Rapid Application Prototyping using GAMS

Steven Dirkse
sDirkse@gams.com
GAMS Development Corp
www.gams.com

Michael Bussieck
MBussieck@gams.com
GAMS Software GmbH
www.gams.de

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Welcome/Agenda

- GAMS Development / GAMS Software
- Working with GAMS – A Guided Tour
- Model Development
- Model Deployment and Maintenance
Agenda

- GAMS Development / GAMS Software
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GAMS Development / GAMS Software

- Roots: Research project
  World Bank 1976
- Pioneer in Algebraic Modeling Systems
  used for economic modeling
- Went commercial in 1987
- Offices in Washington, D.C and Cologne

- Professional software tool provider
- Operating in a segmented niche market
- Broad academic & commercial user base and network
Application Areas:

- 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

* Illustrative examples in the GAMS Model Library
Network of Application Partners
Agenda

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GAMS at a Glance


Design Principles:
- Balanced mix of declarative and procedural elements
- Open architecture and interfaces to other systems
- Different layers with separation of:
  - model and data
  - model and solution methods
  - model and operating system
  - model and interface
More GAMS Features

- State of art professional modeling technology
- Increased productivity
- Robust and scalable
- Rapid development
- Broad Network
- Large model libraries with templates
- Multiple Model Types
- Platform / Solver independence:
  - Maintainable models
  - Protection of investments
System Overview

Connectivity Tools
- Uniform Data Exchange:
  - ASCII
  - GDX (ODBC, SQL, XLS, XML)
- GDX Tools
- Data API
- Ext. programs
  - EXCEL
  - MATLAB
  - GNUPLOT, ...
  - C, Delphi, ...

GAMS Language Compiler and Execution System

Interactive

API/Batch

User Interfaces

Solvers
LP-MIP-QCP-MIQCP-NLP-MINLP-CNS-MCP-MPEC
MPSGE, global, and stochastic optimization

Productivity Tools
- Integrated Development Environment (IDE)
- Model Debugger and Profiler
- Model Libraries
- Data Browser
- Charting Engine
- Benchmarking
- Deployment System
- Quality Assurance and Testing

BARON, COIN, CONOPT, CPLEX, DECIS, DICOPT, KNITRO, LGO, MINOS, MOSEK, OQNLP, PATH, SNOPT, XA, XPRESS, ...
Welcome to the Daily SuDoku!

Today's SuDoku is shown on the right. Click the grid to download a printable version of the puzzle. Visit the archive for previous daily puzzles and solutions. Play online, print a SuDoku, solve and get hints using the new improved Draw/Play function.

But how do I do it?

The object is to insert the numbers in the boxes to satisfy only one condition: each row, column and 3x3 box must contain the digits 1 through 9 exactly once. What could be simpler?

The rules of the new Monster SuDokus are exactly the same, but more numbers and letters are needed.
Christmas tree Sudoku

Daily SuDoku

Daily Seasonal Sudoku: Fri 23-Dec-2005 [instructions]

3  2  9
1  7  3
7  4  9  2
6  2  8  3
3  8  4  5

Christmas tree Sudoku: Fri 23-Dec-2005  very hard
<table>
<thead>
<tr>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAMS Development / GAMS Software</td>
</tr>
<tr>
<td>Working with GAMS – A Guided Tour</td>
</tr>
<tr>
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</tr>
<tr>
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</tbody>
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Important Principles

• Deployed models have often 15+ years lifecycle
  – Changing environment:
    • hardware, operating system, interface (GUI/data)

• Backward compatibility

• Platform/Solver/Interface Independence
  – Model benefits from
    • Advanced hardware
    • Advanced solver technology

• Reduced Total Cost of Ownership (TCO)
Flow of Data

Data Model I
- Application in control of data processing
- No direct data access

Data Model II
- Large Scale/Raw data exchange GAMS↔DB
- Control Data GAMS↔Application
Input/Output through ASCII Files

- ASCII Input Data
  - Part of model input ($include file.txt)
  - Posix Utilities are part of GAMS Windows System
    - Platform independent data file preparation
    - `sed`, `awk`, `grep`, `cut`, ...
      
      $call cut -d, -f1,3- file.txt > filenew.txt

- ASCII File Output
  - GAMS Put Facilities
GAMS Data eXchange

- **GAMS Data eXchange (GDX):**

- Complements the ASCII text data input
- Advantages:
  - Fast exchange of data (factor >20)
  - Syntactical check on data before model starts
  - Compile-time and Run-time Data Exchange
  - Platform Independent
GDX Tools

GDX Tools include:

- GDX API
- gams
- gdxxrw (MS Office)
- gdxdiff
- gdxmerge
- gdxdump
- gdxsplt
Samurai Sudoku

The classic five merged grid Samurai Sudoku. We have one free puzzle each week and three additional weekly puzzles for registered users. See below for previous puzzles.

We also have a printable blank Gattai-5 grid for those of you who want to print out some copies to work on.

Free Samurai #33 (Easy)

Access key:

To access the premium Samurais, you will need to enter an access key in the box above. The same key will also let you access our Senku, Shogun, Sapo and Waseda puzzles and use both the Samurai and standard solvers as many times as you like.

To obtain an access key:

Click the "Buy now" button below to use secure PayPal pages to purchase an access key. Each key costs £3.00 and is valid for 14 days. The key will be sent to you by email. We will only use your email address to administer this service, and will not pass your details to any third party.

Buy Now

Top Notch Free Samurai #33 (Easy)

Registered users can view, save or print the Samurai in Acrobat PDF format.

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Data in Excel and GAMS in Control

- GAMS is the driving program
- Data is stored in Excel (database)
- Use gdxxrw to import data from Excel
- Use gdxxrw to export data to Excel
- Hands-on: samurai_mrb, samurai_xls
Calling GAMS from an Application

Creating Input for GAMS Model
Callout to a GAMS Process/Executable
Reading Output from GAMS Model

• Works from basically every environment
  – Web application (server side)
  – Application Builder
    • Oracle, Eclipse, .NET, …
    • Regular Programming language C++, Java, VB, …
  – MS Office Application / VBA

• Hands-on! samurai_vb.xls
A few Words about Maintenance

**Optimization**
- Takes Longer than one is willing to wait
- It will eventually fail

**Application**
- Real Time
- Always need a *Solution* to Problem

- Key for support/maintenance
  - Catch problems before a model is solved
    - Implement Data Error checks
  - Reproduce the problem offline
    - Get hold of Instance (*dumpopt=11*)
  - Solver related problems in confidential models
    - Get scalar Model using solver **CONVERT**
Summary

- 30+ Years Experience in Modeling
  - Strong views on modeling process (*The GAMS Way*)
    - Development
    - Deployment
    - Maintenance
  - Less than 5% of modeling/optimization projects do not fit the GAMS way
  - Use of GAMS and its productivity tools (after potentially steep learning curve)
    - Increases productivity of model building
    - Reduces total cost of ownership for model client
    - Opens doors to a large network of GAMS developers and clients with modeling needs
Contacting GAMS

Europe:
GAMS Software GmbH
Eupener Str. 135-137
50933 Cologne
Germany
Phone: +49 221 949 9170
Fax: +49 221 949 9171
http://www.gams.de

USA:
GAMS Development Corp.
1217 Potomac Street, NW
Washington, DC 20007
USA
Phone: +1 202 342 0180
Fax: +1 202 342 0181
http://www.gams.com