



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



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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
-



Network of Application Partners

ETSAP

TELEGYR[®]
SYSTEMS

COWI

OPTIENCE

BARKAWI

COPENHAGEN ECONOMICS

**UNIVERSITY
APPS, INC.**

iIT



VA TECH SAT



SAT
AUTOMATION



profitpoint



CGR

Verbund



EcoMod[®]Net

Alteq[®]IT



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GAMS at a Glance

The screenshot displays the GAMS software interface with several windows:

- Code Editor:** Shows GAMS code for creating an example GDX file for charting. The code includes comments and commands like `set`, `parameter`, and `YearData`.
- Data Table:** A table listing entries with columns for Entry, Symbol, Type, Dim, and Nr Elem. Entry 12, StockData, is highlighted.
- StockData Chart:** A line chart showing data for four companies: IBM (red), DELL (green), HP (yellow), and SUN (blue) over time. The x-axis ranges from 38,780 to 38,840, and the y-axis ranges from 102 to 104.
- Surface Plot:** A 3D surface plot showing a sharp peak. The x-axis is labeled with symbols s2 through s49, and the y-axis ranges from -0.2 to 0.6.
- Log Window:** Shows the execution log for the job 'chartdat.gms', including start and stop times and file paths.

General Algebraic Modeling System:
 Algebraic Modeling Language,
 Integrated Solver, Model
 Libraries, Connectivity- &
 Productivity Tools

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

The screenshot displays the GAMS software interface with several windows open:

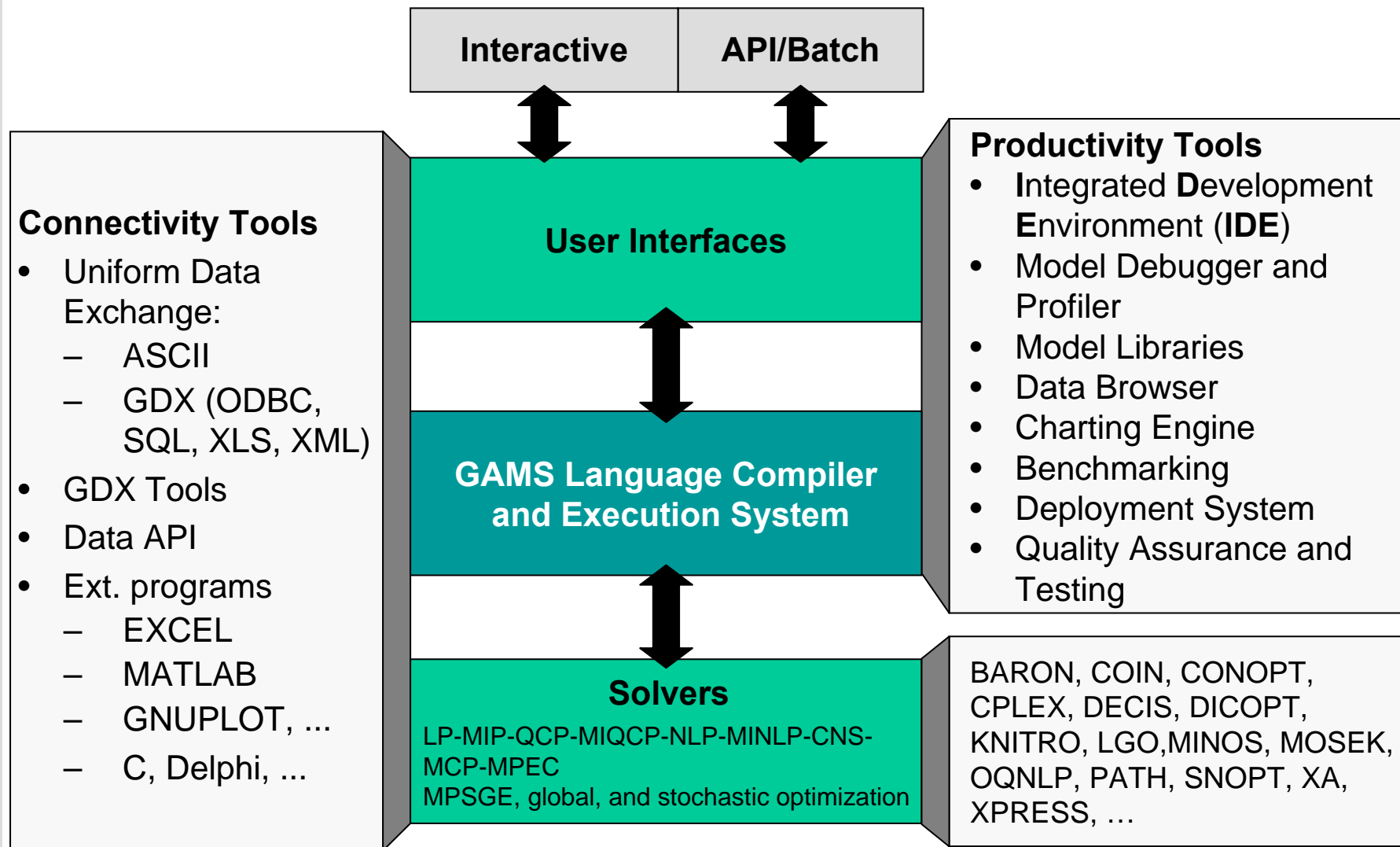
- Code Editor:** Shows GAMS code for creating an example GDX file for charting, including commands like `set`, `parameter`, and `YearData`.
- Data Table:** A table listing model elements:

Entry	Symbol	Type	Dim	Nr Elem
10	GanttData	Par	3	14
4	Points	Par	2	200
8	Scatter2D	Par	2	40
9	Scatter3D	Par	2	60
13	ScenarioData	Par	2	136,000
12	StockData	Par	3	800
11	Surface	Par	2	2,500
5	Vector2D	Par	2	80
6	Vector2Db	Par	2	80
7	Vector3D	Par	2	120
1	YearDataA	Par	1	8
2	YearDataB	Par	1	8
3	YearDataC	Par	1	8
- StockData Chart:** A line chart showing stock prices for IBM, DELL, HP, and SUN over time. The y-axis ranges from 102 to 104, and the x-axis shows values like 38,780, 38,800, 38,820, and 38,840.
- Surface Chart:** A 3D surface plot showing a sharp peak. The y-axis ranges from -0.2 to 0.6, and the x-axis shows values like s2, s5, s8, s12, s16, s20, s24, s28, s32, s36, s40, s45, s49.
- Log Window:** Shows the execution status of the job, including start and stop times and elapsed time.

- 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





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.

Classic

Monster

Kids

Squiggly

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

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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>

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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	3
			1		5		
			8		4		
3							5

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Christmas tree Sudoku: Fri 23-Dec-2005 very hard



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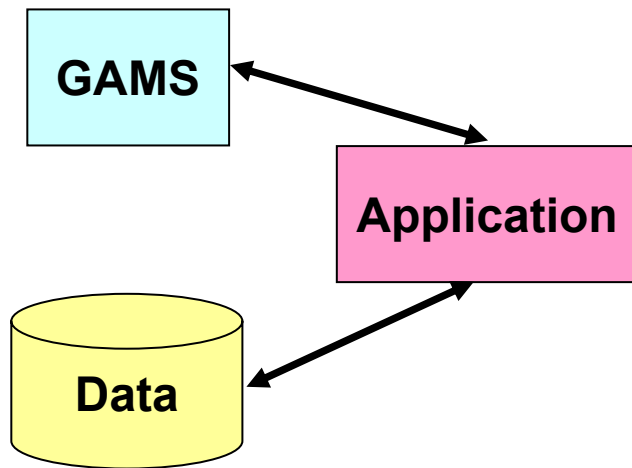


Important Principles

- 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)

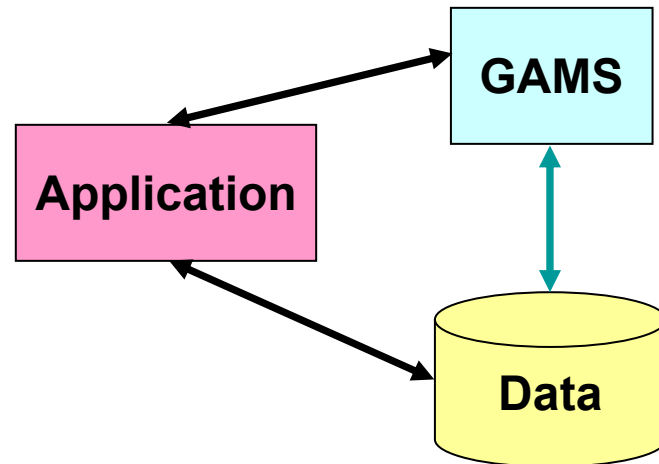


Flow of Data



Data Model I

- Application in control of data processing
- No direct data access



Data Model II

- Large Scale/Raw data exchange $\text{GAMS} \leftrightarrow \text{DB}$
- Control Data $\text{GAMS} \leftrightarrow \text{Application}$



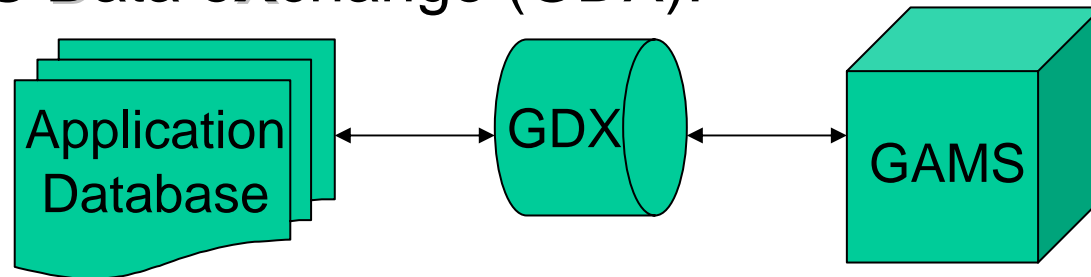
Input/Output through ASCII Files

- 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

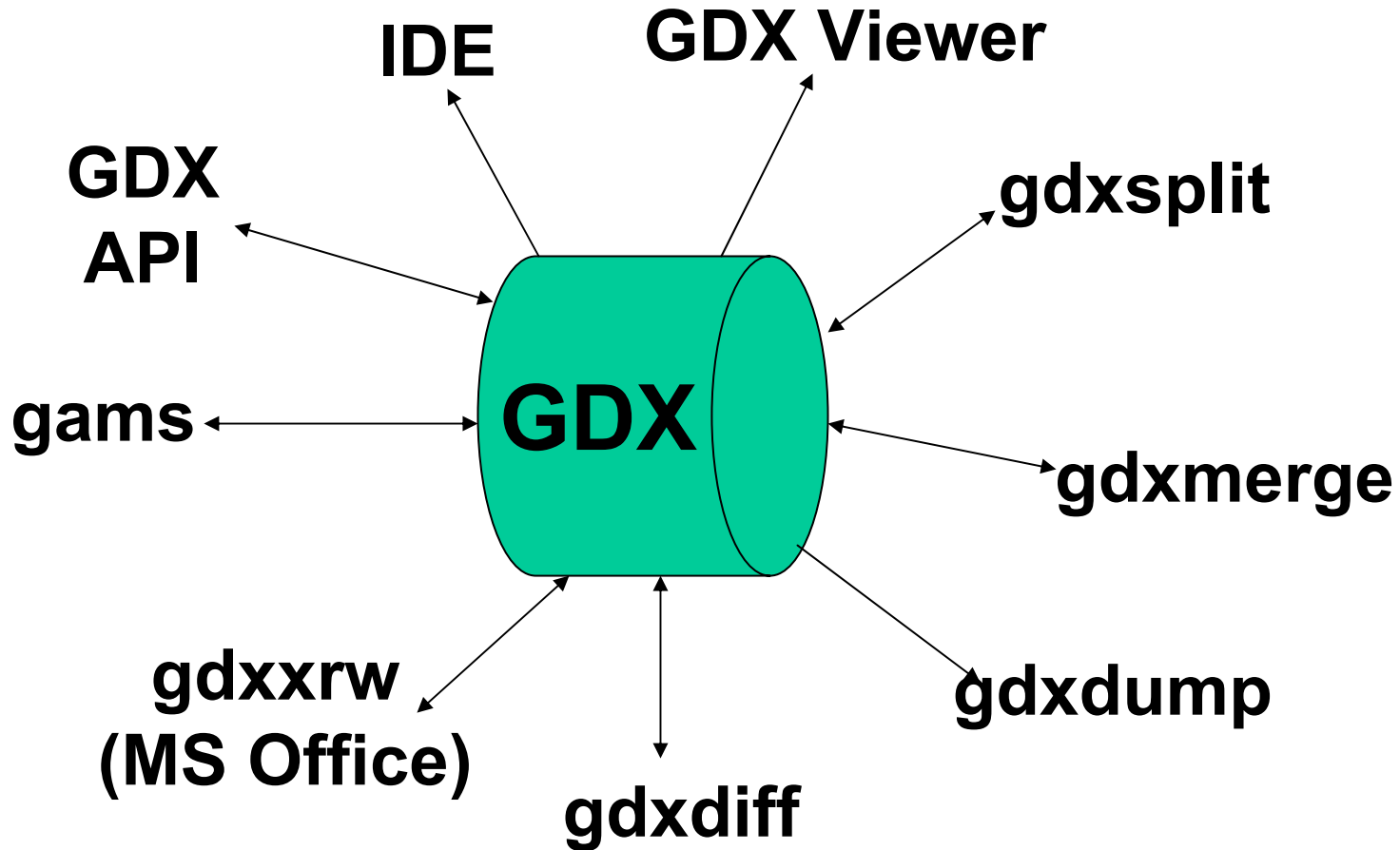
- **GAMS Data eXchange (GDX):**



- 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





Samurai Sudoku

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



Samurai
Sudoku

SAMURAI

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](#).

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.

[Buy Now](#)

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



Data in Excel and GAMS in Control

- GAMS is the driving program
- Data is stored in Excel (database)
- Use gdxrw to import data from Excel
- Use gdxrw 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>