GAMS
General Algebraic Modeling System

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Lutz Westermann

GAMS Software GmbH
www.gams.de
GAMS Development Corporation
www.gams.com
Algebraic Modeling Languages

- High-level programming languages for large scale mathematical optimization problems
- Algebraic formulation
  - Syntax similar to mathematical notation
  - Does not contain any hints how to process it
- Do not solve optimization problems directly, but call appropriate external algorithms

Goals

- Efficient handling of mathematical optimization problems
- Simplify model building and solution process
- Increase productivity and support maintainable models
- Support of decision making 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’ Fundamental concepts

- Different layers with separation of
  - model and data
  - model and solution methods
  - model and operating system
  - model and interface

- Balanced mix of declarative and procedural elements
- Open architecture and interfaces to other systems
- Platform independence
## Typical Application Areas *

* Illustrative examples in the GAMS Model Library

- Agricultural Economics
- Chemical Engineering
- Econometrics
- Environmental Economics
- Finance
- International Trade
- Macro Economics
- Management Science/OR
- Micro Economics
- Applied General Equilibrium
- Economic Development
- Energy
- Engineering
- Forestry
- Logistics
- Military
- Mathematics
- Physics
Downloads by Platform

GAMS 22.5
~525 downloads/week

GAMS 22.6
~590 downloads/week

GAMS 22.7
~590 downloads a week
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
  - …
### Supported Model Types (GAMS 22.7)

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Contributed Plug & Play solvers:
- AMPLscript
- DEA
- Kestrel
## Supported Platforms (GAMS 22.7)

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1. GAMS distribution for HP-UX11/HP-UX in 22.1.
2. GAMS distribution for SGI IRIX in 22.3.

### Contributed Plug&Play solvers

- AMPLirmap
- DEA
- Kestrel
System Overview

Connectivity Tools
- Uniform Data Exchange:
  - ASCII
  - GDX (ODBC, SQL, XLS, XML)
- GDX Tools
- Component Library with Interfaces to C++, Java, .NET, ...
- Ext. programs
  - EXCEL
  - MATLAB
  - GNUPLOT, ...
- CONVERT

Productivity Tools
- Integrated Development Environment
- Integrated Data Browser and Charting Engine
- Model Libraries
- Benchmarking and Deployment
- Model Debugger and Profiler
- Transparent and reproducible Quality Assurance and Testing System
- Data and Model Encryption
- Grid Computing
- Scenario Reduction
- MPSGE for general equilibrium modeling

User Interfaces

GAMS Language Compiler and Execution System

Solvers
- LP/MIP-QCP-MIQCP-NLP/DNLP-MINLP-CNS-MCP-MPEC, global, and stochastic

Interactive

API / Batch

ALPHAEC, BARON, COIN, CONOPT, CPLEX, DECIS, DICOPT, KNITRO, LGO, LINDO, MINOS, MOSEK, OQNLP, PATH, SNOPT, XA, XPRESS, …
Hands-on! Installing GAMS

export PATH=/home/jhjagla/gams:$PATH
What is a Model?

• Mathematical Programming (MP) Model
  – List of Equations

• Collection of several intertwined MP Models
  – Data Preparation
  – Data Calibration
  – “Solution” Module (e.g. sequential, parallel, loop)
  – Report Module
A Transportation Model

Minimize Transportation cost
subject to Demand satisfaction at markets
Supply constraints
\[
\sum_{c,p:\ (c,p)\in \mathcal{N}} t_{\text{cost}} \cdot d_{\text{ist}}(c, p) \cdot x_{p}^{c} \rightarrow \min
\]

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

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

\[
x_{p}^{c} \geq 0 \quad \forall c, p : (c, p) \in \mathcal{N}
\]
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 \( j \);

\[
\text{cost} \quad z = \text{sum}((i,j), c(i,j) \times x(i,j)) ;
\]
\[
\text{supply}(i) \quad \text{sum}(j, x(i,j)) = \text{a}(i) ;
\]
\[
\text{demand}(j) \quad \text{sum}(i, x(i,j)) = \text{b}(j) ;
\]

Model transport /all/ ;
Hands-on! IDE - A Guided Tour

- Project Management
- Documentation
  - User’s Guide
  - McCarl User’s Guide
  - Solver Manuals
- Model Library
- Solver Selection
- Option Editor
- Listing file
  - Tree view
  - Error navigation
- Spell checking
GAMS Talks at IFORS 2008

**Global optimization with GAMS**

*Lutz Westermann*
Monday, 2:00 PM - 3:30 PM
Sandton Sun: Oleander

**Extended mathematical programming in GAMS**

*Jan-Hendrik Jagla*
Monday, 4:00 PM - 5:30 PM
Sandton Sun: Oleander

**Recent enhancements in GAMS**

*Jan-Hendrik Jagla*
Tuesday, 8:00 AM - 9:30 AM
Sandton Sun: Oleander
## GAMS on the Web

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<th><strong>Download</strong></th>
<th><a href="http://www.gams.de">www.gams.de</a>  <a href="http://www.gams.com">www.gams.com</a></th>
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### Help and Support

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<td><a href="http://groups.google.de/group/gamsworld">http://groups.google.de/group/gamsworld</a></td>
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### Search all GAMS Websites

| **Websites** | [http://www.gams.com/search.htm](http://www.gams.com/search.htm) |
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