

# Rapid Application Prototyping Using GAMS

**Steve Dirkse** 

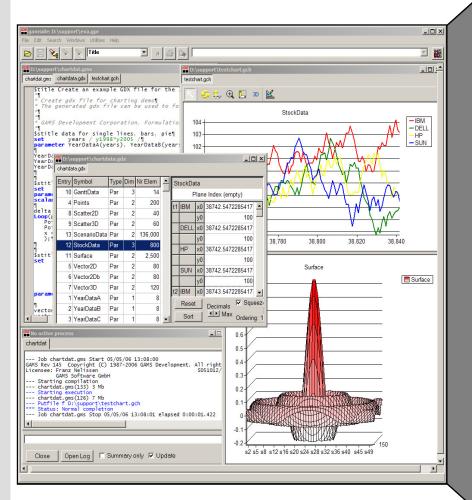
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**GAMS Development Corporation** 

www.gams.com

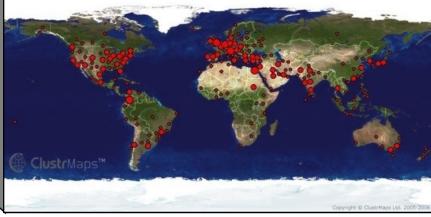


### **GAMS** at a Glance



#### 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 \***

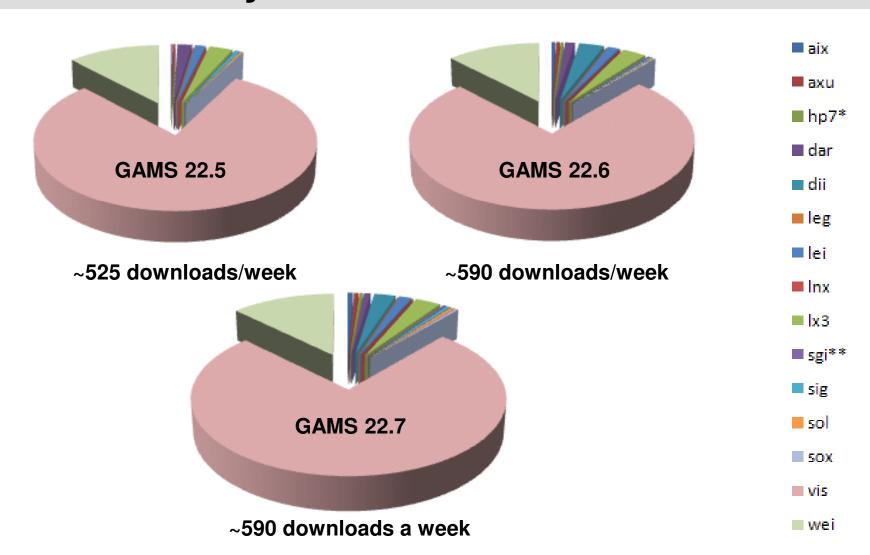
- Agricultural Economics
- Chemical Engineering
- Econometrics
- Environmental Economics
- Finance
- International Trade
- Macro Economics
- Management Science/OR
- Micro Economics

- Applied General Equilibrium
- Economic Development
- Energy
- Engineering
- Forestry
- Logistics
- Military
- Mathematics
- Physics

<sup>\*</sup> Illustrative examples in the GAMS Model Library

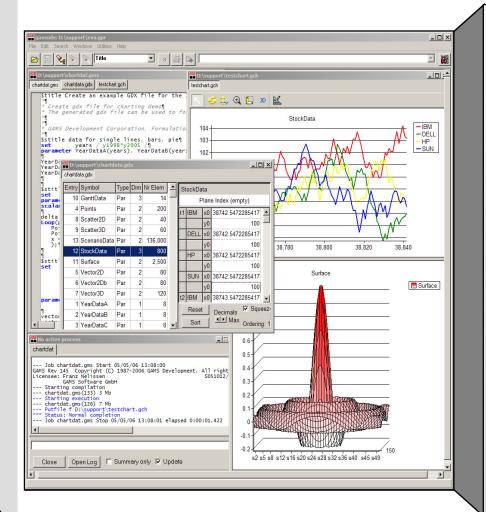


# **Downloads by Platform**





## **GAMS** at a Glance

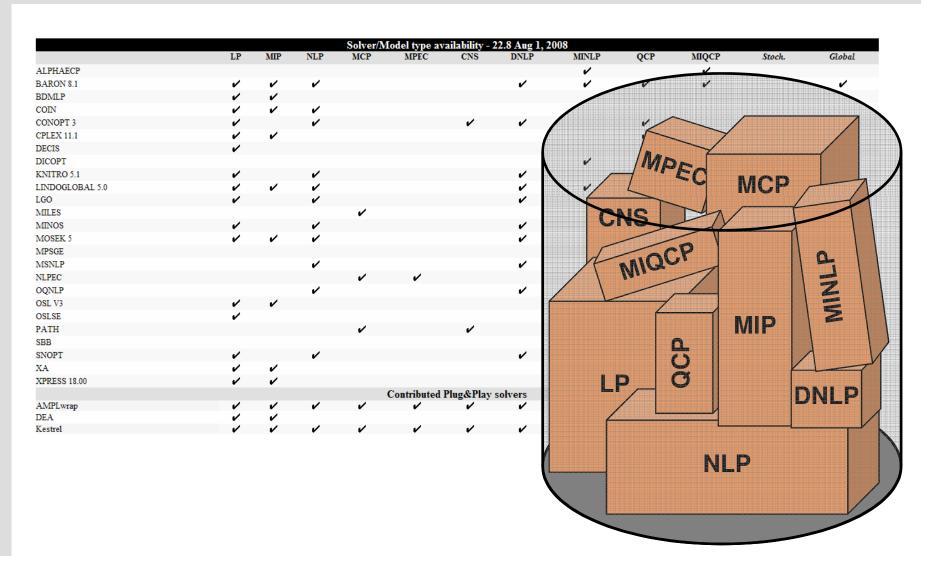


#### General Algebraic Modeling System

- 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 22.8)

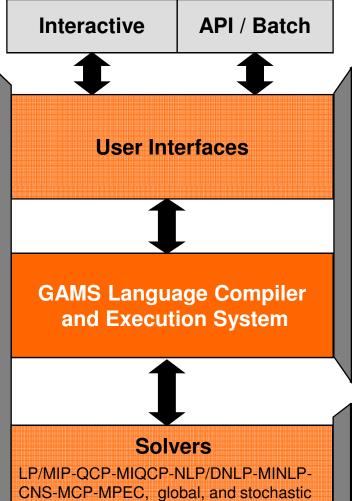




## **System Overview**

#### **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

ALPHAECP, BARON, COIN, CONOPT, CPLEX, DECIS, DICOPT, KNITRO, LGO, LINDO, MINOS, MOSEK, OQNLP, PATH, SNOPT, XA, XPRESS, ...

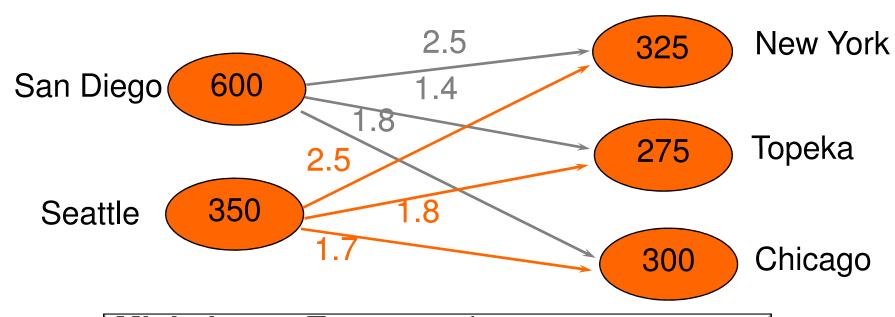


#### What is a Model?

- 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



## **Mathematical Algebra**

$$\sum_{\substack{c,p:\\ (c,p)\in\mathcal{N}}} t cost \cdot dist(c,p) \cdot x_p^c \rightarrow \min$$

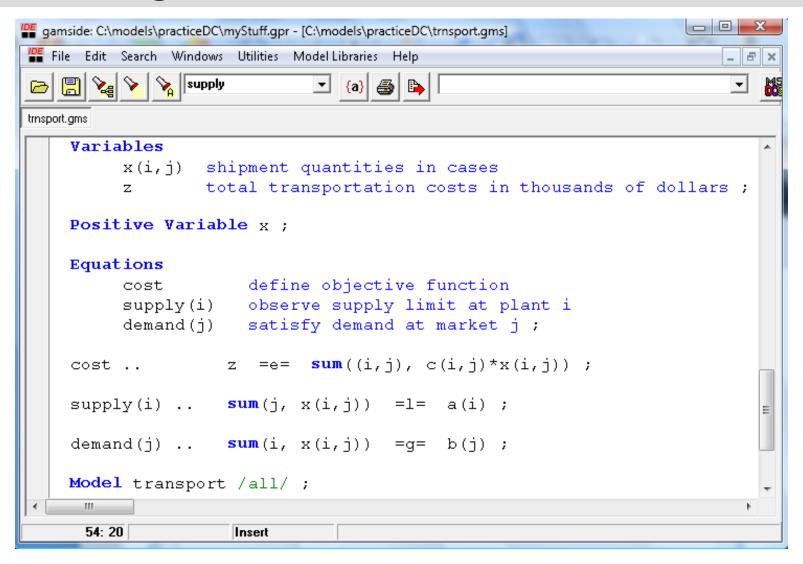
$$\sum_{\substack{c,p:\\ (c,p)\in\mathcal{N}}} x_p^c \leq sup(c) \quad \forall c$$

$$\sum_{\substack{c,p:\\ (c,p)\in\mathcal{N}}} x_p^c \geq dem(p) \quad \forall p$$

$$x_p^c \geq 0 \quad \forall c,p:(c,p)\in\mathcal{N}$$



## **GAMS Algebra**





#### **Basic Sudoku**

Address 🙆 http://www.dailysudoku.com/sudoku/index.shtml

# Daily SuDoku



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#### 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.

	indicate included in the squiggry								
						6		1	
			7	3	1			4	
5 6					9				
6			2				1		  -
		8				4			reserved
	1				5			8	All rights
			9					3	td 2006.
7			8	6	3				Sudden L
9		2							(c) Daily Sudoku Ltd 2008. All rights reserved.

Classic Monster Kids Squiggly

Daily SuDoku: Thu 2-Nov-2006

very hard



## **Christmas Tree Sudoku**

Address 🙆 http://www.dailysudoku.com/sudoku/archive.shtml?year=2005&month=12&day=23&type=seasonal

# Daily SuDoku



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

	3			2			9		
		1				2			
			7		3				
	7		4		9		2		
	6	2				8	2		reservec
			1		5				All rights
									.td 2005.
			8		4				Sudoku L
3								5	(c) Daily Sudoku Ltd 2005. All rights reserved

Christmas tree Sudoku: Fri 23-Dec-2005

very hard



## Samurai Sudoku

Address 🚳 http://sudoku.top-notch.co.uk/gattai5.asp



#### 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 Sensei, Shogun, Sumo and Wordoku 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 £2.00 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.

BuyNow

#### Top Notch Free Samurai #33 (Easy)

Get the solution to this puzzle from our solver. Registered users can view, save or print this Samurai in Acrobat PDF format.

4					8	3								2	9		3		6	5
7				5		8		1							1		4			
			6		4			5				9				7	6			
6	3	1						4						3				2		
		5		4									8			1			3	
8	4					1						5		1				9		7
5			8		3										3				7	2
				6						6										
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5	2				8										9		1			3
3		6				4		5						7					8	6
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1	9	$\Box$	8		2	5								6	2					8



# 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
- Integrates with existing user IT infrastructure



# **Contacting GAMS**

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