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

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

- 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

- MOSEK
- XPRESS
- XA
- MINOS
- CONOPT
- LINDOGLOBAL
- BARON
- DICOPT
- ALPHAEC
- BDMLP
- CPLEX
- LGO
GAMS at a Glance

10+ Supported MP classes

- CNS
- MCP
- MPEC
- MIQCP
- MINLP
- MIP
- QCP
- DNLP
- NLP
- LP
GAMS at a Glance

10+ Supported Platforms

- Solaris 64bit
- Solaris
- AXU
- AIX
- Linux 64bit
- Mac
- Windows 64bit
- Windows
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

Deployed models have often 15+ years lifecycle
- Changing environment (Hardware, OS, Interface)
- Improving solver technology

→ Different layers with separation of
- model and data
- model and solution methods
- model and operating system
- model and interface
GAMS’ Fundamental concepts

→ Models benefit from
  – Advancing hardware
  – Enhanced / new solver technology
  – Improved / upcoming interfaces to other systems

→ Backward compatibility

→ Protection of user investments
A Transportation Model

Minimize Transportation cost
subject to Demand satisfaction at markets
       Supply constraints

San Diego 600

Seattle 350

New York 325
Topeka 275
Chicago 300

Distances:
San Diego to New York: 2.5
San Diego to Topeka: 1.4
San Diego to Chicago: 1.8
Seattle to New York: 2.5
Seattle to Topeka: 1.7
Seattle to Chicago: 1.8
\[ \sum_{c,p: (c,p) \in \mathcal{N}} t_{c,p} \cdot \text{dist}(c, p) \cdot x_p^c \rightarrow \min \]

\[ \sum_{c,p: (c,p) \in \mathcal{N}} x_p^c \leq \sup(c) \quad \forall c \]

\[ \sum_{c,p: (c,p) \in \mathcal{N}} x_p^c \geq \text{dem}(p) \quad \forall p \]

\[ x_p^c \geq 0 \quad \forall c, p : (c, p) \in \mathcal{N} \]
Variables
\[ x(i,j) \] shipment quantities in cases
\[ z \] total transportation costs in thousands of dollars

Positive Variable \[ x \];

Equations
\[ \text{cost} \] define objective function
\[ \text{supply}(i) \] observe supply limit at plant \( i \)
\[ \text{demand}(j) \] satisfy demand at market \( j \);

\[ \text{cost} \ldots \]
\[ z = \text{sum}(i,j), c(i,j) \cdot x(i,j)) \]

\[ \text{supply}(i) \ldots \]
\[ \text{sum}(j, x(i,j)) - l = a(i) \]

\[ \text{demand}(j) \ldots \]
\[ \text{sum}(i, x(i,j)) - g = b(j) \]

Model \( \text{transport} \) /all/ ;
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
• Documentation
• Model libraries
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. GDX utilities

• Practical Financial Optimization Models
  Models of the forthcoming book

  “PRACTICAL FINANCIAL OPTIMIZATION – A Library of GAMS Models”

  by Consiglio, Nielsen and Zenios
Maintained libraries of established and varied set of both theoretical and practical test models:

- CONELib
- GLOBALLib
- LinLib
- MINLPLib
- MPECLib
- MPSGELib
- PrincetonLib
- XPRESSLib
- …
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
- GDX2XLS
- GDXxrw
- GDXdiff
- MDB2GMS
- GDXAPI
GAMS in Control

GAMS Model

Direct GDX Interface
External Database
Import

Direct GDX Interface
External Database
GUIs
Export
Application in Control

Application

GDX API

GDX Container

Creating Input

GAMS (Executable / DLL)

Call GAMS

GDX API

GDX Container

Reading Solution
Layout of an Integrated Model

Integrated Model

Data Import Module
Data Manipulation Module
Solution Module
Report Module

GDX Container
GDX Container
GDX Container

GDX Container

MS Excel

GDX Container

MS Excel
Calling GAMS from an Application

Works from basically every environment

- MS Office Application / VBA
- Programming languages:
  - C, C++, C#
  - Delphi
  - Java
  - VB.NET
  - Fortran
- Web application (server side)
- ERP Systems: Oracle, SAP
- ...
Interfacing with GIS Applications
Interfacing with MATLAB

Figure 1: US dollar short rate scenarios

Figure 2: Short vs. long rates
Interfacing with GNUPLOT
Interfacing with Web Applications

![Image of a web interface for scheduling and constraint violations.](image-url)

### Cadet Schedules with Constraint Violations: AY 2001-1

**Header Information**

- **Select Constraint Type:** FREE HOUR CONSTRAINT
- **Filter by:**
- **Free Hour Violations:** 43
- **Design Group Violations:** 4
- **Unbalanced Schedule Violations:** 7

### Cadets With Schedule Violations

<table>
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**Cadets:** 43

**Details**

**Course Hours**

**Schedule**

- **(3) 1 Day:**
  - **Course:** FE310
  - **Violation:**
  - **Override:**

- **(3) 2 Day:**
  - **Course:** 88307
  - **Violation:**
  - **Override:**

- **OK**
- **Close**
Interfacing with Individual Front Ends
Interfacing with MS Office / VBA
Software Demonstration – Rapid Application Prototyping with GAMS

Steven Dirkse
Sunday Oct 12, 08:00am - 09:30am

Scenario Tree Generation for Stochastic Programming Models using GAMS/SCENRED

Holger Heitsch
Tuesday Oct 14, 04:30pm - 06:00pm
GAMS Talks at INFORMS 2008

Session: Using COIN-OR via GAMS
Sunday Oct 12, 01:30pm - 03:00pm

- Open-source Quality Assurance and Performance Analysis Tools
  *Alex Meeraus*

- GAMS Branch-and-Cut & Heuristic Facility
  *Michael Bussieck*

- Hooking Your Solver to GAMS
  *Stefan Vigerske*
# GAMS on the Web

## Download
- [www.gams.de](http://www.gams.de)
- [www.gams.com](http://www.gams.com)

## Help and Support
- **Support Wiki**: [http://support.gams-software.com](http://support.gams-software.com)
- **Interfaces Wiki**: [http://interfaces.gams-software.com](http://interfaces.gams-software.com)
- **User Group**: [http://www.gams.com/maillist/gams_l.htm](http://www.gams.com/maillist/gams_l.htm)
- **Google Group**: [http://groups.google.de/group/gamsworld](http://groups.google.de/group/gamsworld)

## Search all GAMS Websites
- [http://www.gams.com/search.htm](http://www.gams.com/search.htm)
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  [Link to Linux Evaluation License](http://www.gams.com/evals/dc/l/gamslice.txt)

- Macintosh:
  [Link to Macintosh Evaluation License](http://www.gams.com/evals/dc/m/gamslice.txt)
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