Recent enhancements in GAMS

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EURO XXIV LISBON
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’ 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
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

The GAMS/BASE Module

- Compiler and Execution System
- GAMS IDE (Windows)
- Documentation + Model libraries
- GDX Utilities
- Free Solvers/Solver Links
Integrated Development Environment

- Project management
- Editor / Syntax coloring / Spell checking
- Launching and monitoring of (multiple) GAMS processes
- Listing file / Tree view / Syntax-error navigation
- Solver selection / Option selection
- GDX viewer
  - Data cube
  - Data export (e.g. to MS Excel)
  - Charting facilities
- Model libraries
- Documentation
Documentation

• **Distributed Documentation**
  – GAMS Users Guide
  – Expanded GAMS Users Guide (McCarl)
  – Solver Manuals
  – GAMS Utility Manuals

• **Wikis**
  – Support Wiki [http://support.gams-software.com](http://support.gams-software.com)
  – Interfaces Wiki [http://interfaces.gams-software.com](http://interfaces.gams-software.com)

• **Search all GAMS Websites**
  [http://www.gams.com/search.htm](http://www.gams.com/search.htm)
Distributed Model Libraries

- **GAMS Model Library**
  - Example and user-contributed models
  - Very often used as templates
  - Tests for
    - Solver robustness and correctness
    - Backward compatibility

- **GAMS Test Library**
  - Transparent and reproducible Quality Assurance Tests
  - Tests for
    - Solver correctness
    - Special functions
    - GAMS utilities
Distributed Model Libraries

• **GAMS Data Utilities Library**
  – Demonstration of the various utilities interfacing GAMS with other applications
  – E.g. gdxxrw, mdb2gms, sql2gms

• **GAMS EMP Library**
  – Examples for the use of Extended Mathematical Programming

• **Practical Financial Optimization Models**
  Models of the book

  “PRACTICAL FINANCIAL OPTIMIZATION – A Library of GAMS Models”

  by Consiglio, Nielsen and Zenios
Gams Data eXchange

Binary Data Exchange

- Fast exchange of data
- Syntactical check on data before model starts
- Data Exchange at any stage (Compile and Run-time)
- Platform Independent
- Direct GDX interfaces and general API
- Scenario Management Support
- Full Support of Batch Runs

GDX Tools

- Invert
- IDE
- GDX Viewer
- GDXrank
- GDX2HAR/HAR2GDX
- GDXmerge
- GDXdump
- GDXcopy
- GDX diff
- GDX copy
- GDX2XLS
- GDX xrw
- GAMS
- GDX API
GAMS at a Glance

The GAMS/BASE Module

Free Solvers

- Convert
- EMP/JAMS, LOGMIP, NLPEC
- BENCH, EXAMINER, GAMSCHK
- BDMLP, LS, and MILES
- COIN-OR Cbc, IpOpt, BonMin, Couenne
- Glpk, Scip (academic only)
# New GAMS Distribution 23.5

Released July, 4th!

## Download GAMS Distribution 23.5.1 - July 4, 2010

Note: To deliver GAMS with the best performance we are using the Amazon CloudFront web service, a global network of edge locations for content delivery.

Please consult the release notes before downloading a system. The installation notes for Windows and UNIX and the complete system documentation are included in each system.

### Windows

<table>
<thead>
<tr>
<th>Bit</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 bit</td>
<td>Windows 7 x64, Windows Vista x64, Windows XP x64, Windows Server 2008 x64, Windows Server 2003 x64, and compatible on AMD- or Intel-based (x86_64) architectures</td>
</tr>
</tbody>
</table>

### UNIX

<table>
<thead>
<tr>
<th>OS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIX</td>
<td>AIX 5.3 or higher, PowerPC chip, 64 bit (ppc_64)</td>
</tr>
<tr>
<td>Digital UNIX</td>
<td>Digital Unix 4 or higher on DEC Alpha (sparc_64). Please note that the current GAMS distribution for Digital Unix is 22.7</td>
</tr>
<tr>
<td>HP-UX</td>
<td>HP-UX 11 or higher on HP PA-RISC (hppa_32). Please note that the current GAMS distribution for HP-UX is 22.1</td>
</tr>
<tr>
<td>Linux 32 bit</td>
<td>AMD- or Intel-based (x86_32) Intel-based 32-bit Linux systems. Most likely these will have a 2.4 X kernel or higher. The software was built with Intel's Linux compilers, ver 11.1 or higher.</td>
</tr>
<tr>
<td>Linux 64 bit</td>
<td>AMD- or Intel-based (x86_64) Linux systems. These were built on a 2.6 kernel with Intel's Linux compilers, ver 11.1 or higher.</td>
</tr>
<tr>
<td>IRIX</td>
<td>IRIX 6.2 or higher on SGI MIPS (sgi_32). Please note that the current GAMS distribution for IRIX is 22.3</td>
</tr>
</tbody>
</table>

### Mac OS X

<table>
<thead>
<tr>
<th>Bit</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 bit</td>
<td>Macintosh Intel-based systems (x86_32) built on Darwin 9. Please note that this is a Mac OS X Terminal application and must be installed and executed using the command line interface.</td>
</tr>
<tr>
<td>64 bit</td>
<td>Macintosh Intel-based systems (x86_64) built on Darwin 9. Please note that this is a Mac OS X Terminal application and must be installed and executed using the command line interface.</td>
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</table>

### Additional Information

- [Additional Information](link)
New GAMS Distribution 23.5 cont’d

- **Solver updates**
  - BARON 9.0.6
  - CPLEX 12.2
  - GUROBI 3.0.1
  - LINDOGLOBAL 6.1.1
  - MOSEK 6
  - SCIP 1.2
  - XPRESS 20.00
  - Coin-OR
    - (CBC 2.4, Bonmin 1.3, Couenne 0.3, Ipopt 3.8, Glpk 4.43, OS 2.1)

- **New platforms**
  - 64bit Intel Mac
  - 64bit AIX
### New GAMS Distribution 23.5 cont’d

<table>
<thead>
<tr>
<th>Solver/Platform availability - 23.5</th>
<th>July 4, 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solver</strong></td>
<td><strong>Windows</strong></td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>ALPHAECP</td>
<td>✓</td>
</tr>
<tr>
<td>BARON 9.0</td>
<td>✓</td>
</tr>
<tr>
<td>BDMLP</td>
<td>✓</td>
</tr>
<tr>
<td>COIN-OR</td>
<td>✓</td>
</tr>
<tr>
<td>CONOPT 3</td>
<td>✓</td>
</tr>
<tr>
<td>CPLEX 12.2</td>
<td>✓</td>
</tr>
<tr>
<td>DECIS</td>
<td>✓</td>
</tr>
<tr>
<td>DICOPT</td>
<td>✓</td>
</tr>
<tr>
<td>GUROBI 3.0</td>
<td>✓</td>
</tr>
<tr>
<td>KNITRO 6.0</td>
<td>✓</td>
</tr>
<tr>
<td>LINDOGLOBAL 6.1</td>
<td>✓</td>
</tr>
<tr>
<td>LGO</td>
<td>✓</td>
</tr>
<tr>
<td>MILES</td>
<td>✓</td>
</tr>
<tr>
<td>MINOS</td>
<td>✓</td>
</tr>
<tr>
<td>MOSEK 6</td>
<td>✓</td>
</tr>
<tr>
<td>MPSGE</td>
<td>✓</td>
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<tr>
<td>MSNLPI</td>
<td>✓</td>
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<tr>
<td>NLPEC</td>
<td>✓</td>
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<tr>
<td>OQNLP</td>
<td>✓</td>
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<tr>
<td>PATH</td>
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<tr>
<td>SBB</td>
<td>✓</td>
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<td>✓</td>
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<td>SNOPT</td>
<td>✓</td>
</tr>
<tr>
<td>XA</td>
<td>✓</td>
</tr>
<tr>
<td>XPRESS 20.00</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note: The table above lists the availability of various solvers and platforms supported by GAMS Distribution 23.5.
New GAMS Distribution 23.5 cont’d

- Free Coin-OR OSI-based links to CPLEX, GUROBI, MOSEK and XPRESS

- GAMS on Amazon EC2

- GAMS API’s
  - Improvements on all frontiers
  - Now supported: Python
  - Examples/Documentation
  - Project and configuration files

- …
New GAMS Distribution 23.5 cont’d

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- …
A standard API providing access to a variety of solver

Solver independent

http://projects.coin-or.org/Osi
Open Solver Interface-based links

GAMS base includes OSI-based links to
  – CPLEX
  – GUROBI
  – MOSEK
  – XPRESS

→ Free, yet, it does not support all features of a real GAMS solver link (LP/MIP only!)

→ !!! Require a valid solver license !!!
New GAMS Distribution 23.5 cont’d

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- …
Amazon Elastic Compute Cloud
- *Unlimited* computing resources available on demand
- Pay by the hour
- No up-front commitment

Pre-configured Instances with GAMS base available
- Immediate access with no IT investment/management
- Pay-as-you-go: No reservation, no long term contracts
- Full access to Windows (rdp) or Unix (ssh)
- 64 bit environment, 15 GB of RAM and 4 cores
GAMS on Amazon EC2 cont’d

More information at:  http://www.gams.com/aws
We use Amazon instances ourselves

- Nightly system builds
- Nightly quality assurance tests using our public test libraries

<table>
<thead>
<tr>
<th>Latest GAMS System Builds and Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>nightly α</td>
</tr>
<tr>
<td>Friday</td>
</tr>
<tr>
<td>Friday</td>
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<tr>
<td>Friday</td>
</tr>
<tr>
<td>Friday</td>
</tr>
</tbody>
</table>

| nightly β | System | Libraries | Build | Ref | Status and Time (UTC) | Initial Tests | Full Tests | Comment |
| Friday    | lum    | Download  | 25.4   | 1602 | Test started 12Jun2010 01:58:26 | 542 runs 0 failures (+0,0%) | Report | result pending |
| Tuesday   | lum    | Download  | 25.4   | 1784 | Test done 28May2010 06:55:24 | 529 runs 0 failures (+0,0%) | Report | 440 runs 0 failures (+0,0%) |
| Tuesday   | va8    | Download  | 25.4   | 1784 | Test done 28May2010 16:42:04 | 506 runs 0 failures (+0,0%) | Report | 462 runs 0 failures (+0,0%) |
| Wednesday | va8    | Download  | 25.4   | 1784 | Test done 27May2010 14:27:13 | 488 runs 0 failures (+0,0%) | Report | 759 runs 1 failures (+0,1%) |

| alpha     | System | Libraries | Build | Ref | Status and Time (UTC) | Initial Tests | Full Tests | Comment |
| 20100408  | x8     | Download  | 25.4   | 1686 | Test done 09Apr2010 06:29:24 | 290 runs 0 failures (+0,0%) | Report | 269 runs 3 failures (+0,0%) |
| 20100408  | new    | Download  | 25.4   | 1686 | Test done 09Apr2010 06:55:46 | 406 runs 0 failures (+0,0%) | Report | 406 runs 0 failures (+0,0%) |
| 20100408  | day    | Download  | 25.4   | 1686 | Test done 09Apr2010 14:06:50 | 420 runs 7 failures (+0,2%) | Report | 455 runs 2 failures (+0,2%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 09:39:57 | 520 runs 0 failures (+0,0%) | Report | 503 runs 0 failures (+0,0%) |
| 20100408  | lum    | Download  | 25.4   | 1686 | Test done 09Apr2010 04:59:44 | 526 runs 0 failures (+0,0%) | Report | 517 runs 1 failures (+0,2%) |
| 20100408  | va8    | Download  | 25.4   | 1686 | Test done 09Apr2010 12:06:53 | 520 runs 0 failures (+0,0%) | Report | 515 runs 3 failures (+0,0%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 05:58:29 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 14:01:49 | 526 runs 0 failures (+0,0%) | Report | 503 runs 0 failures (+0,0%) |
| 20100408  | va8    | Download  | 25.4   | 1686 | Test done 09Apr2010 11:25:37 | 564 runs 0 failures (+0,0%) | Report | 545 runs 2 failures (+0,0%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 02:08:14 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 01:47:36 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
| 20100408  | va8    | Download  | 25.4   | 1686 | Test done 09Apr2010 02:08:14 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 01:47:36 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
| 20100408  | hst    | Download  | 25.4   | 1686 | Test done 09Apr2010 01:47:36 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
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| 20100408  | va8    | Download  | 25.4   | 1686 | Test done 09Apr2010 02:08:14 | 526 runs 0 failures (+0,0%) | Report | 503 runs 1 failures (+0,2%) |
New GAMS Distribution 23.5 cont’d

- Free Coin-OR OSI-based links to CPLEX, GUROBI, MOSEK and XPRESS

- GAMS on Amazon EC2

  - GAMS API’s
    - Improvements on all frontiers
    - Now supported: Python
    - Examples/Documentation
    - Project and configuration files

- ...
Interfacing: GAMS in Control

GAMS Model

Direct GDX Interface
External Database
Import

Direct GDX Interface
External Database
GUls
Export
Interfacing: Application in Control

Application

GDX API
GDX Container
Creating Input

GAMS (Executable / DLL)
Call GAMS

GDX API
GDX Container
Reading Solution

GDX Container
• Need to support a variety of applications
  – Web application (server side)
  – Application Builder
    • Oracle, Eclipse, .NET, …
    • Regular Programming language C(++), C#, Java, VB, Fortran, Python, …
  – MS Office Application / VBA
Distributed GAMS APIs

- Component Libraries
  - GAMS
  - GDX
  - Option

- Supported languages
  - C, C++, C#
  - Delphi
  - Fortran
  - Java
  - VBA, VB.Net
  - Python

- Examples/Documentation
Calling GAMS from your Application

Creating Input for GAMS Model
→ Data handling using GDX API

Callout to GAMS
→ GAMS option settings using Option API
→ Starting GAMS using GAMS API

Reading Solution from GAMS Model
→ Data handling using GDX API
Calling GAMS from Python

```python
from gdxcc import *
from gamsxcc import *
from optcc import *
import sys
import os

if __name__ == "__main__":

    numberParams = len(sys.argv)
    if numberParams != 2:
        print("Usage:", sys.argv[0], "sysDir"
        os._exit(1)

    gdxHandle = new_gdxHandle_tp()
    optHandle = new_optHandle_tp()
    gamsxHandle = new_gamsxHandle_tp()

    sysDir = sys.argv[1]
    print(sys.argv[0], "using GAMS system directory:", sys.argv[1]

    assert gamsxCreateD(gamsxHandle, sysDir, GMS_SSSIZE)[0]
    assert gdxCreateD (gdxHandle, sysDir, GMS_SSSIZE)[0]
    assert optCreateD (optHandle, sysDir, GMS_SSSIZE)[0]

    status = writeModelData(gdxHandle, "demanddata.gdx")
    if not status:
        print("Model data not written")
        terminate(gdxHandle, gamsxHandle, optHandle)

    status = callGams(gamsxHandle, optHandle, sysDir)
    if not status:
        print("Call to GAMS failed")
        terminate(gdxHandle, gamsxHandle, optHandle)

    status = readSolutionData(gdxHandle, "results.gdx")
    if not status:
        print("Could not read solution back")
    terminate(gdxHandle, gamsxHandle, optHandle)
```

Creating Input for GAMS Model

Callout to GAMS

Reading Solution from GAMS Model
Calling GAMS from Python cont’d

Creating Input for GAMS Model

```python
def writeModelData(gdxHandle, fngdxfile):
    ret, errNr = gdxOpenWrite(gdxHandle, fngdxfile, "Example1")
    if errNr:
        print "*** Error gdxOpenWrite: " + gdxErrorStr(gdxHandle, errNr)[1]
        return False

    if not gdxDataWriteStrStart(gdxHandle, "Demand", "Demand data", 1, GMS_DT_PAR, 0):
        reportGDXError(gdxHandle, "DataWriteStrStart")

    values = doubleArray(GMS_VAL_MAX)
    values[GMS_VAL_LEVEL] = 324.0
    gdxDataWriteStr(gdxHandle, ["New-York"], values)
    values[GMS_VAL_LEVEL] = 299.0
    gdxDataWriteStr(gdxHandle, ["Chicago"], values)
    values[GMS_VAL_LEVEL] = 274.0
    gdxDataWriteStr(gdxHandle, ["Topeka"], values)

    if not gdxDataWriteDone(gdxHandle):
        reportGDXError(gdxHandle, "WriteData")

    errNr = gdxGetLastError(gdxHandle)
    if errNr:
        print "*** Error while writing GDX File: " + gdxErrorStr(gdxHandle, errNr)[1]
        return False

    errNr = gdxClose(gdxHandle)
    if errNr:
        print "*** Error gdxClose: " + gdxErrorStr(gdxHandle, errNr)[1]
        return False

    return True
```
def callGams(gamsxHandle, optHandle, sysDir):
    deffile = sysDir + '\optgams.def'

    if optReadDefinition(optHandle, deffile):
        print("*** Error ReadDefinition, cannot read def file:" + deffile)
        return False

    optSetStrStr(optHandle, "SysDir", sysDir)
    optSetStrStr(optHandle, "Input", "model2.gms")
    optSetIntStr(optHandle, "LogOption", 3)
    ret = gamsxRunExecDLL(gamsxHandle, optHandleToPtr(optHandle), sysDir, 1)
    if ret[0] != 0:
        print("*** Error RunExecDLL: Error in GAMS call = " + str(ret[1]))
        return False

    return True
Calling GAMS from Python cont’d

Reading Solution from GAMS Model

def readSolutionData(gdxHandle, fngdxfile):
    errNr = gdxOpenRead(gdxHandle, fngdxfile)[1]
    if errNr:
        print "**** Error OpenRead: " + gdxErrorStr(gdxHandle, errNr)[1]
    return False

    ret, varNr = gdxFindSymbol(gdxHandle, "result")
    if not ret:
        print "*** Error FindSymbol: Could not find variable result"
        return False

    ret, symName, dim, varType = gdxSymbolInfo(gdxHandle, varNr)
    if dim != 2 or varType != GMS_DT_VAR:
        print "**** Error SymbolInfo: result is not a a two dimensional variable"
        return False

    ret, nrRecs = gdxDataReadStrStart(gdxHandle, varNr)
    if not ret:
        reportGDXError(gdxHandle, "DataReadStrStart")
        return False

    ...
Calling GAMS from Excel (VBA)
How to keep Up To Date

http://www.gams.com/maillist/

The GAMS Mailing List
GAMS users worldwide use the list name GAMS-L to exchange information about GAMS. GAMS-L is open to everyone around the world and can easily be reached via the Internet.
Subscribe (and more information)

Bruce McCarl's GAMS Newsletter
With his newsletter Bruce McCarl wants to provide some additional information on the use and features which emerge as GAMS develops. He intends to periodically issue a very short newsletter that informs people of things that are new and or under documented as well as opportunities to learn more about GAMS features and usage.
Archive/Subscribe/Unsubscribe

The GAMS Release Mailing List
For people interested in receiving the latest information about new GAMS releases and trying out beta releases.
Subscribe/Unsubscribe

Please visit us at our booth in Building C6!
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