

# GAMS

## Recent Enhancements in GAMS

Toni Lastusilta: [tlastusilta@gams.com](mailto:tlastusilta@gams.com)

20th CONFERENCE OF THE INTERNATIONAL FEDERATION OF OPERATIONAL RESEARCH SOCIETIES



**I F O R S**  
Internacional Federation of Operational Research Societies

The Art of Modeling **BARCELONA 2014**  
13th-18th July

# Agenda

What is GAMS?

Overview of Enhancements

Paver 2

Youtube Channel: GAMS lessons

Summary

# Algebraic Modeling Languages (AML)

1

- High-level computer programming languages
- Formulation of mathematical optimization problems
- Notation similar to algebraic notation

2

- Do not solve problems directly, but offer links to state-of-the-art algorithms (“solver-links”)

Source: [http://en.wikipedia.org/wiki/Algebraic\\_modeling\\_language](http://en.wikipedia.org/wiki/Algebraic_modeling_language)

# What does a modeler have to think about?

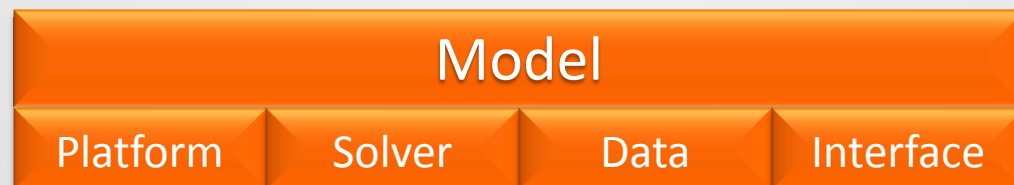


1. Application
2. Mathematics
3. Programming
4. Performance
5. Scalability
6. Connectivity
7. Deployment
8. Maintenance (Life Cycle)
9. ...

**GAMS makes  
modeling easier**

# Design Principle

- 1 {
  - Simple modeling language with a balanced mix of declarative and procedural elements
- 2 {
  - Open architecture and interfaces to other systems, independent layers



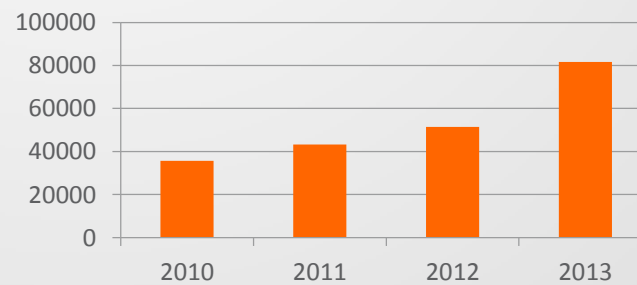
# Broad User **Community and Network**

**GAMS used in more than 120 countries**



**25+ Years**  
GAMS Development

**Number of visits to GAMS  
download website**



# Broad Range of **Application Areas**

<b>Agricultural Economics</b>	<b>Applied General Equilibrium</b>
<b>Chemical Engineering</b>	<b>Economic Development</b>
<b>Econometrics</b>	<b>Energy</b>
<b>Environmental Economics</b>	<b>Engineering</b>
<b>Finance</b>	<b>Forestry</b>
<b>International Trade</b>	<b>Logistics</b>
<b>Macro Economics</b>	<b>Military</b>
<b>Management Science/OR</b>	<b>Mathematics</b>
<b>Micro Economics</b>	<b>Physics</b>

# Agenda

What is GAMS?

Overview of Enhancements

Paver 2

Youtube Channel: GAMS lessons

Summary



# Upcoming release – **GAMS 24.3** (estimated release date: August 2014)

## Enhancements during last year

GAMS System Updates

Solver Updates

New Tools and API Updates

New Model Library Examples

# Enhancements during last year

## GAMS System Updates

Singleton set

Obfuscate restart file

### CPP function library

- Automatic differentiation
- Multi-variate Normal Distributions

## Solver Updates for > 15 solvers

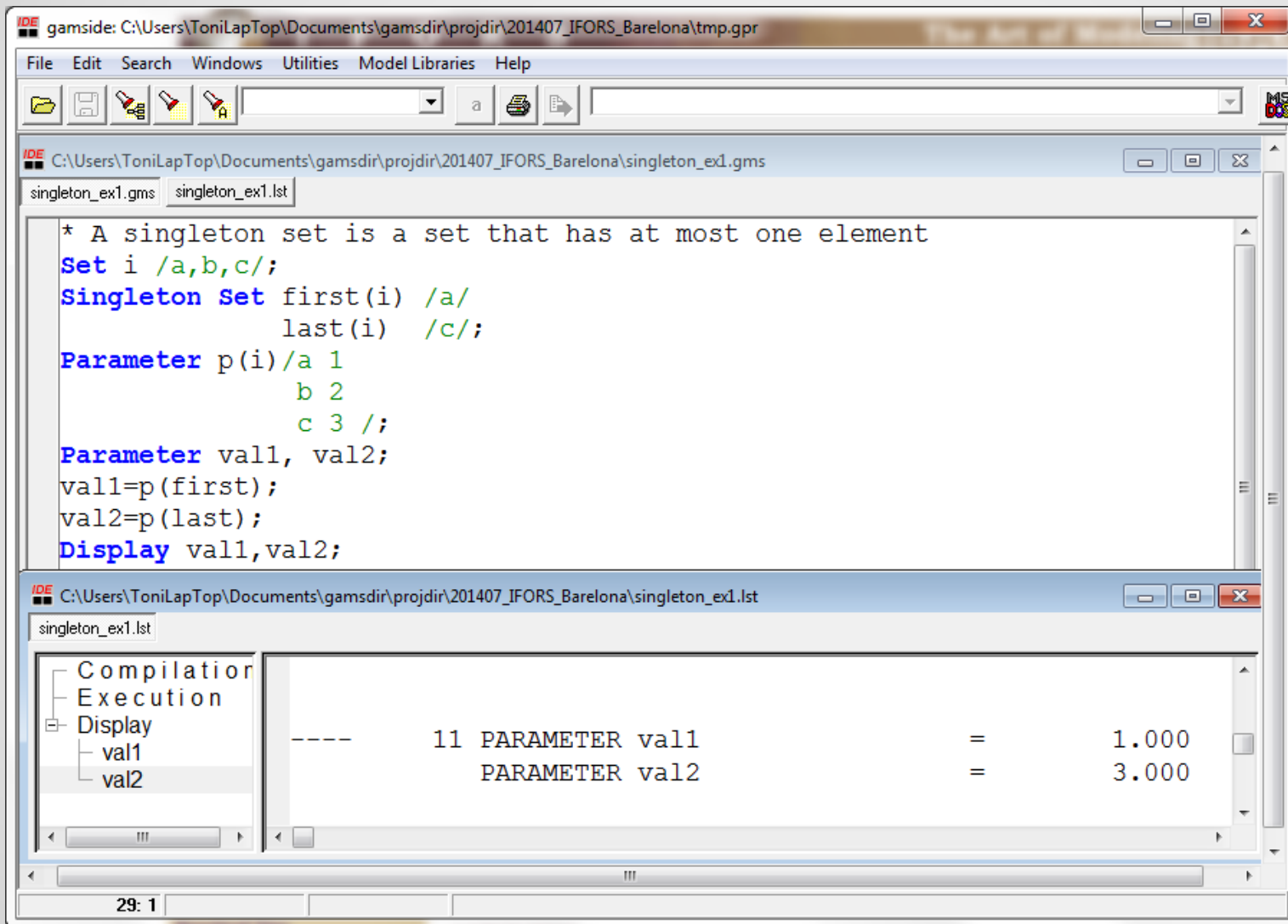
BARON 14.0.0: Significant advances in the handling of integer programs

CONOPT: New option to control definitional equations.

GUSS/Scenario solver can now be combined with the GAMS Grid Facility.

...

# Singleton set



The screenshot shows the GAMS IDE with a script defining a singleton set and its execution results.

**Script (singleton\_ex1.gms):**

```
* A singleton set is a set that has at most one element
Set i /a,b,c/;
Singleton Set first(i) /a/
               last(i) /c/;
Parameter p(i) /a 1
               b 2
               c 3 /;
Parameter val1, val2;
val1=p(first);
val2=p(last);
Display val1,val2;
```

**Execution Results (singleton\_ex1.lst):**

Line	Text	Value
11	PARAMETER val1	1.000
	PARAMETER val2	3.000

The IDE interface includes a menu bar (File, Edit, Search, Windows, Utilities, Model Libraries, Help), a toolbar, and a status bar at the bottom showing line 29 of the script.

# Obfuscate restart file

gamside: C:\Users\ToniLapTop\Documents\gamsdir\projdir\201407\_IFORS\_Barelona\tmp.gpr

File Edit Search Windows Utilities Model Libraries Help

C:\Users\ToniLapTop\Documents\gamsdir\projdir\201407\_IFORS\_Barelona\obfuscate\_ex.gms

```

* Create restart file on your safe machine
$call gamslib trnsport
$call gams trnsport a=c s=0named saveobfuscate=0anon
* Send 0named.g00 to "unsafe machine"

* Execute obfuscated restart file on remote unsafe machine
$echo * Empty > empty.gms
$call gams empty r=0anon s=1anon lo=%GAMS.lo% gdx=obfus1

* Send the result restart file to "safe machine" and view result
$echo * Empty > empty2.gms
$call gams empty2.gms r=1anon restartNamed=0named gdx=obfus2
  
```

No active process

obfuscate\_ex

Iteration	Dual Objective	In Variable	Out Variable
1	73.125000H('!!!!!!!!', '!!!!!!!!')	A00002('!!!!!!!!' sla	
2	119.025000 H('!!!!!!!!', '#!!!!!!!!')	A00002('#!!!!!!!!' sla	
3	153.675000H('!!!!!!!!', '!!!!!!!!')	A00002('!!!!!!!!' sla	
4	153.675000H('!!!!!!!!', '!!!!!!!!')	A00001('!!!!!!!!' sla	

LP status(1): optimal

Close Open Log ☐ Summary only ☒ Update

1: 1 Insert

obfus1.gdx

Entry	Symbol	Type	Dim	Nr Elem
6	F	Par	0	1
7	G	Par	2	6
8	H	Var	2	6
9	I	Var	0	1
10	A001	Equ	0	1
11	A00001	Equ	1	2
12	A00002	Equ	1	3

H(A, B):

	Level	Marginal
"!!!!"	50	
"#!!!!"	300	
"!!!!"		0.036
"!!!!"	275	
"#!!!!"		0.009000000000000001
"!!!!"	275	

Symbol search

Reset ☒ Squeeze defaults Ordering: 1 2 3

Decimals Search

Sort  Next Prev

obfus2.gdx

Entry	Symbol	Type	Dim	Nr Elem
6	f	Par	0	1
7	c	Par	2	6
8	x	Var	2	6
9	z	Var	0	1
10	cost	Equ	0	1
11	supply	Equ	1	2
12	demand	Equ	1	3

x(i, j): shipment quantities in cases

	Level	Marginal
seattle new-york	50	
chicago	300	
topeka		0.036
san-diego new-york	275	
chicago		0.009000000000000001
topeka	275	

Symbol search

Reset ☒ Squeeze defaults Ordering: 1 2 3

Decimals Search

Sort  Next Prev

# Enhancements during last year

## New tools and API updates

**GDXRENAME:** Rename the same unique elements in a GDX file using a mapping given by a second GDX file.

**GDXDUMP:** new option **SymbolsAsSet** - to write the symbol table for a set as data.

**.NET, Java and Python** fixes and improvements.

## New Model Library Examples

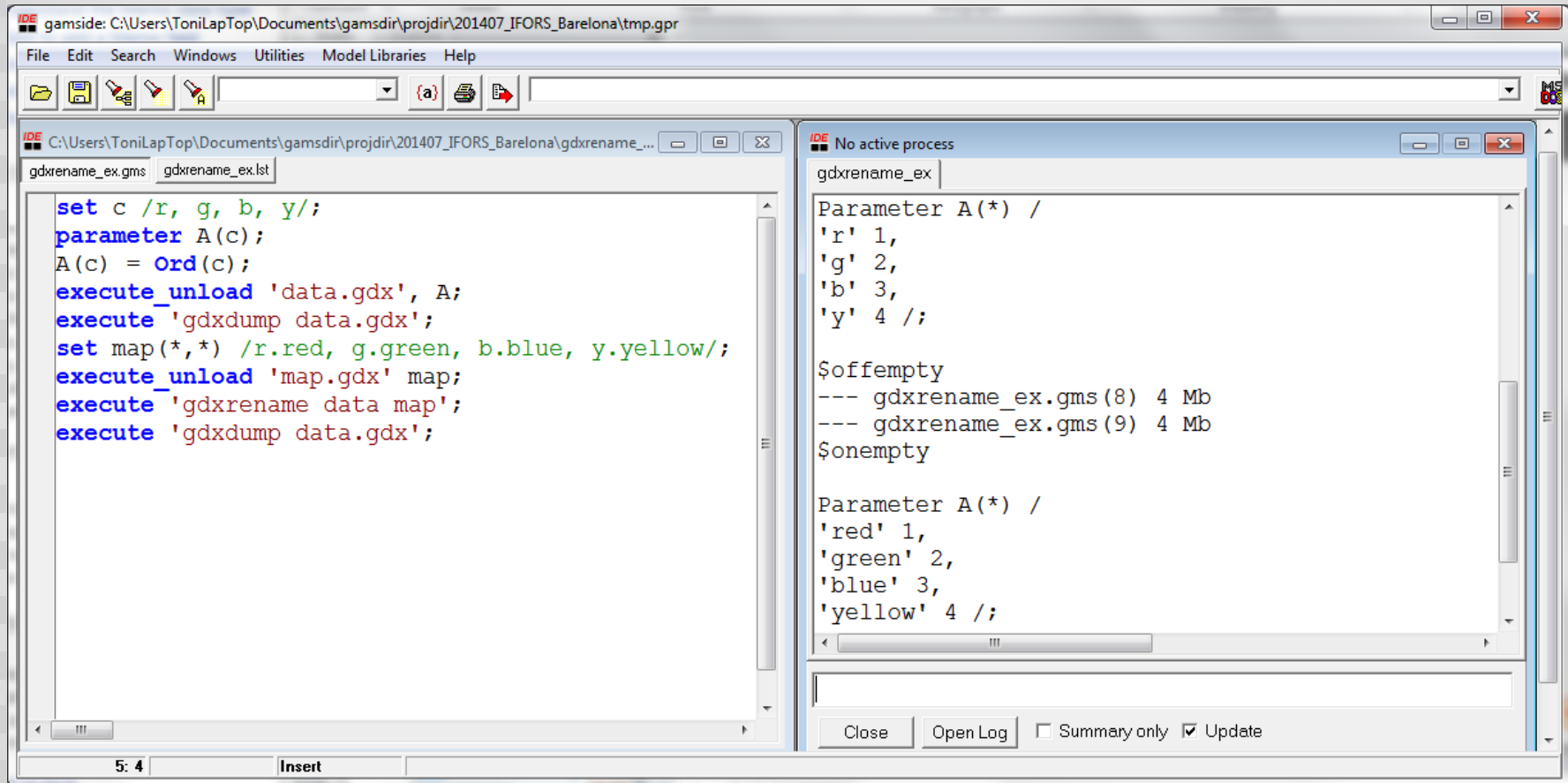
**New examples to:**

- Model Library = 7
- Test Library = 48
- Data Utilities = 5
- EMP Library = 4

Total > 1250 models

Note: The GAMS System includes also a Practical **Financial Optimization Models Library**

## GDXRENAME Tool



The screenshot shows the GAMS IDE interface with the GDXRENAME tool. The left pane displays the source code for 'gdxrename\_ex.gms', and the right pane shows the output log.

**Source Code (gdxrename\_ex.gms):**

```
set c /r, g, b, y/;
parameter A(c);
A(c) = Ord(c);
execute_unload 'data.gdx', A;
execute 'gdxdump data.gdx';
set map(*,*) /r.red, g.green, b.blue, y.yellow/;
execute_unload 'map.gdx' map;
execute 'gdxrename data map';
execute 'gdxdump data.gdx';
```

**Output Log (gdxrename\_ex):**

```
No active process

gdxrename_ex

Parameter A(*) /
'r' 1,
'g' 2,
'b' 3,
'y' 4 /;

$offempty
--- gdxrename_ex.gms (8) 4 Mb
--- gdxrename_ex.gms (9) 4 Mb
$onempty

Parameter A(*) /
'red' 1,
'green' 2,
'blue' 3,
'yellow' 4 /;
```

At the bottom of the IDE, there are buttons for 'Close', 'Open Log', and checkboxes for 'Summary only' and 'Update'.

# SpawnGAMSAccess (Datalib,#87)

SpawnGAMS : Database (Access 2007 - 2010) - Microsoft Access

**All Access Objects**

- Tables
  - tblConstant
  - tblDistance
  - tblGamsSource
  - tblMarket
  - tblPlant
  - tblShipment
  - tblTotalCost
  - tblTransCost
- Queries
- Forms
  - frmGamsControlPanel
  - frmGamsModel
- Modules

**GAMS Main Control of Solution Process**

Solve Model

Interrupt

Stop

View Db Model

☐ Use Tmp Model

View Tmp Model

View Listing

View Log

View Result

Reset Result

--- Starting compilation  
 --- trnsport.gms(44) 2 Mb  
 --- GD\Xin=C:\Users\TonilapTop\Documents\gamsdir\projdir\201407\_IFORS\_Barelona\inputdata.gdx  
 --- trnsport.gms(73) 3 Mb  
 --- Starting execution: elapsed 0:00:00.004  
 --- trnsport.gms(52) 4 Mb  
 --- Generating LP model transport  
 --- trnsport.gms(67) 4 Mb  
 --- 6 rows 7 columns 19 non-zeroes  
 --- Executing CPLEX: elapsed 0:00:00.014

IBM ILOG CPLEX 24.3.0 r46830 BETA Released 10Jul14 VS8 x86 32bit/MS Windows  
 Cplex 12.6.0.0

Reading data...  
 Starting Cplex...  
 Space for names approximately 0.00 Mb  
 Use option 'names no' to turn use of names off  
 Tried aggregator 1 time.  
 LP Presolve eliminated 1 rows and 1 columns.  
 Reduced LP has 5 rows, 6 columns, and 12 nonzeros.  
 Presolve time = 0.00 sec. (0.00 ticks)

Iteration	Dual Objective	In Variable	Out Variable
1	73.125000	x(San-Diego,New-York)	demand(New-York) slack
2	119.025000	x(Seattle,Chicago)	demand(Chicago) slack
3	153.675000	x(San-Diego,Topeka)	demand(Topeka) slack

LP status(1): optimal  
 Cplex Time: 0.00sec (det. 0.01 ticks)

Optimal solution found.  
 Objective : 153.675000

--- Restarting execution  
 --- trnsport.gms(67) 2 Mb  
 --- Reading solution for model transport  
 --- trnsport.gms(73) 3 Mb  
 \*\*\* Status: Normal completion  
 --- Job trnsport.gms Stop 07/11/14 13:12:46 elapsed 0:00:00.071

Record: 1 of 1

# SpawnGAMSAccess (Datalib,#87)

The Access VBA code is in control

From VBA we can write a GDX file either with:

- **GDXAPI**
- **MDB2GMS tool**

Spawn GAMS . Note that we can also control (stop) the GAMS solver.

We use **GDXDUMP** to write a text file that is transferred to Access.

Notes.

The GAMS model is saved in an Access Memo field.

A temporary model can be modified in the GAMSIDE and executed from Access.



# Agenda

What is GAMS?

Overview of Enhancements

Paver 2

Youtube Channel: GAMS lessons

Summary

# GAMS related advances

## Paver 2

[www.gamsworld.org/  
performance/paver2/](http://www.gamsworld.org/performance/paver2/)

## Paver 2

**PAVER server (Performance Analysis and Visualization for Effortless Reproducibility)**

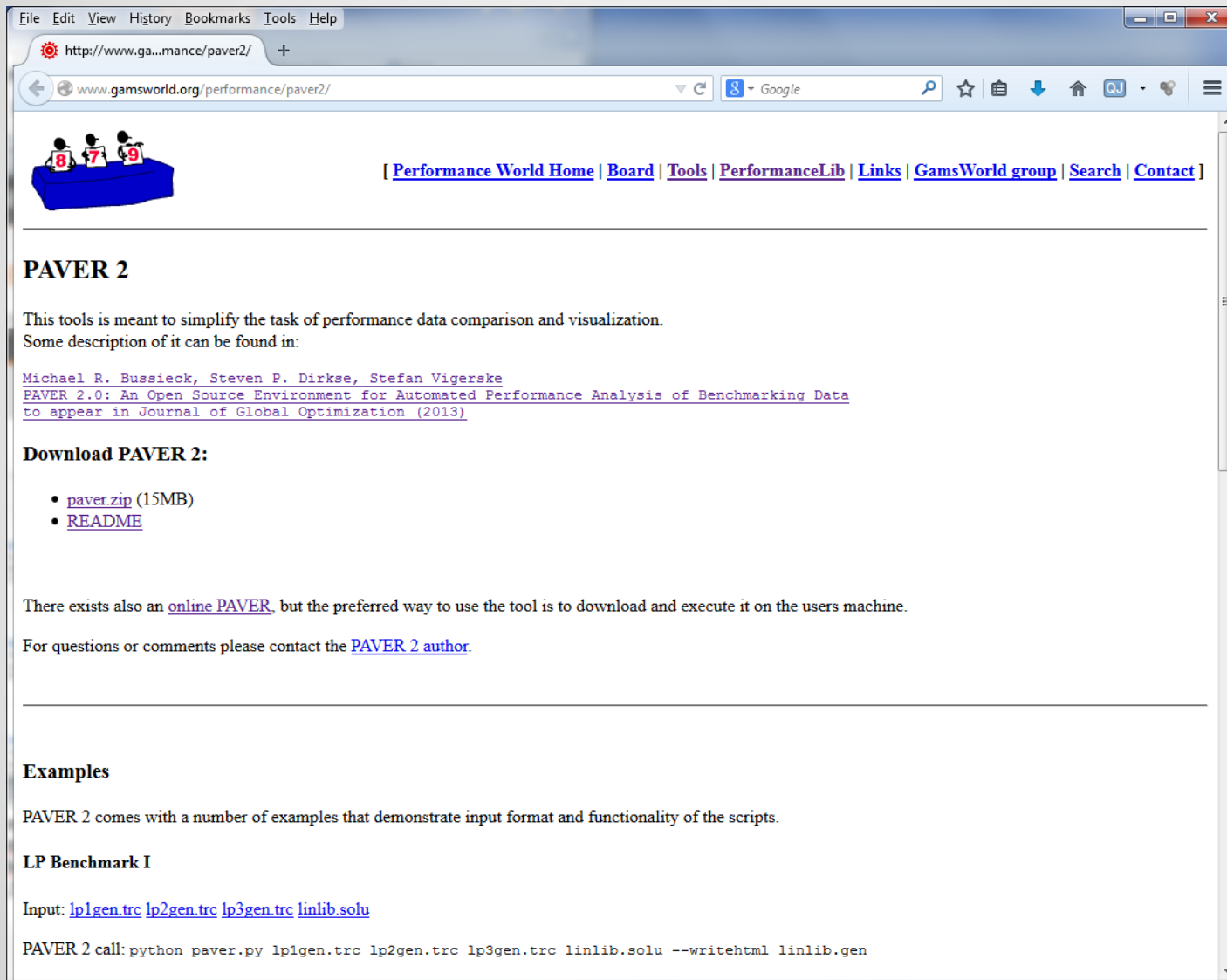
Complete rewrite PAVER 2.0, 2013 (Python)

New functionality:

- Consistency checks
- Comparison against solution database
- Many more metrics

Open source (COIN-OR project)


# Paver 2



File Edit View History Bookmarks Tools Help

http://www.ga...mance/paver2/ +

www.gamsworld.org/performance/paver2/ Google

 [ [Performance World Home](#) | [Board](#) | [Tools](#) | [PerformanceLib](#) | [Links](#) | [GamsWorld group](#) | [Search](#) | [Contact](#) ]

---

## PAVER 2

This tools is meant to simplify the task of performance data comparison and visualization.  
Some description of it can be found in:

[Michael R. Bussieck, Steven P. Dirkse, Stefan Vigerske](#)  
[PAVER 2.0: An Open Source Environment for Automated Performance Analysis of Benchmarking Data to appear in Journal of Global Optimization \(2013\)](#)

### Download PAVER 2:

- [paver.zip](#) (15MB)
- [README](#)

There exists also an [online PAVER](#), but the preferred way to use the tool is to download and execute it on the users machine.

For questions or comments please contact the [PAVER 2 author](#).

---

### Examples

PAVER 2 comes with a number of examples that demonstrate input format and functionality of the scripts.

#### LP Benchmark I

Input: [lp1gen.trc](#) [lp2gen.trc](#) [lp3gen.trc](#) [linlib.solu](#)

PAVER 2 call: `python paver.py lp1gen.trc lp2gen.trc lp3gen.trc linlib.solu --writehtml linlib.gen`

# Paver 2

## PAVER 2 SERVER - Performance Analysis Web Submission Tool

The PAVER web-submission tool runs the PAVER performance tool.

- [paver.zip](#). See the [README](#) for details.

Users can input their data in the form of trace files, which can be generated in the format.

If you find this tool useful, please consider citing the paper  
M. Bussieck, S. Dirkse, S. Vigerske (2013). PAVER 2.0: An Open Source

**Note:** there is a maximum total file size limit of 1Mb.

### Submit trace files:

- |         |  |                   |
|---------|--|-------------------|
| Trace 1 | <input type="button" value="Browse..."/> | blitzen.trc       |
| Trace 2 | <input type="button" value="Browse..."/> | comet.trc         |
| Trace 3 | <input type="button" value="Browse..."/> | cupid.trc         |
| Trace 4 | <input type="button" value="Browse..."/> | No file selected. |
| Trace 5 | <input type="button" value="Browse..."/> | No file selected. |
| Trace 6 | <input type="button" value="Browse..."/> | No file selected. |
| Trace 7 | <input type="button" value="Browse..."/> | No file selected. |
| Trace 8 | <input type="button" value="Browse..."/> | No file selected. |

### Submit solution files (optional):

- |             |  |
|-------------|--|
| MINLPLib    | <input type="checkbox"/>                                   |
| GlobalLib   | <input type="checkbox"/>                                   |
| LinLib      | <input type="checkbox"/>                                   |
| MIPLIB 2010 | <input type="checkbox"/>                                   |
| Solutions 1 | <input type="button" value="Browse..."/> No file selected. |

### Optional Settings:

- |   |                                     |  |
|---|-------------------------------------|--|
| Relative Tolerance on Bounds:               | <input type="text" value="1e-6"/>   | (Consistency Checks)                                 |
| Absolute Tolerance on Bounds:               | <input type="text" value="0.0001"/> | (Consistency Checks)                                 |
| (Primal) Feasibility Tolerance:             | <input type="text" value="2e-6"/>   | (Consistency Checks w.r.t. Examiner computed values) |
| Optimality (Dual Feasibility) Tolerance:    | <input type="text" value="2e-6"/>   | (Consistency Checks w.r.t. Examiner computed values) |
| Reference Solver (Name):                    | <input type="text"/>                | (Performance Evaluation)                             |
| Shift for Time (s):                         | <input type="text" value="10"/>     | (Performance Evaluation)                             |
| Shift for Number of Nodes:                  | <input type="text" value="100"/>    | (Performance Evaluation)                             |
| Minimal Time:                               | <input type="text" value="1"/>      | (Performance Evaluation)                             |
| Time in case of failure:                    | <input type="text"/>                | (Performance Evaluation)                             |
| Number of Nodes in case of failure:         | <input type="text"/>                | (Performance Evaluation)                             |
| (Relative) Gap Tolerance:                   | <input type="text" value="1e-6"/>   | (Performance Evaluation)                             |
| Threshold for being relatively faster:      | <input type="text" value="0.1"/>    | (Performance Evaluation)                             |
| Threshold for relatively better obj. value: | <input type="text" value="0.1"/>    | (Performance Evaluation)                             |
| Regard Dual Bounds (if available):          | <input checked="" type="checkbox"/> | (Performance Evaluation)                             |
| Number of ticks (points):                   | <input type="text" value="40"/>     | (Performance Profiles)                               |
| Extended Performance Profiles:              | <input type="checkbox"/>            | (Performance Profiles)                               |
| Include virt. best solver:                  | <input checked="" type="checkbox"/> | (Performance Profiles)                               |
| Option file name is runname:                | <input type="checkbox"/>            | (Reading)  |

For questions or comments please contact the [PAVER 2 author](#).

# Paver 2

## Analysis Results

Your data was successfully submitted to the PAVER - Performance Analysis of Versatile Engine Runs

- <http://www.gamsworld.org/performance/paver2/analysis>

You can also download the results at

- <http://www.gamsworld.org/performance/paver2/analysis>

Submit data:

Date/Time Mon Jul 1 16:02:46 EDT 2013

[Log file](#)

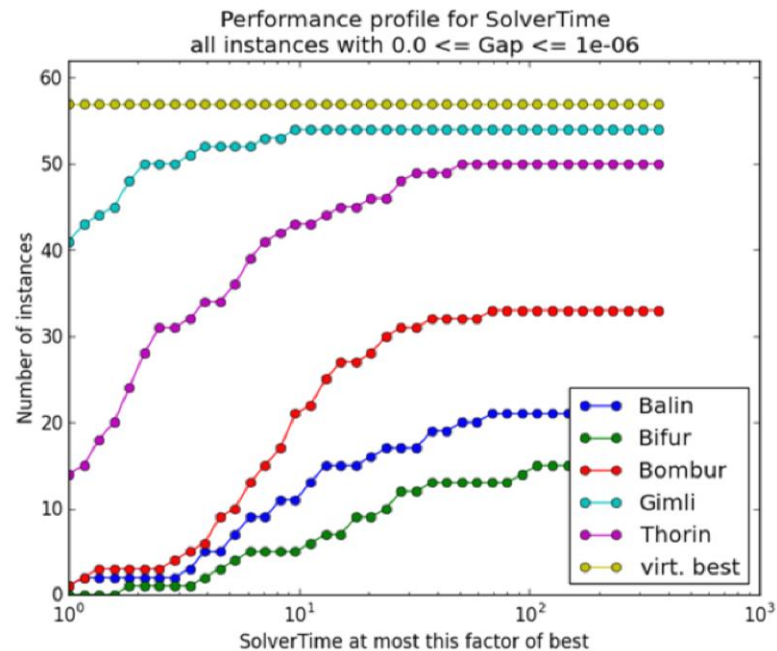
## Solver Runs

- Thorin
- Gimli
- Bombur
- Balin
- Bifur

## [Solving Data](#)

## [Statistics \(Counts and Means\)](#)

## Performance Profiles



# Agenda

What is GAMS?

Overview of Enhancements

Paver 2

Youtube Channel: GAMS lessons

Summary

# GAMS related advances


**Youtube Channel:**

**GAMS lessons**

[www.youtube.com/channel/  
UCfTAizXPo4vN54CC-Zs9TTg](http://www.youtube.com/channel/UCfTAizXPo4vN54CC-Zs9TTg)




# Youtube Channel: GAMS lessons

**GENERAL ALGEBRAIC MODELING SYSTEM**


**GAMS lessons**


Home Videos Playlists Channels Discussion About

All activities

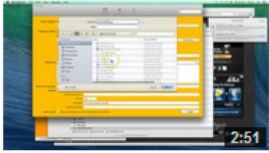



GAMS lessons uploaded a video

**An Introduction to Sets in GAMS**  
1 day ago • 8 views  
In this video we will give an introduction to static sets, dynamic sets, and multi-dimensional sets. Furthermore, we will write a GAMS program that aims to illustrate how sets can be use...




GAMS lessons uploaded a video

**Install the Windows Version of GAMS on a Mac by Using Wine**  
2 months ago • 188 views  
We will setup the graphical user interface for GAMS, GAMSIDE, on a Mac by using a third party software called Wine.



GAMS lessons uploaded a video

**How to Install the Native GAMS Version on a Mac**  
2 months ago • 154 views  
We will make a apple script that launches a terminal window, which is set up in a way that GAMS keywords can be immediately used.



# Agenda

What is GAMS?

Overview of Enhancements

Paver 2

Youtube Channel: GAMS lessons

Summary



# Summary

GAMS 24.3 System  
Enhancements

Singleton sets

CPP function library

GAMS related  
advances

Paver 2

Youtube Channel



# GAMS

## Thank You

### USA

GAMS Development Corp. 1217 Potomac  
Street, NW Washington, DC 20007

### USA

Phone: +1 202 342 0180

Fax: +1 202 342 0181

[sales@gams.com](mailto:sales@gams.com)

### Europe

GAMS Software GmbH

P.O. Box 40 59

50216 Frechen, Germany

Phone: +49 221 949 9170

Fax: +49 221 949 9171

[info@gams.de](mailto:info@gams.de)