 3.0                                         | ✓  | ✓   |     |     |      |     |      |       |     |       |        |        |
| KNITRO 6.0                                         | ✓  |     | ✓   |     |      |     | ✓    | ✓     | ✓   | ✓     |        |        |
| LINDOGLOBAL 6.0                                    | ✓  | ✓   | ✓   |     |      |     | ✓    | ✓     | ✓   | ✓     |        | ✓      |
| LGO                                                | ✓  |     | ✓   |     |      |     | ✓    |       | ✓   |       |        | ✓      |
| MILES                                              |    |     |     | ✓   |      |     |      |       |     |       |        |        |
| MINOS                                              | ✓  |     | ✓   |     |      |     | ✓    |       | ✓   |       |        |        |
| MOSEK 6                                            | ✓  | ✓   | ✓   |     |      |     | ✓    |       | ✓   | ✓     |        |        |
| MPSGE                                              |    |     |     |     |      |     |      |       |     |       |        |        |
| MSNLP                                              |    |     | ✓   |     |      |     | ✓    |       | ✓   |       |        | ✓      |
| NLPEC                                              |    |     |     | ✓   | ✓    |     |      |       |     |       |        |        |
| OQNLP                                              |    |     | ✓   |     |      |     | ✓    | ✓     | ✓   | ✓     |        | ✓      |
| OSL V3                                             | ✓  | ✓   |     |     |      |     |      |       |     |       |        |        |
| OSLSE                                              | ✓  |     |     |     |      |     |      |       |     |       | ✓      |        |
| PATH                                               |    |     |     | ✓   |      | ✓   |      |       |     |       |        |        |
| SBB                                                |    |     |     |     |      |     |      | ✓     |     | ✓     |        |        |
| SCIP                                               | ✓  | ✓   |     |     |      |     |      |       | ✓   | ✓     |        |        |
| SNOPT                                              | ✓  |     | ✓   |     |      |     | ✓    |       | ✓   |       |        |        |
| XA                                                 | ✓  | ✓   |     |     |      |     |      |       |     |       |        |        |
| XPRESS 20.00                                       | ✓  | ✓   |     |     |      |     |      |       | ✓   |       |        |        |
| Contributed Plug&Play solvers                      |    |     |     |     |      |     |      |       |     |       |        |        |
| AMPLwrap                                           | ✓  | ✓   | ✓   | ✓   | ✓    | ✓   | ✓    | ✓     | ✓   | ✓     | ✓      | ✓      |
| DEA                                                | ✓  | ✓   |     |     |      |     |      |       |     |       |        |        |
| Kestrel                                            | ✓  | ✓   | ✓   | ✓   | ✓    | ✓   | ✓    | ✓     | ✓   | ✓     | ✓      | ✓      |



# GAMS/Bench & GAMS/Examiner

- GAMS/Bench
  - Benchmarks GAMS solvers
  - Creates problem matrix once and gives it to all solvers
  - Creates trace files for visualization
  - Can call GAMS/Examiner to verify correctness of solutions
- GAMS/Examiner
  - produces an unbiased, independent report on the merit of points
  - Points may come from GAMS or a solver
  - tolerances can be adjusted, default is tight
  - Examiner only *reports*, it doesn't *fix*





# GAMS/Bench & GAMS/Examiner

gamside: C:\Work\_Greenmont\GEM\gem.gpr

File Edit Search Windows Utilities Model Libraries Help

trnsport.gms trnsport.lst

```

$title A Transportation Problem (TRNSPORT,SEQ=1)
$ontext

This problem finds a least cost shipping schedule
requirements at markets and supplies at factories

Dantzig, G B, Chapter 3.3. In Linear Programming and Extensions
Princeton University Press, Princeton, New Jersey, 1963.

This formulation is due to
Rosenthal, R E, Chapter 10. In Linear Programming
The Scientific Press,

The line numbers will be
comments.

$offtext

Sets
  i  canning plants
  j  markets

Parameters
  a(i) capacity of canning plants
      /   seattle      san-diego
  b(j) demand at markets
      /   new-york     chicago    topeka

Table d(i,j) distance between locations
      /   seattle      new-york    chicago    topeka

```

trnsport.log

```

--- BENCH SUMMARY:

  Solver  Modstat Solstat      Objective      ResUsd  Examiner
-----
  CPLEX   1         1        153.6750      0.007    P/P
  COINCB  1         1        153.6750      0.002    P/P
  COINSCIP 1         1        153.6750      0.001    P/P
  GUROBI  1         1        153.6750      0.000    P/P
  MOSEK   1         1        153.6750      0.117    P/P
  XPRESS  1         1        153.6750      0.020    P/P

--- Restarting execution
--- trnsport.gms(66) 2 Mb
--- Reading solution for model transport
--- Executing after solve: elapsed 0:00:00.616
--- trnsport.gms(68) 3 Mb
*** Status: Normal completion
--- Job trnsport.gms Stop 06/11/10 06:57:51 elapsed 0:00:00.617

```



# Agenda

GAMS

Benchmarking - Challenges

Benchmarking - Perspectives

↳ User

↳ Solver Developer

↳ GAMS – Software Quality Assurance



# Perspectives

Solver Developer

- *How does my solver compare to competitive products?*
- *Is my new version at least as good as the old one?*



# How does my solver perform?

- Different objectives
  - Solver robustness and correctness
  - Solver efficiency
  - Quality of solution (non-convex and discrete models)
- Collecting/creating models for this is not easy
- Results need to be reproducible to provide credibility
  - Shared test libraries allow reproducible results



# gamsworld.org



**The Worlds**

**CONE**

**GLOBAL**

**MINLP**

**MPEC**

**MPSGE**

**Performance**

**Translation**

**Search**

**Contact**

## GAMS World

### Welcome to the GAMS World

This is the home page of the GAMS World, a web site aiming to bridge the gap between academia and industry by providing highly focused forums and dissemination services in specialized areas of mathematical programming.

Substantial progress was made in the 1980s and 1990s with the development of algebra based modeling systems, algorithms, and computer codes to solve large and complex mathematical programs. The application of these tools, however, was less than expected. The abstraction, expression, and translation of real world problems into reliable and effective operational systems requires highly specialized and domains specific knowledge. The process of acquisition and dissemination of this knowledge is complex and poorly understood and the number of "good modelers" is much less than we all hoped for. Similarly, the process of transforming a new algorithm into a reliable and effective solution system is a slow and expensive process and there are few "good implementers". This web site hopes to address some of these problems by helping with the collection and dissemination of domain specific information and knowledge that is outside the established channels because of its content or form.

For example, model structures and results get published in commercial and academic papers but it is virtually impossible to reproduce any of those results or lift model components and data from one study to be used in some other study. Algorithm implementers face a similar dilemma when trying to get their hands on real world data models and data to test and refine their systems. This web site offers a few, well focused and maintained services to help with the dissemination of problems and solutions.



# Performance World



## Performance World

### Welcome to the Performance World!

Performance World is a forum for discussion and dissemination of information and tools about all aspects of performance testing of solvers for mathematical programming problems. This world has been established in response to user demands for independent and reproducible performance results.

Overall performance highly depends on problem formulation, solver, and tuning parameters. Our performance tools are designed to serve the different needs of our user community. One user may be interested in finding the most reliable way to solve a proprietary or classified model. On the other hand, an academic researcher may be interested in testing a new algorithm against a set of existing test problems and competing approaches. The main features are:

- Uniform access to a comprehensive set of established and new test problems
- Automation tools for collecting performance measurements
- Tools for analyzing and visualizing test results

### What's New:

- Several new libraries ([Fixed Cost Network Flow](#) and the [Princeton NLP](#) collection) have been added to the [Performance Libraries](#).
- A collection of quadratically constrained programs (QCP) have been added to the TINI TR set of models

**Editorial Board**

**PerformanceLib**

**Performance Tools**

**PAVER Server**

**Performance List**

**Related Links**

**Search**



# Performance Libraries



[ [Performance World Home](#) | [Board](#) | [Tools](#) | [PerformanceLib](#) | [Links](#) |

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## Performance Libraries

The purpose of the collections is to provide users with an established and varied set of both theoretical and practical test models and automation tools for collecting performance measurements on an established set of models.

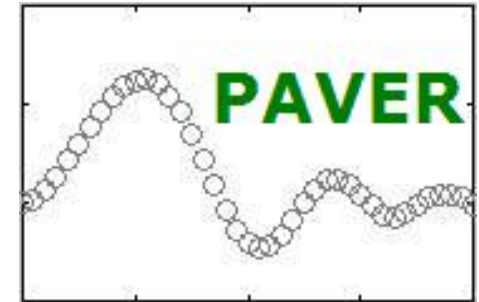
Our current collection consists of the following libraries:

- [AMPLBookLib](#) - LP, MIP, and NLP
- [FCNetLib](#) - MIP
- [GLOBALLib](#) - NLP
- [LINLib](#) - LP, MIP, and QCP
- [MacMOOPLib](#) - LP, NLP
- [MINLPLib](#) - MINLP
- [MPLLib](#) - LP, NLP
- [PrincetonLib](#) - NLP
- [Selected Continuous Global Optimization Lib](#) - NLP and DNLP
- [XPRESSLib](#) - LP, NLP



# PAVER Server

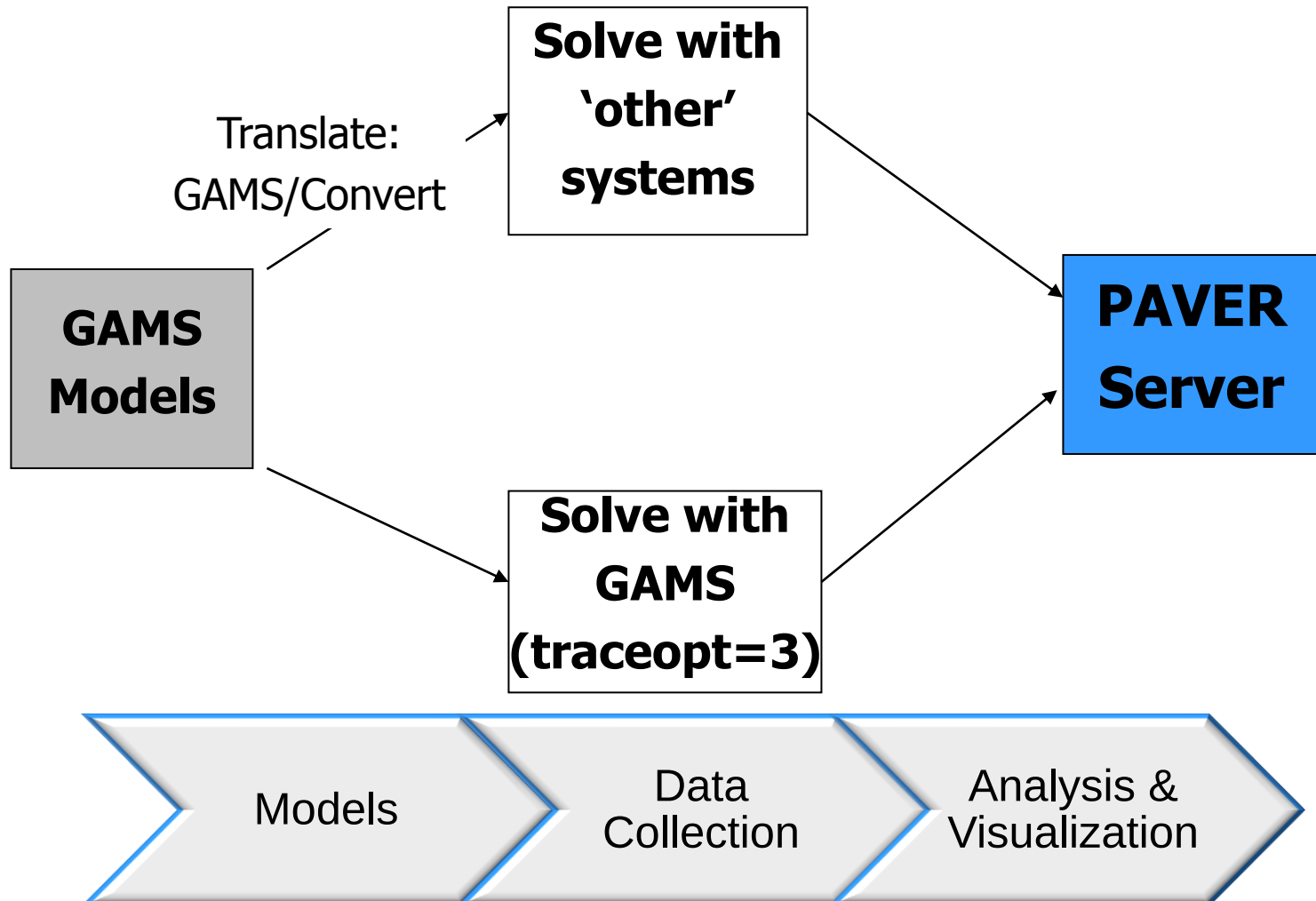
Performance Analysis and Visualization  
for Efficient Reproducibility



- Online server to facilitate performance testing and analysis/visualization
- Results sent via e-mail in HTML format
  - Platform independent
- Tools are GAMS independent !
- Up to 8 solvers can be compared concurrently



# Open Testing Architecture





# PAVER Trace File

## Trace file parameters

The column headers for traceopt=3 are as follows:

1. filename: GAMS model filename
2. modeltype: LP, MIP, NLP, etc.
3. solvername:
4. NLP def: default NLP solver
5. MIP def: default MIP solver
6. juliantoday: start day/time of job
7. direction: 0=min, 1=max
8. equnum: total number of equations
9. varnum: total number of variables
10. dvarnum: number of discrete variables
11. nz: number of nonzeros
12. nl nz: number of nonlinear nonzeros
13. optfile: 1= optfile included
14. modelstatus: GAMS model return status - see the [GAMS return codes](#) section.
15. solvestatus: GAMS solver return status - see the [GAMS return codes](#) section.
16. obj: value of objective function
17. object: objective function estimate
18. res used: resource time used (sec)
19. iter used: number of solver iterations
20. dom used:
21. nodes used:
22. user1: user comment - preceded by a #

```
* Trace Record Definition
* GamsSolve
* InputFileName,ModelType,SolverName,NLP,MIP,JulianDate,Direction,NumberOfEquations,Number
* ,ObjectiveValueEstimate,SolverTime,NumberOfIterations,NumberOfDomainViolations,NumberOf
*
transport,LP,CPLEX,CONOPT,CPLEX,40342.481,0,6,7,0,19,0,NA,1,1,153.675,NA,0.015,4,0,NA,#
```



# PAVER Server - Tools

- **Solver square summary**  
Cross comparison of solver outcomes of two solvers
- **Resource time summary**  
Cross comparison of solver resource times of two solvers
- **Performance profile summary**  
Visualization
- ...

FYI: The benchmark used for illustration is a benchmark between CBC and SCIP done by Stefan Vigerske (Feb 2010)  
see <http://www.coin-or.org/GAMSlinks/benchmarks/>



# PAVER Server – Tools cont'd

## Solver square summary:

The solver square utility compares solver outcomes of two given solvers over a model test set. The tool is described in detail at <http://www.gamsworld.eu/performance/square.htm>.

|            | CBC.trc | CPLEX.trc               | GUROBI.trc              | SCIP.trc                |
|------------|---------|-------------------------|-------------------------|-------------------------|
| CBC.trc    | --      | <a href="#">results</a> | <a href="#">results</a> | <a href="#">results</a> |
| CPLEX.trc  | --      | --                      | <a href="#">results</a> | <a href="#">results</a> |
| GUROBI.trc | --      | --                      | --                      | <a href="#">results</a> |
| SCIP.trc   | --      | --                      | --                      | --                      |

## Resource time summary:

The resource time utility compares solver resource times of two given solvers over a model test set. The tool is described in detail at <http://www.gamsworld.eu/performance/restime.htm>.

|            | CBC.trc | CPLEX.trc               | GUROBI.trc              | SCIP.trc                |
|------------|---------|-------------------------|-------------------------|-------------------------|
| CBC.trc    | --      | <a href="#">results</a> | <a href="#">results</a> | <a href="#">results</a> |
| CPLEX.trc  | --      | --                      | <a href="#">results</a> | <a href="#">results</a> |
| GUROBI.trc | --      | --                      | --                      | <a href="#">results</a> |
| SCIP.trc   | --      | --                      | --                      | --                      |



# PAVER - Solver Square Summary

|                            | SCIP:<br>optimal | SCIP:<br>locally<br>optimal | SCIP:<br>feasible | SCIP:<br>infeasible | SCIP:<br>unbounded | SCIP:<br>fail | SCIP:<br>no<br>data | total<br>Cbc |
|----------------------------|------------------|-----------------------------|-------------------|---------------------|--------------------|---------------|---------------------|--------------|
| Cbc:<br>optimal            | 97<br>*****      | -                           | 3<br>****         | -                   | -                  | -             | -                   | 100<br>***** |
| Cbc:<br>locally<br>optimal | -                | -                           | -                 | -                   | -                  | -             | -                   | -            |
| Cbc:<br>feasible           | 2<br>****        | -                           | 25<br>*****       | 1<br>****           | -                  | -             | -                   | 28<br>*****  |
| Cbc:<br>infeasible         | -                | -                           | -                 | -                   | -                  | -             | -                   | -            |
| Cbc:<br>unbounded          | -                | -                           | -                 | -                   | -                  | -             | -                   | -            |
| Cbc:<br>fail               | 1<br>****        | -                           | -                 | -                   | -                  | -             | -                   | 1<br>****    |
| Cbc:<br>no data            | -                | -                           | -                 | -                   | -                  | -             | -                   | -            |
| total SCIP                 | 100<br>*****     | -                           | 28<br>*****       | 1<br>****           | -                  | -             | -                   | 129<br>***** |



# PAVER - Solver Square Detail

Cbc: feasible -- SCIP: infeasible

[Back to top](#)

| Modelname | Time (Cbc) | Time (SCIP) | Ratio (Cbc/SCIP) | Obj (Cbc)  | Status (SCIP)       |
|-----------|------------|-------------|------------------|------------|---------------------|
| bc        | 3603.2200  | 36.8700     | ---              | 7.00000000 | mstat(19) sstat( 1) |

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Cbc: fail -- SCIP: optimal

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| Modelname   | Time (Cbc) | Time (SCIP) | Ratio (Cbc/SCIP) | Status (Cbc)        | Obj (SCIP) |
|-------------|------------|-------------|------------------|---------------------|------------|
| acc-tight-2 | 3601.2800  | 1088.0300   | ---              | mstat(14) sstat( 3) | 0.00000000 |

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# PAVER Server – Tools cont'd

## Solver square summary:

The solver square utility compares solver outcomes of two given solvers over a model test set. The tool is described in detail at <http://www.gamsworld.eu/performance/square.htm>.

|            | CBC.trc | CPLEX.trc               | GUROBI.trc              | SCIP.trc                |
|------------|---------|-------------------------|-------------------------|-------------------------|
| CBC.trc    | --      | <a href="#">results</a> | <a href="#">results</a> | <a href="#">results</a> |
| CPLEX.trc  | --      | --                      | <a href="#">results</a> | <a href="#">results</a> |
| GUROBI.trc | --      | --                      | --                      | <a href="#">results</a> |
| SCIP.trc   | --      | --                      | --                      | --                      |

## Resource time summary:

The resource time utility compares solver resource times of two given solvers over a model test set. The tool is described in detail at <http://www.gamsworld.eu/performance/restime.htm>.

|            | CBC.trc | CPLEX.trc               | GUROBI.trc              | SCIP.trc                |
|------------|---------|-------------------------|-------------------------|-------------------------|
| CBC.trc    | --      | <a href="#">results</a> | <a href="#">results</a> | <a href="#">results</a> |
| CPLEX.trc  | --      | --                      | <a href="#">results</a> | <a href="#">results</a> |
| GUROBI.trc | --      | --                      | --                      | <a href="#">results</a> |
| SCIP.trc   | --      | --                      | --                      | --                      |



# PAVER – Resource Time Summary

|                                          | Total              | Obj Cbc better    | Obj same           | Obj SCIP better   |
|------------------------------------------|--------------------|-------------------|--------------------|-------------------|
| Solver Cbc infinitely faster :           | <a href="#">1</a>  | <a href="#">1</a> | -                  | -                 |
| Solver Cbc much faster :                 | <a href="#">26</a> | -                 | <a href="#">26</a> | -                 |
| Solver Cbc faster :                      | <a href="#">20</a> | -                 | <a href="#">20</a> | -                 |
| Solvers perform the same :               | <a href="#">35</a> | <a href="#">8</a> | <a href="#">21</a> | <a href="#">6</a> |
| Solver SCIP faster :                     | <a href="#">23</a> | -                 | <a href="#">23</a> | -                 |
| Solver SCIP much faster :                | <a href="#">23</a> | <a href="#">3</a> | <a href="#">19</a> | <a href="#">1</a> |
| Solver SCIP infinitely faster :          | <a href="#">1</a>  | -                 | -                  | <a href="#">1</a> |
| Both solvers failed to solve optimally : | -                  | -                 | -                  | -                 |
| Total models: :                          | <b>129</b>         | <b>12</b>         | <b>109</b>         | <b>8</b>          |



# PAVER – Resource Time Detail

Solver SCIP much faster - Obj of Cbc better:

| Modelname  | Time (Cbc) | Time (SCIP) | Ratio (Cbc / SCIP) | Obj (Cbc)             | Obj (SCIP)     |
|------------|------------|-------------|--------------------|-----------------------|----------------|
| bcl        | 1497.3200  | 15.7800     | 94.887             | <b>3.33836255E+00</b> | 3.49143049E+00 |
| markshare1 | 3604.2100  | 1306.2900   | 2.759              | <b>4.00000000E+00</b> | 1.00000000E+01 |
| markshare2 | 3601.3200  | 1527.1900   | 2.358              | <b>1.10000000E+01</b> | 1.90000000E+01 |

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Solver SCIP much faster - Obj same for both solvers:

| Modelname   | Time (Cbc) | Time (SCIP) | Ratio (Cbc / SCIP) | Obj (Cbc)      | Obj (SCIP)     |
|-------------|------------|-------------|--------------------|----------------|----------------|
| acc-tight-3 | 1301.4600  | 113.3800    | 11.479             | 0.00000000E+00 | 0.00000000E+00 |
| bell15      | 3.1100     | 0.4400      | 7.068              | 8.96640649E+06 | 8.96640649E+06 |
| blend2      | 2.8200     | 0.3300      | 8.545              | 7.59898500E+00 | 7.59898500E+00 |
| eild76      | 1491.7500  | 31.1000     | 47.966             | 8.85411847E+02 | 8.85411847E+02 |
| enigma      | 2.2300     | 0.9300      | 2.398              | 0.00000000E+00 | 0.00000000E+00 |

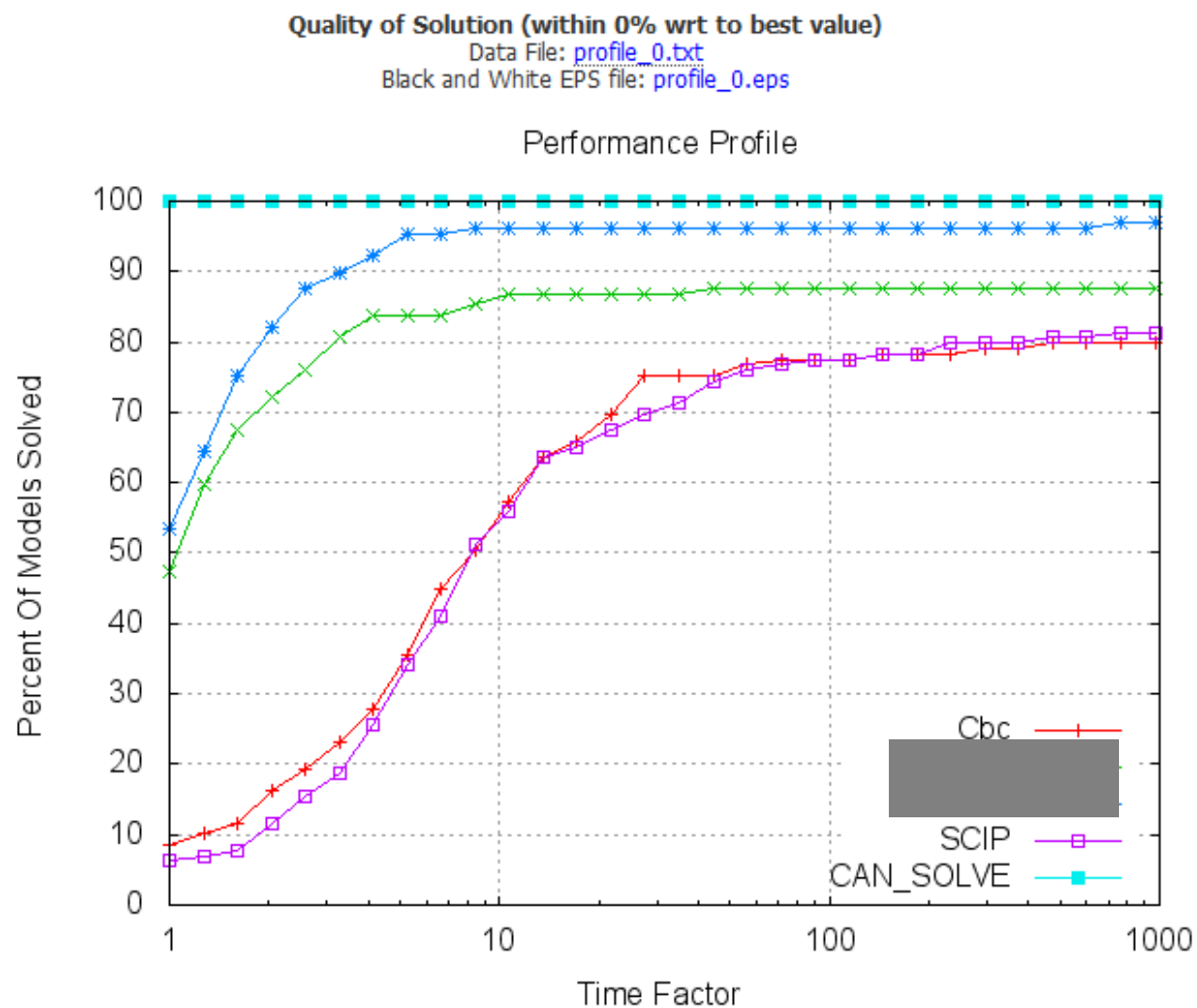


# PAVER – Performance Profile Summary

- Cumulative distribution function for a performance metric
- Performance metric: ratio of current solver time over best time of all solvers
- Intuitively: probability of success if given  $\tau$  times fastest time ( $\tau$ =ratio)

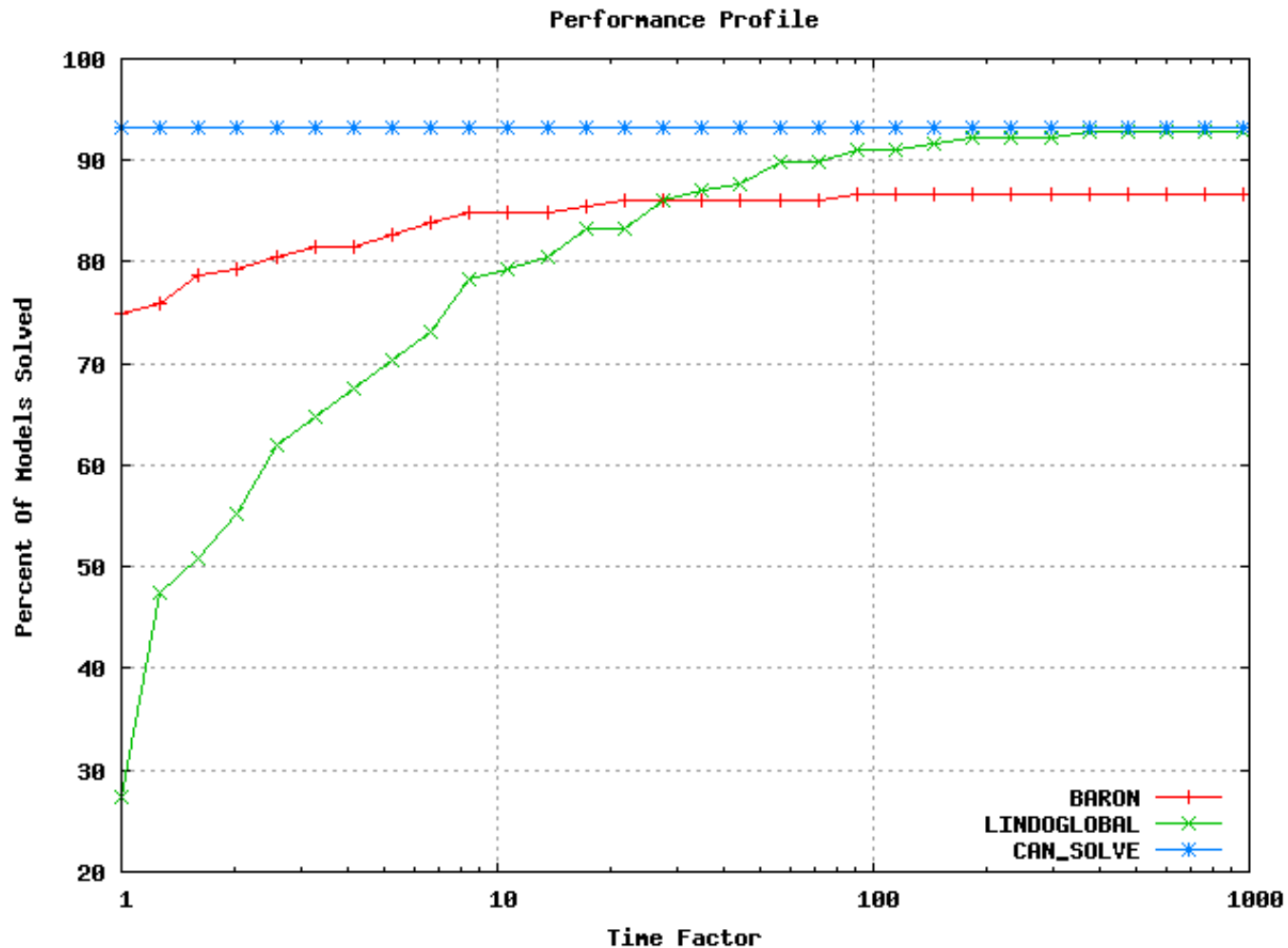


# PAVER – Performance Profile Summary cont'd





# PAVER – Performance Profile Summary





# Agenda

GAMS

Benchmarking - Challenges

Benchmarking - Perspectives

└─ User

└─ Solver Developer

└─ GAMS – Software Quality Assurance



# Perspectives

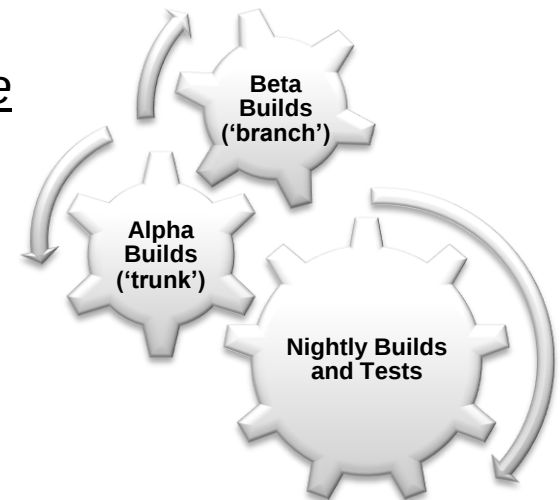
## GAMS – Software Quality Assurance

- *Do we meet our standards?*
- *Is our new distribution backward compatible?*
- *What is the impact of new implementation of parts of the GAMS system?*



# Key components of SQA

- **Software configuration management (SCM)**
  - All activities related to version control and change control
    - Version control via remote SVN server
    - Bug tracking via remote TRAC server
- **Quality control and testing**
  - Focus on the quality of product within each phase of the software development lifecycle
  - Objective: identify and remove defects throughout the lifecycle, as early as possible
    - Public Test Libraries
    - Performance comparison tools
    - Solution verification tools
    - Proactive Software Development Lifecycle





# Proactive Software Development Lifecycle

Latest GAMS System Builds and Test Results

Monday 14Jun10 16:23 (UTC)

[ [Latest Builds](#) | [Alpha Builds](#) | [Beta Builds](#) | [Nightly Builds](#) | [System Codes](#) | [History](#) ]

[Comments](#)

| nightly a                 | System              | Libraries                | Build  | Rev   | Status and Time (UTC)           | Initial Tests                 | Full Tests                                               |
|---------------------------|---------------------|--------------------------|--------|-------|---------------------------------|-------------------------------|----------------------------------------------------------|
| <a href="#">Friday</a>    | <a href="#">lnx</a> | <a href="#">Download</a> | 23.6.0 | 18017 | Test done 12Jun2010 02:07:32    | 420 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 1036 runs 6 failures (q=6,s=0)    |
| <a href="#">Friday</a>    | <a href="#">lx3</a> | <a href="#">Download</a> | 23.6.0 | 18017 | Test done 12Jun2010 02:06:41    | 425 runs 1 failures (q=0,s=0) | <a href="#">Report</a> 1058 runs 6 failures (q=6,s=0)    |
| <a href="#">Friday</a>    | <a href="#">vs8</a> | <a href="#">Download</a> | 23.6.0 | 18019 | Test done 14Jun2010 08:39:31    | 444 runs 1 failures (q=0,s=0) | <a href="#">Report</a> 9016 runs 25 failures (q=8,s=17)  |
| <a href="#">Friday</a>    | <a href="#">wei</a> | <a href="#">Download</a> | 23.6.0 | 18022 | Test done 13Jun2010 20:55:24    | 425 runs 2 failures (q=1,s=1) | <a href="#">Report</a> 7630 runs 76 failures (q=11,s=65) |
| nightly β                 | System              | Libraries                | Build  | Rev   | Status and Time (UTC)           | Initial Tests                 | Full Tests                                               |
| <a href="#">Friday</a>    | <a href="#">lnx</a> | <a href="#">Download</a> | 23.5.0 | 18021 | Test started 12Jun2010 01:55:30 | 543 runs 0 failures (q=0,s=0) | <a href="#">Report</a> results pending                   |
| <a href="#">Thursday</a>  | <a href="#">lx3</a> | <a href="#">Download</a> | 23.4.3 | 17848 | Test done 28May2010 06:59:06    | 529 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9435 runs 0 failures (q=0,s=0)    |
| <a href="#">Thursday</a>  | <a href="#">vs8</a> | <a href="#">Download</a> | 23.4.3 | 17852 | Test done 28May2010 16:42:04    | 508 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 8424 runs 0 failures (q=0,s=0)    |
| <a href="#">Wednesday</a> | <a href="#">wei</a> | <a href="#">Download</a> | 23.4.3 | 17812 | Test done 27May2010 14:27:23    | 488 runs 2 failures (q=2,s=0) | <a href="#">Report</a> 7539 runs 1 failures (q=1,s=0)    |
| alpha                     | System              | Libraries                | Build  | Rev   | Status and Time (UTC)           | Initial Tests                 | Full Tests                                               |
| <a href="#">20100408</a>  | <a href="#">aix</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 06:29:24    | 290 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 2893 runs 1 failures (q=1,s=0)    |
| <a href="#">20100408</a>  | <a href="#">deq</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 01:45:46    | 406 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 5301 runs 1 failures (q=1,s=0)    |
| <a href="#">20100408</a>  | <a href="#">diq</a> | <a href="#">Download</a> | 23.4.0 | 16878 | Test done 09Apr2010 16:46:57    | 410 runs 7 failures (q=0,s=7) | <a href="#">Report</a> 5685 runs 99 failures (q=32,s=67) |
| <a href="#">20100408</a>  | <a href="#">leq</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 09:29:57    | 520 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 8954 runs 2 failures (q=2,s=0)    |
| <a href="#">20100408</a>  | <a href="#">lei</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 04:55:44    | 526 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9397 runs 1 failures (q=1,s=0)    |
| <a href="#">20100408</a>  | <a href="#">lnx</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 12Apr2010 13:04:53    | 520 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 8955 runs 3 failures (q=3,s=0)    |
| <a href="#">20100408</a>  | <a href="#">lx3</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 05:58:20    | 526 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9408 runs 1 failures (q=1,s=0)    |
| <a href="#">20100408</a>  | <a href="#">siq</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 03:08:14    | 422 runs 2 failures (q=2,s=0) | <a href="#">Report</a> 5511 runs 4 failures (q=4,s=0)    |
| <a href="#">20100408</a>  | <a href="#">sol</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 09Apr2010 11:25:37    | 364 runs 2 failures (q=2,s=0) | <a href="#">Report</a> 4549 runs 2 failures (q=2,s=0)    |
| <a href="#">20100408</a>  | <a href="#">sox</a> | <a href="#">Download</a> | 23.4.0 | 16878 | Test done 10Apr2010 00:26:13    | 363 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 4548 runs 0 failures (q=0,s=0)    |
| <a href="#">20100408</a>  | <a href="#">vs8</a> | <a href="#">Download</a> | 23.4.0 | 16862 | Test done 10Apr2010 08:52:08    | 526 runs 2 failures (q=0,s=1) | <a href="#">Report</a> 9406 runs 18 failures (q=6,s=12)  |
| <a href="#">20100408</a>  | <a href="#">wei</a> | <a href="#">Download</a> | 23.4.0 | 16878 | Test done 10Apr2010 14:21:48    | 525 runs 1 failures (q=0,s=1) | <a href="#">Report</a> 9404 runs 29 failures (q=5,s=24)  |
| <a href="#">20100408</a>  | leiONubuntu64       | ---                      | 23.4.0 | ---   | Test done 09Apr2010 23:12:26    | 525 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9397 runs 3 failures (q=3,s=0)    |
| <a href="#">20100408</a>  | lx3ONubuntu32       | ---                      | 23.4.0 | ---   | Test done 09Apr2010 15:45:16    | 525 runs 1 failures (q=1,s=0) | <a href="#">Report</a> 9408 runs 3 failures (q=3,s=0)    |
| <a href="#">20100408</a>  | lx3ONubuntu64       | ---                      | 23.4.0 | ---   | Test done 09Apr2010 18:52:21    | 525 runs 1 failures (q=1,s=0) | <a href="#">Report</a> 9408 runs 5 failures (q=5,s=0)    |
| <a href="#">20100408</a>  | vs8ONmonte          | ---                      | 23.4.0 | ---   | Test done 10Apr2010 00:35:59    | 525 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9406 runs 1 failures (q=1,s=0)    |
| <a href="#">20100408</a>  | vs8ONtoyvista       | ---                      | 23.4.0 | ---   | Test done 13Apr2010 03:54:22    | 525 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9406 runs 2 failures (q=1,s=1)    |
| <a href="#">20100408</a>  | vs8ONtoypxp         | ---                      | 23.4.0 | ---   | Test done 13Apr2010 12:18:16    | 525 runs 0 failures (q=0,s=0) | <a href="#">Report</a> 9406 runs 2 failures (q=2,s=0)    |



**From: John Hooker <[john@hooker.tepper.cmu.edu](mailto:john@hooker.tepper.cmu.edu)>**

Key benchmarking issues to be addressed:

1. How are representative problem instances selected?
2. How are algorithmic parameters/settings adjusted, without tuning the software to a particular set of benchmark instances?
3. How are parameters/settings adjusted when comparing software packages, without favoring one over the other?
4. How do you control for different computing platforms?
5. How are test results used to improve the software?
6. Other issues you think are important.



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