Rapid Application Prototyping using GAMS

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Welcome/Accord

- Working with GAMS – A Guided Tour
- Basic Sudoku
- Samurai Sudoku
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
GAMS at a Glance

**General Algebraic Modeling System:**

**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
### 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**

**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

**User Interfaces**
- Interactive
- API/Batch

**Solvers**
- BARON, COIN, CONOPT, CPLEX, DECIS, DICOPT, KNITRO, LGO, MINOS, MOSEK, OQNLP, PATH, SnoPy, XA, XPRESS, ...
Minimize Transportation cost

subject to Demand satisfaction at markets

Supply constraints
\[
\sum_{c,p: (c,p) \in \mathcal{N}} t_{\text{cost}} \cdot \text{dist}(c, p) \cdot x^c_p \rightarrow \min
\]

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

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

\[
x^c_p \geq 0 \quad \forall c, p : (c, p) \in \mathcal{N}
\]
GAMS Syntax – GAMS Algebra

Variables
\[ x(i,j) \quad \text{shipment quantities in cases} \]
\[ z \quad \text{total transportation costs in thousands of dollars} \]

Positive Variable \( x \);

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

\[ \text{cost} .. \quad z = \text{e} = \sum(i,j) a(i) \times x(i,j) \]
\[ \text{supply}(i) .. \quad \sum(j, x(i,j)) =l= a(i) \]
\[ \text{demand}(j) .. \quad \sum(i, x(i,j)) =g= b(j) \]

Model transport /all/ ;
GAMS IDE – notable features

- IDE Project Management
- Documentation
- Model Library
- Editor
- Solver Selection
- Option Selection
- Listing file/Tree view/Error navigation
- GDX Viewer
  - Data cube
  - Export to Excel
  - Graphs
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
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)
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

- IDE GDX browser
GDX Tools

IDE
GDX Viewer

GDX
GDX API

Gams

gdxxrw (MS Office)

gdxsplit

GDXdiff

gdxmerge

gdxdump
Samurai Sudoku

Top Notch 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 Siamese, Chopan, Sams and Montia 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 £5.00 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
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
Contacting GAMS

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