

GAMS



GAMS

General Algebraic Modeling System

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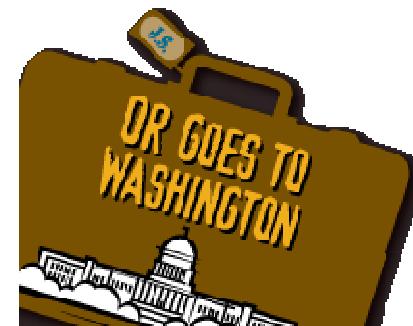
lwestermann@gams.com

GAMS Development Corporation

www.gams.com

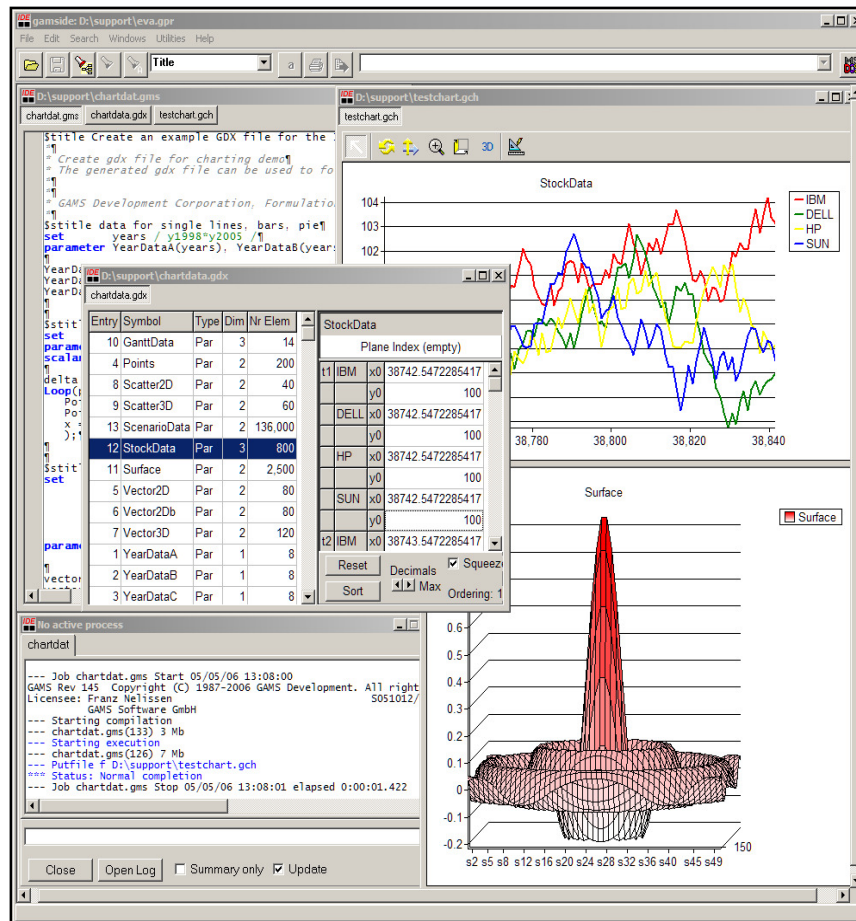
GAMS Software GmbH

www.gams.de



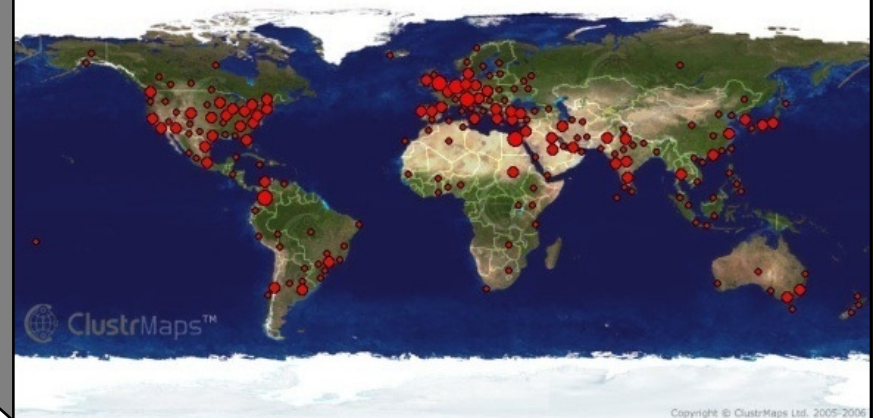


GAMS at a Glance



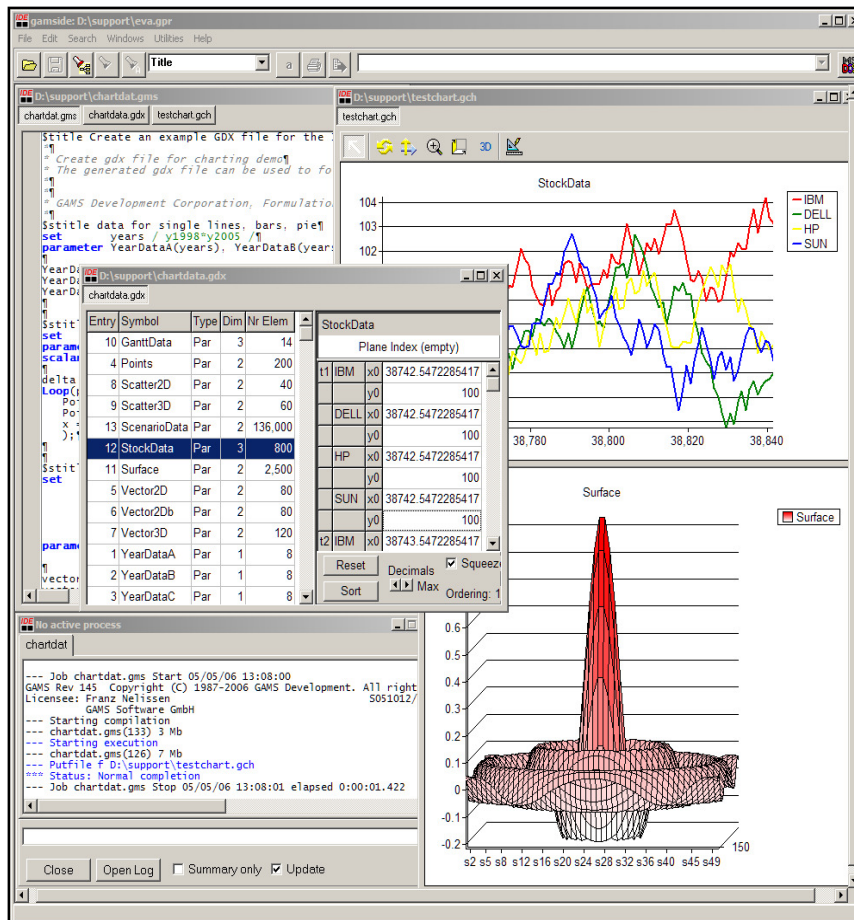
General Algebraic Modeling System

- Roots: World Bank, 1976
- Went commercial in 1987
- GAMS Development Corp.
- GAMS Software GmbH
- Broad academic & commercial user community and network





GAMS at a Glance

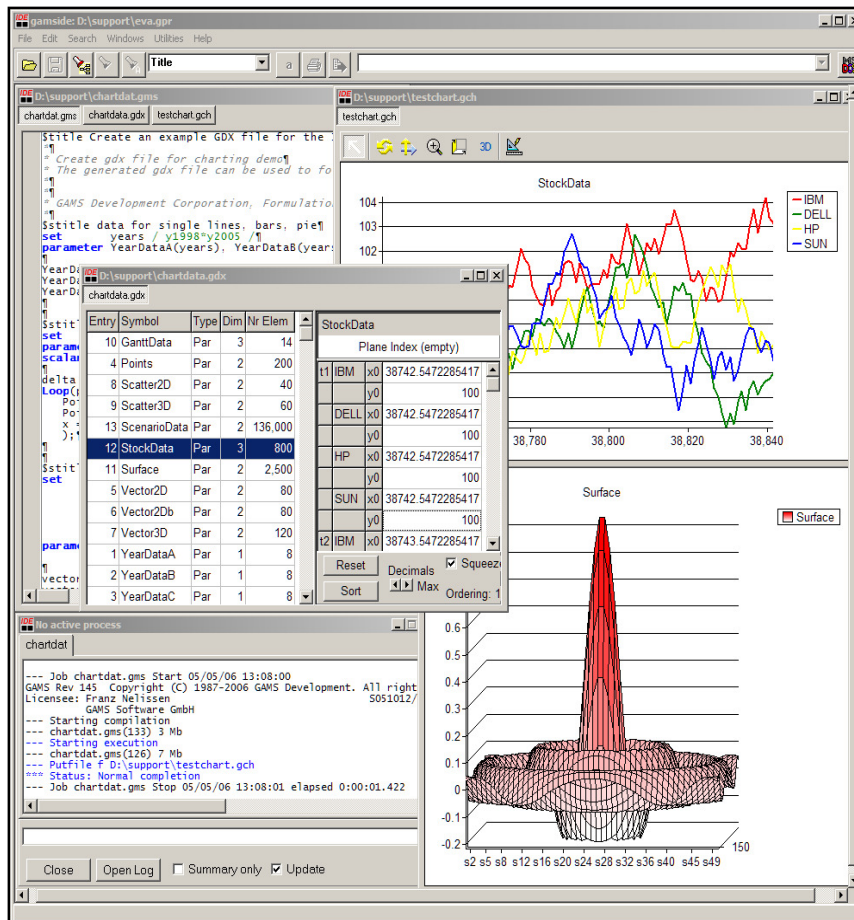


Algebraic Modeling System

- Facilitates to formulate mathematical optimization problems similar to algebraic notation
 - ➔ Simplified model building
- Provides links to appropriate state-of-the-art external algorithms
 - ➔ Efficient solution process



GAMS at a Glance

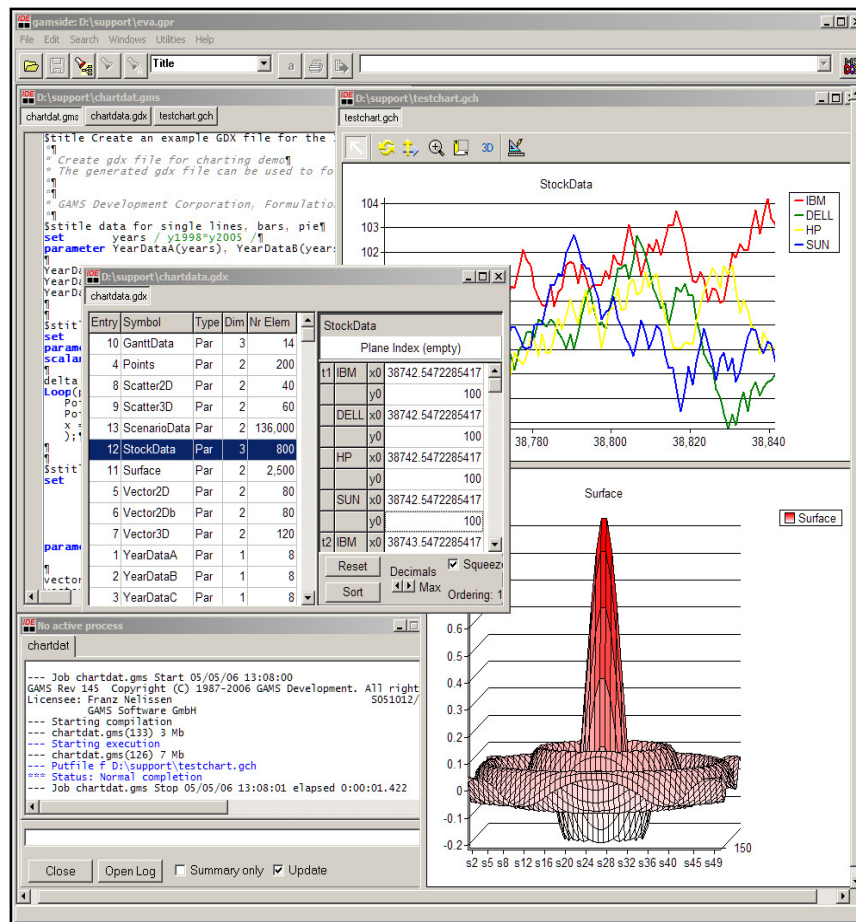


General Algebraic Modeling System

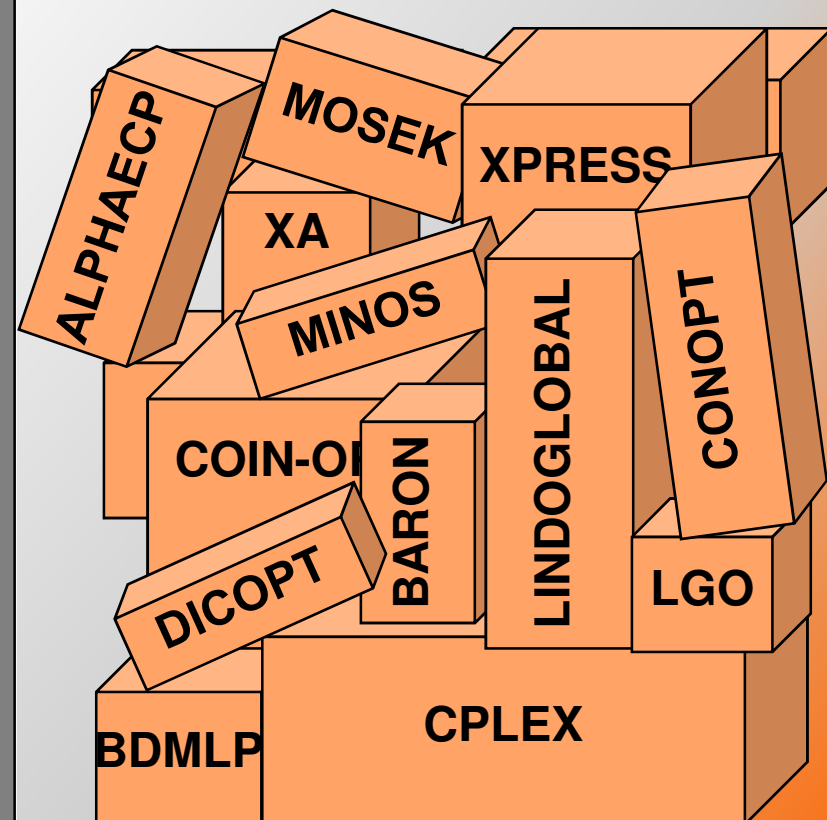
- Algebraic Modeling Language
- 25+ Integrated Solvers
- 10+ Supported MP classes
- 10+ Supported Platforms
- Connectivity- & Productivity Tools
 - IDE
 - Model Libraries
 - GDX, Interfaces & Tools
 - Grid Computing
 - Benchmarking
 - Compression & Encryption
 - Deployment System
 - ...



GAMS at a Glance

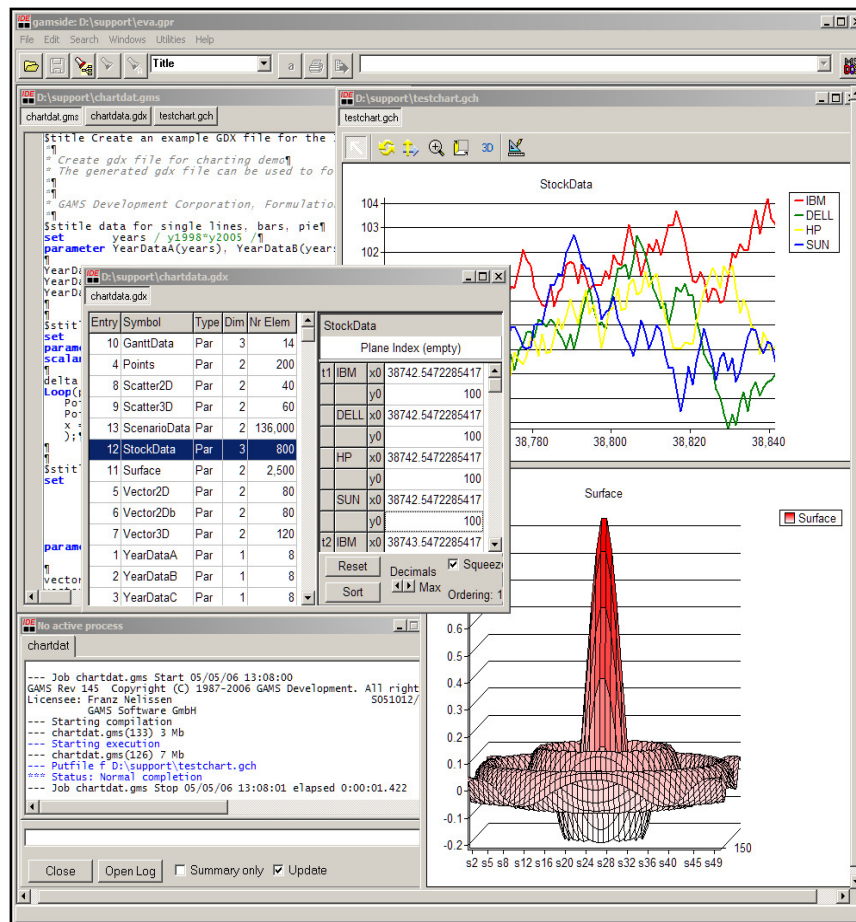


25+ Integrated Solvers

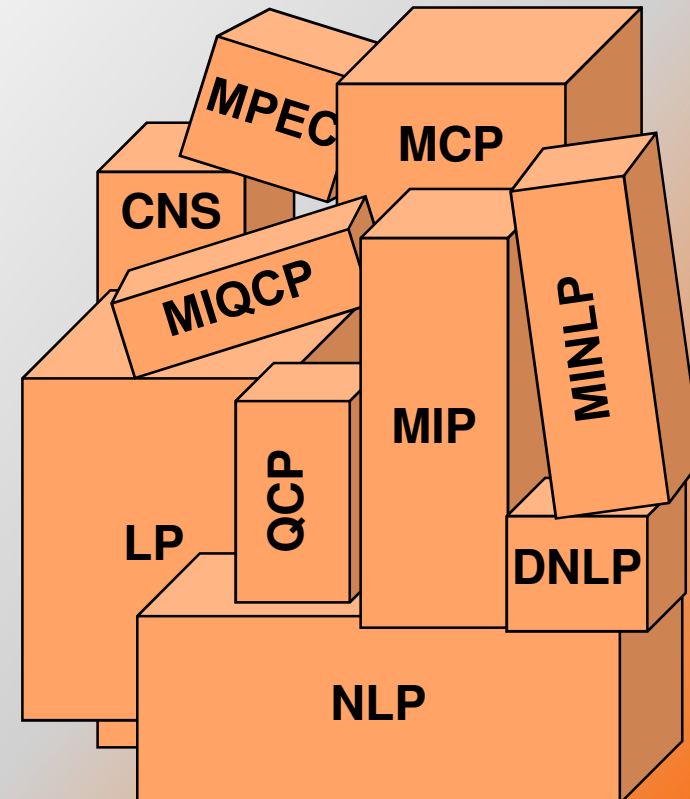


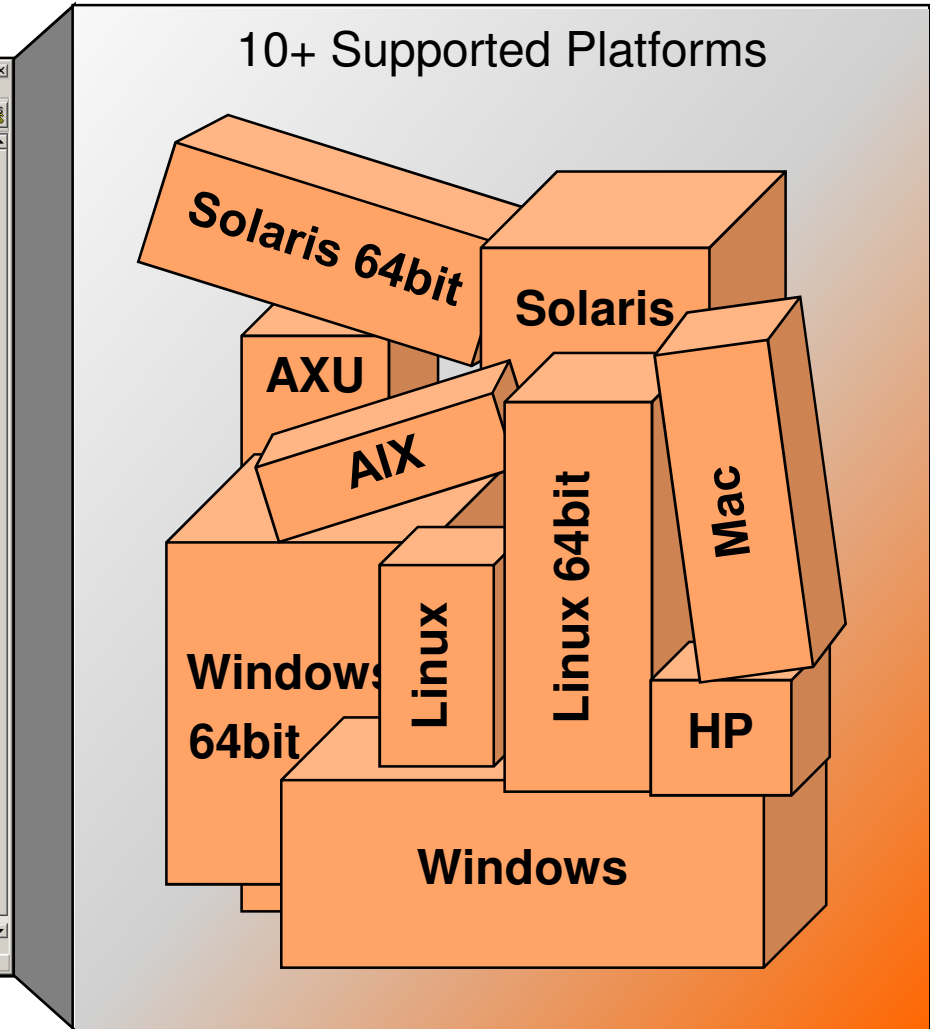


GAMS at a Glance



10+ Supported MP classes



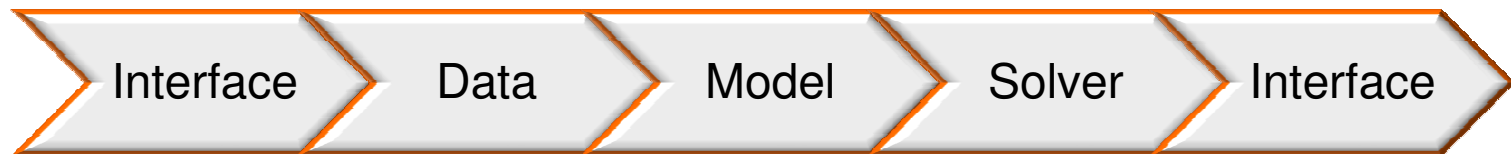


Windows



GAMS' Fundamental concepts

- **Platform independence**
- **Open architecture and interfaces to other systems**
- **Balanced mix of declarative and procedural elements**
 - Declaration of Sets, Parameters, Variables, Equations, Models,
 - Procedural Elements like loops, if-then-else, ...
- **Layers of separation**





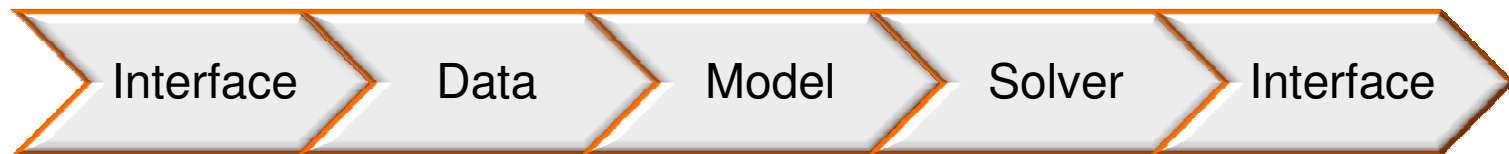
GAMS' Fundamental concepts

Deployed models have often 15+ years lifecycle

- Changing environment (Hardware, OS, Interface)
- Improving solver technology

→ Different layers with separation of

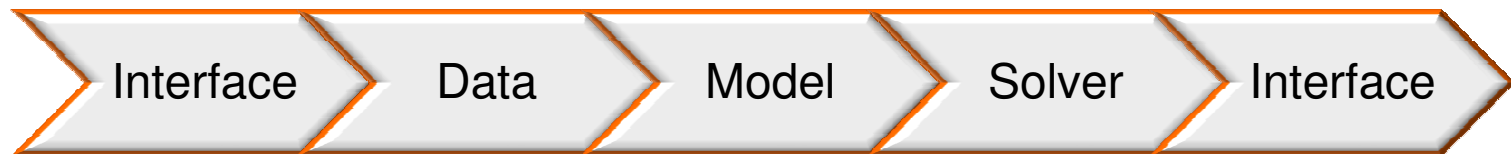
- model and data
- model and solution methods
- model and operating system
- model and interface





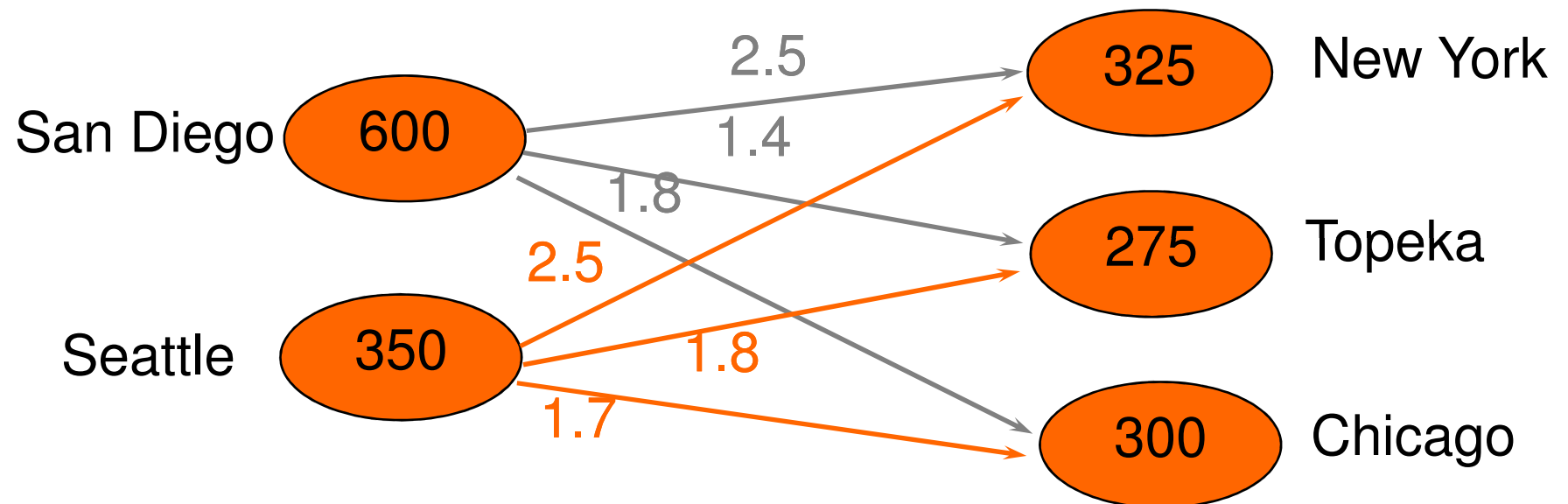
GAMS' Fundamental concepts

- Models benefit from
 - Advancing hardware
 - Enhanced / new solver technology
 - Improved / upcoming interfaces to other systems
- Backward compatibility
- Protection of user investments





A Transportation Model



Minimize Transportation cost
subject to Demand satisfaction at markets
Supply constraints



Mathematical Algebra

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

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

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

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



GAMS Algebra

```
IDE gamside: C:\Documents and Settings\bussieck\My Documents\gamsdir\project.gpr - [c:\documents an...
IDE File Edit Search Windows Utilities Help
[Icons] call {a} [Icons]
transport.gms

Variables
    x(i,j)  shipment quantities in cases
    z        total transportation costs in thousands of dollars ;

Positive Variable x ;

Equations
    cost      define objective function
    supply(i) observe supply limit at plant i
    demand(j) satisfy demand at market j ;

cost ..      z  =e=  sum((i,j), c(i,j)*x(i,j)) ;

supply(i) ..  sum(j, x(i,j))  =l=  a(i) ;

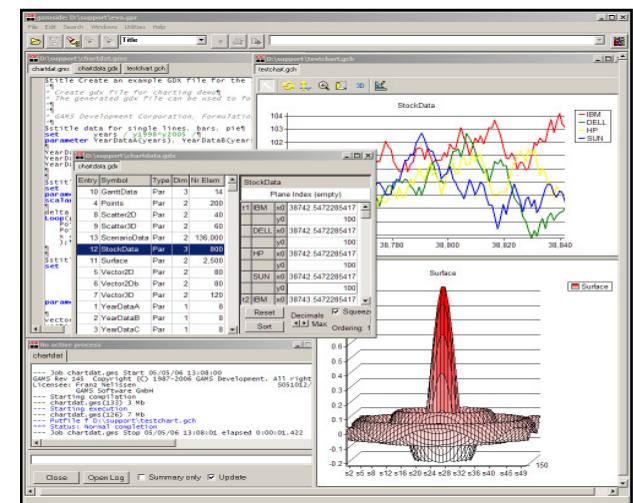
demand(j) ..  sum(i, x(i,j))  =g=  b(j) ;

Model transport /all/ ;
```



Integrated Development Environment

- Project management
- Editor / Syntax coloring / Spell checking
- Launching and monitoring of (multiple) GAMS processes
- Listing file / Tree view / Syntax-error navigation
- Solver selection / Option selection
- GDX viewer
 - Data cube
 - Data export (e.g. to MS Excel)
 - Charting facilities
- Documentation
- Model libraries





Distributed Model Libraries

- **GAMS Model Library**

- Example and user-contributed models
- Very often used as templates
- Tests for
 - Solver robustness and correctness
 - Backward compatibility

Model Libraries	Help
GAMS Model Library	
GAMS Test Library	
GAMS Data Utilities Models	
Practical Financial Optimization Models	

- **GAMS Test Library**

- Transparent and reproducible Quality Assurance Tests
- Tests for
 - Solver correctness
 - Special functions
 - GAMS utilities

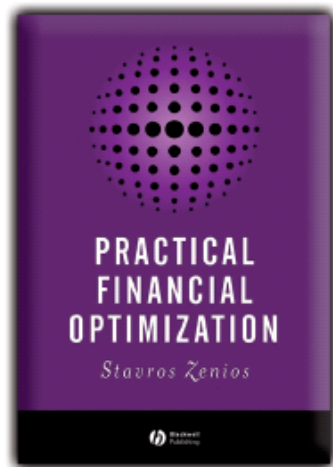


Distributed Model Libraries

- **GAMS Data Utilities Library**

- Demonstration of the various utilities interfacing GAMS with other applications
- e.g. GDX utilities

Model Libraries	Help
GAMS Model Library	
GAMS Test Library	
GAMS Data Utilities Models	
Practical Financial Optimization Models	



- **Practical Financial Optimization Models**

Models of the forthcoming book

*“PRACTICAL FINANCIAL OPTIMIZATION –
A Library of GAMS Models”*

by Consiglio, Nielsen and Zenios



GAMSworld Model Libraries



The Worlds

CONE

GLOBAL

MINLP

MPEC

MPSGE

Performance

Translation

Search

Contact

GAMS World

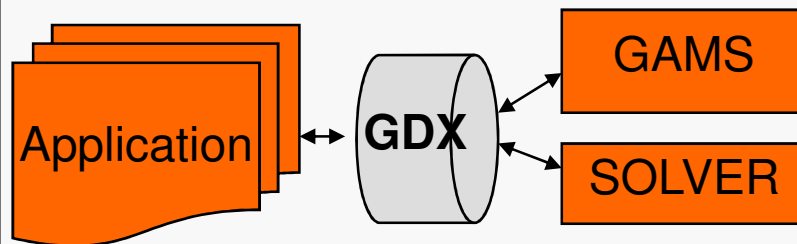
Maintained libraries of established and varied set of both theoretical and practical test models:

- CONELib
- GLOBALLib
- LinLib
- MINLPLib
- MPECLib
- MPSGELib
- PrincetonLib
- XPRESSLib
- ...



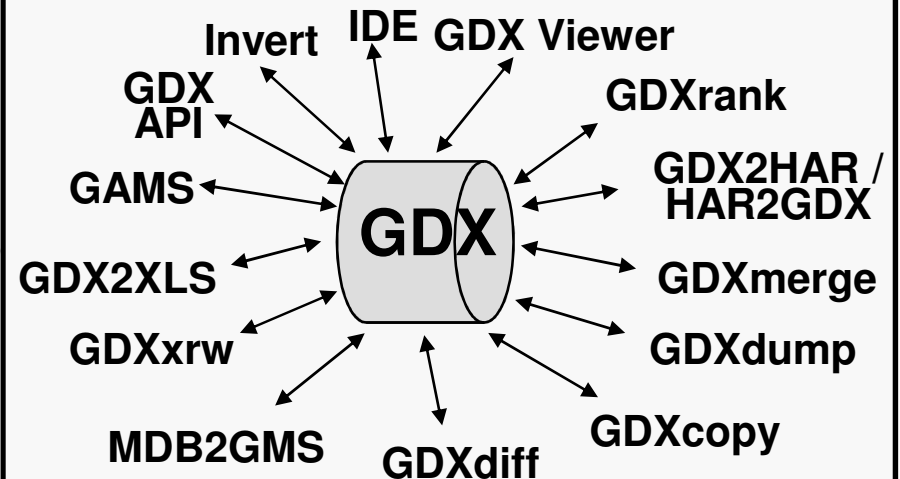
Gams Data eXchange

Binary Data Exchange



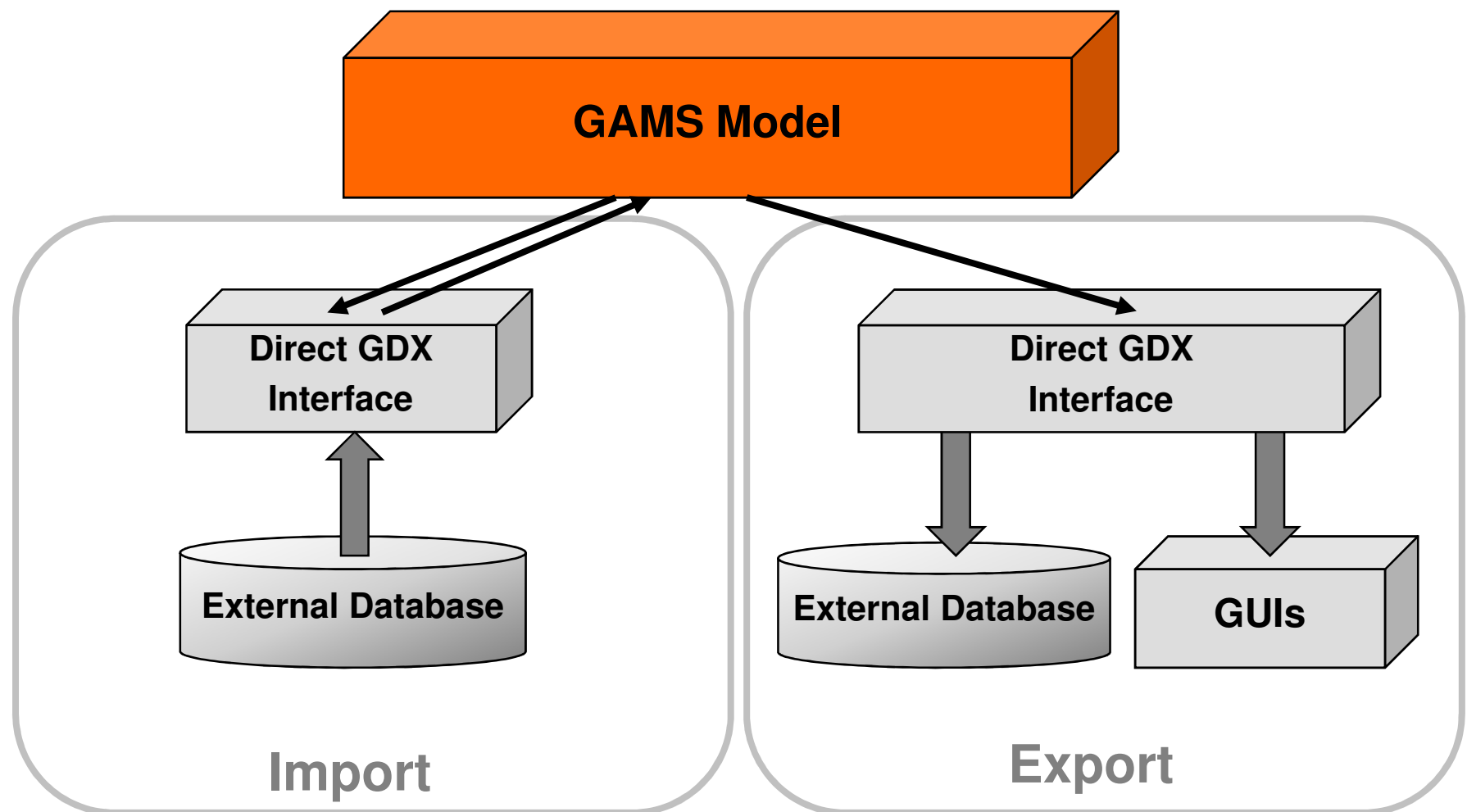
- Fast exchange of data
- Syntactical check on data before model starts
- Data Exchange at any stage (Compile and Run-time)
- Platform Independent
- Direct GDX interfaces and general API
- Scenario Management Support
- Full Support of Batch Runs

GDX Tools



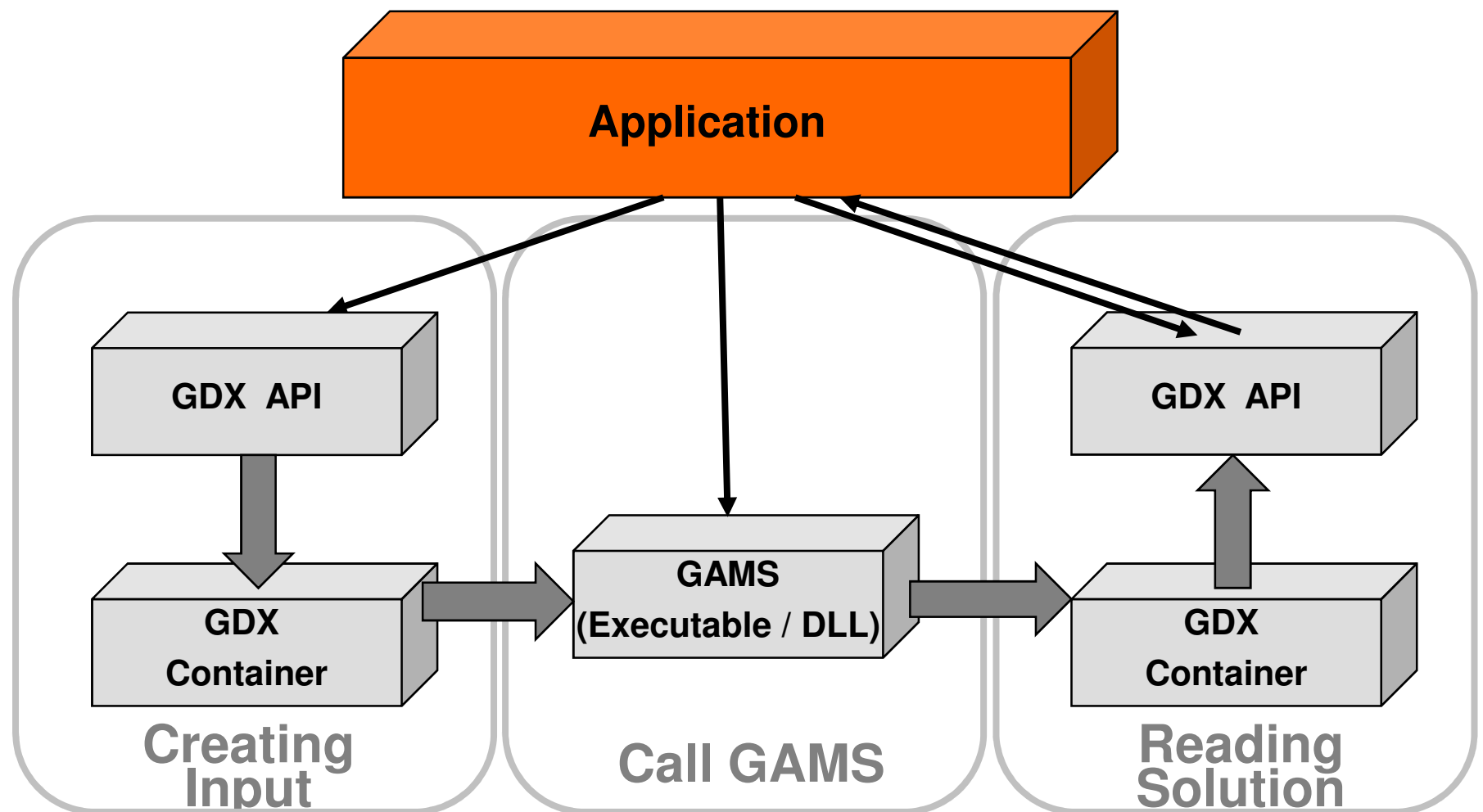


GAMS in Control



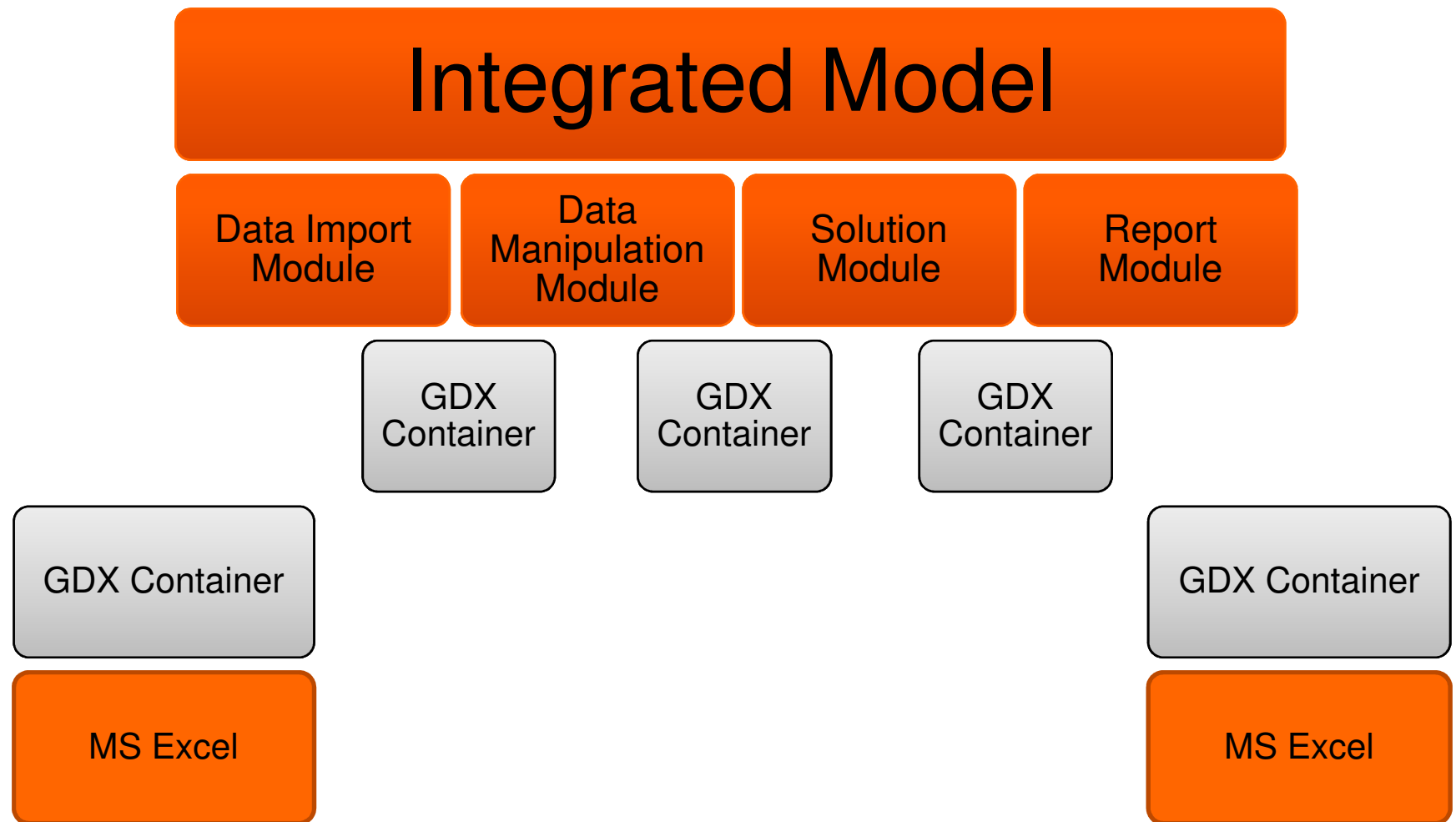


Application in Control





Layout of an Integrated Model





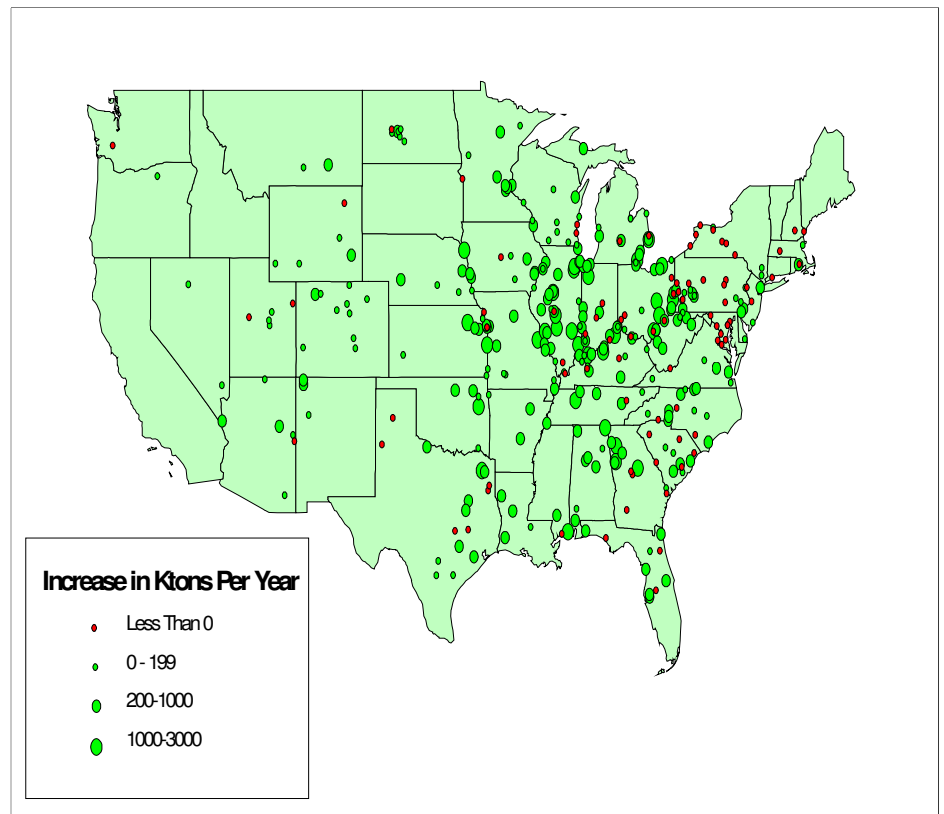
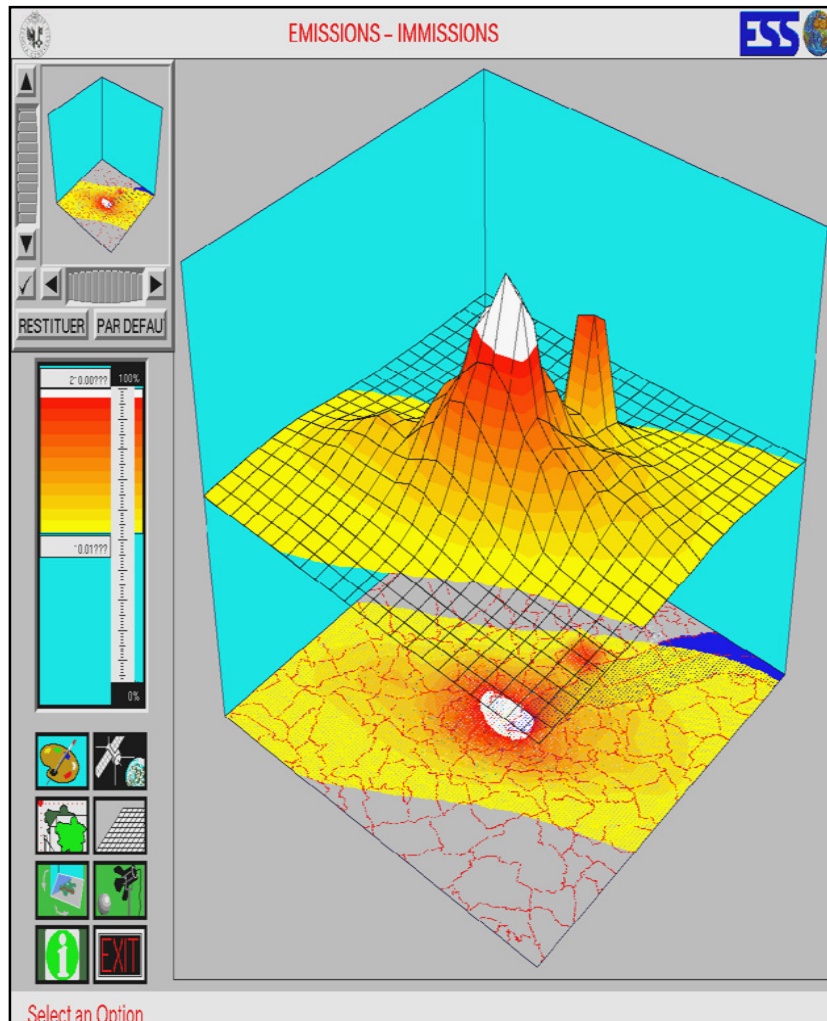
Calling GAMS from an Application

Works from basically every environment

- MS Office Application / VBA
- Programming languages:
 - C,C++,C#
 - Delphi
 - Java
 - VB.NET
 - Fortran
- Web application (server side)
- ERP Systems: Oracle, SAP
- ...



Interfacing with GIS Applications





Interfacing with MATLAB

Figure 1: US dollar short rate scenarios

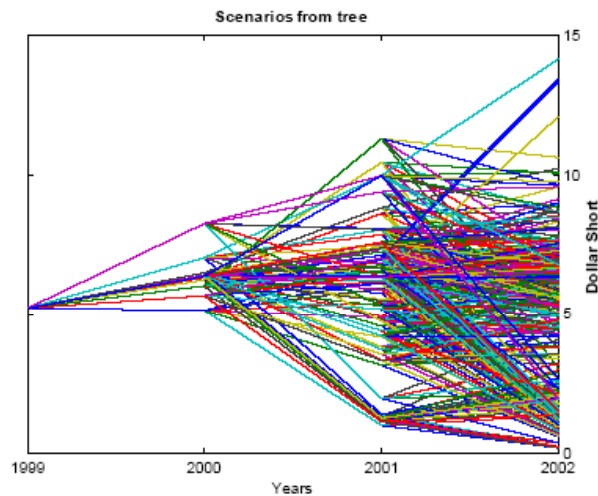
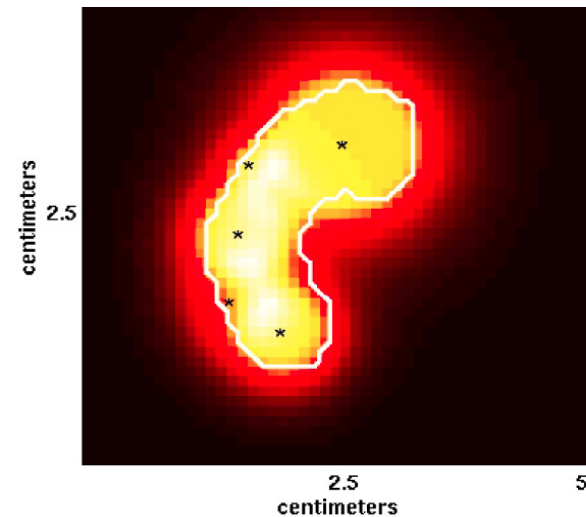
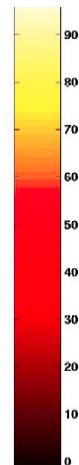
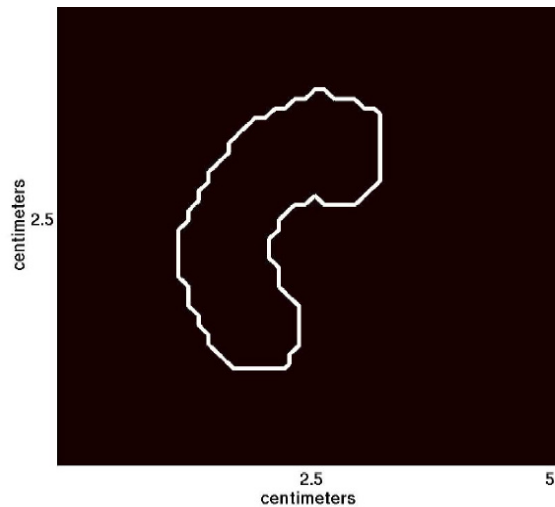
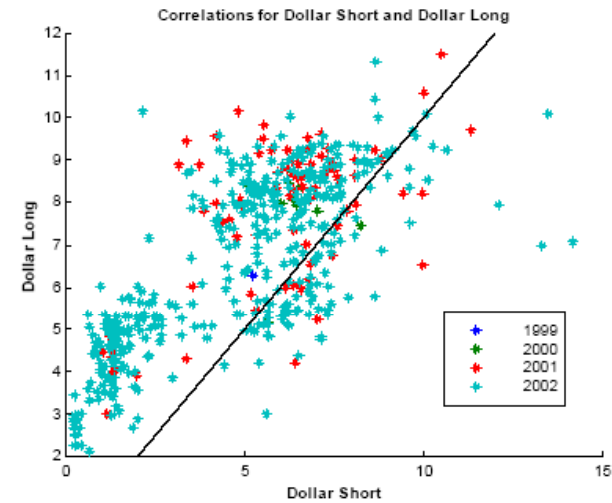
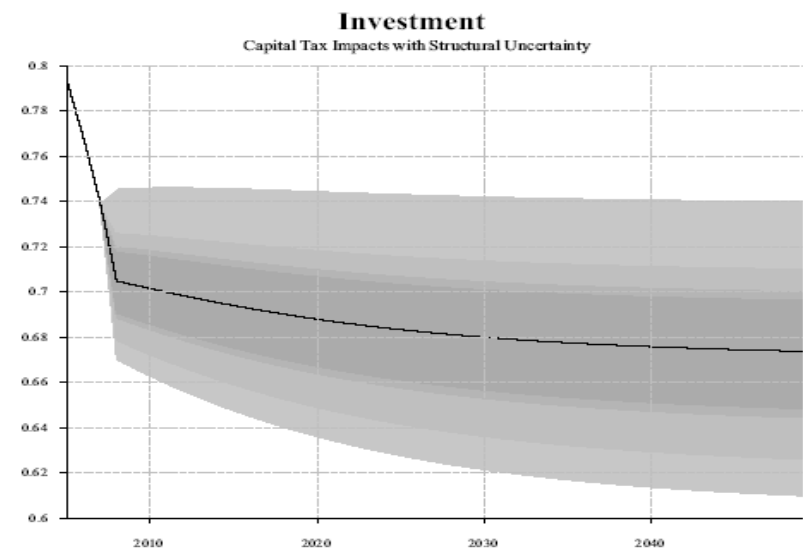
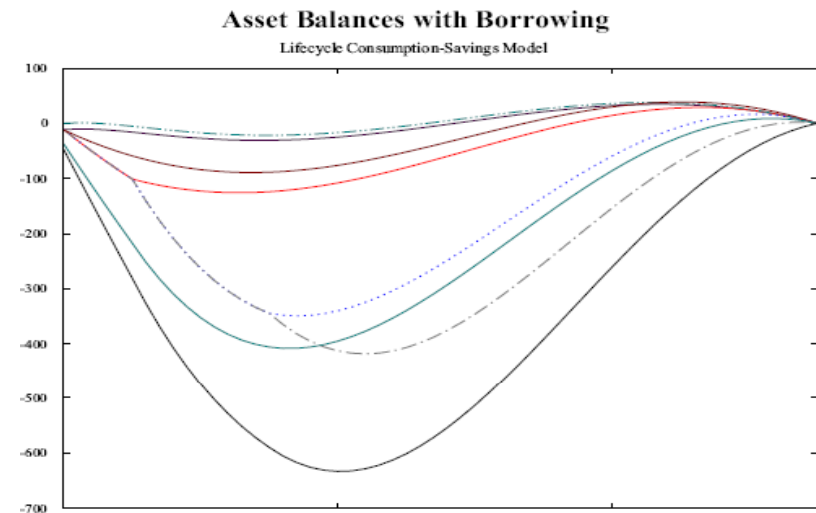
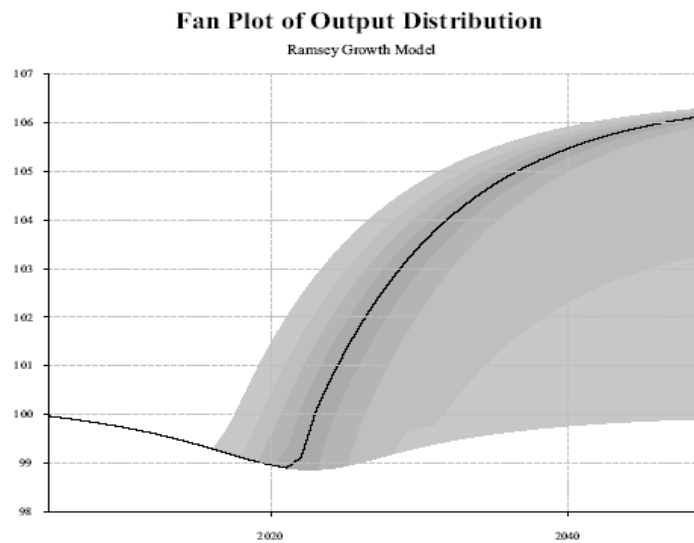
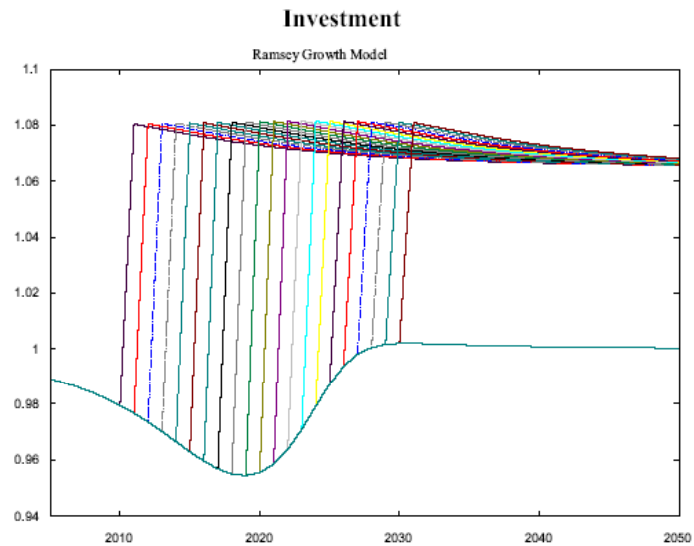


Figure 2: Short vs. long rates





Interfacing with GNPLOT





Interfacing with Web Applications

Cadet Schedules with Constraint Violations, AYT 2001-1

Header Information

Select Constraint Type: 3 FREE HOUR CONSTRAINT Free Hour Violations: 43 →

Filter by: Design Group Violations: 4 →

Unbalanced Schedule Violations: 7 →

Cadets With Schedule Violations FREE HOUR CONSTRAINT

Course	Total Enrollment	Name	SSN	Grad Yr	Reviewed
EM362A		BASS, WILLIE C.		2002	☐
PH365		BROWN, JAMEY A.		2002	☐
EM362A		BUNTING, BRIAN M.		2002	☐
EM301A		CHONOWSKI, DAVID P.		2002	☐
EN302		COOPER, GRAIG W.		2002	☐
EM301A		CULLUMBER, CRAIG M.		2002	☐
EM362A		DONNELL, TYLER R.		2002	☐
EM362A		EDGAR, BENJAMIN T.		2002	☐

Cadets: 43

Name: BASS, WILLIE C. FOS1: Civil Engineering Major FOS2:

Eng Seq: CIVIL ENGINEERING TQPA: 2.414 CQPA: 2.699 (3) 2 Day

Activity: CSWV (3) 1 Day

Hour	Course	Violation	Override
A	PE310		
B	MA364		
C	PL300		
D	PL300		
E	EM362A	FREE HOUR CONSTRAINT	
F	EM362A	FREE HOUR CONSTRAINT	

Schedule

Hour	Course	Violation	Override
G	SS307		
H	HI301		
I	EM364A		
J	EM364A		
K	, R		
L			

Details

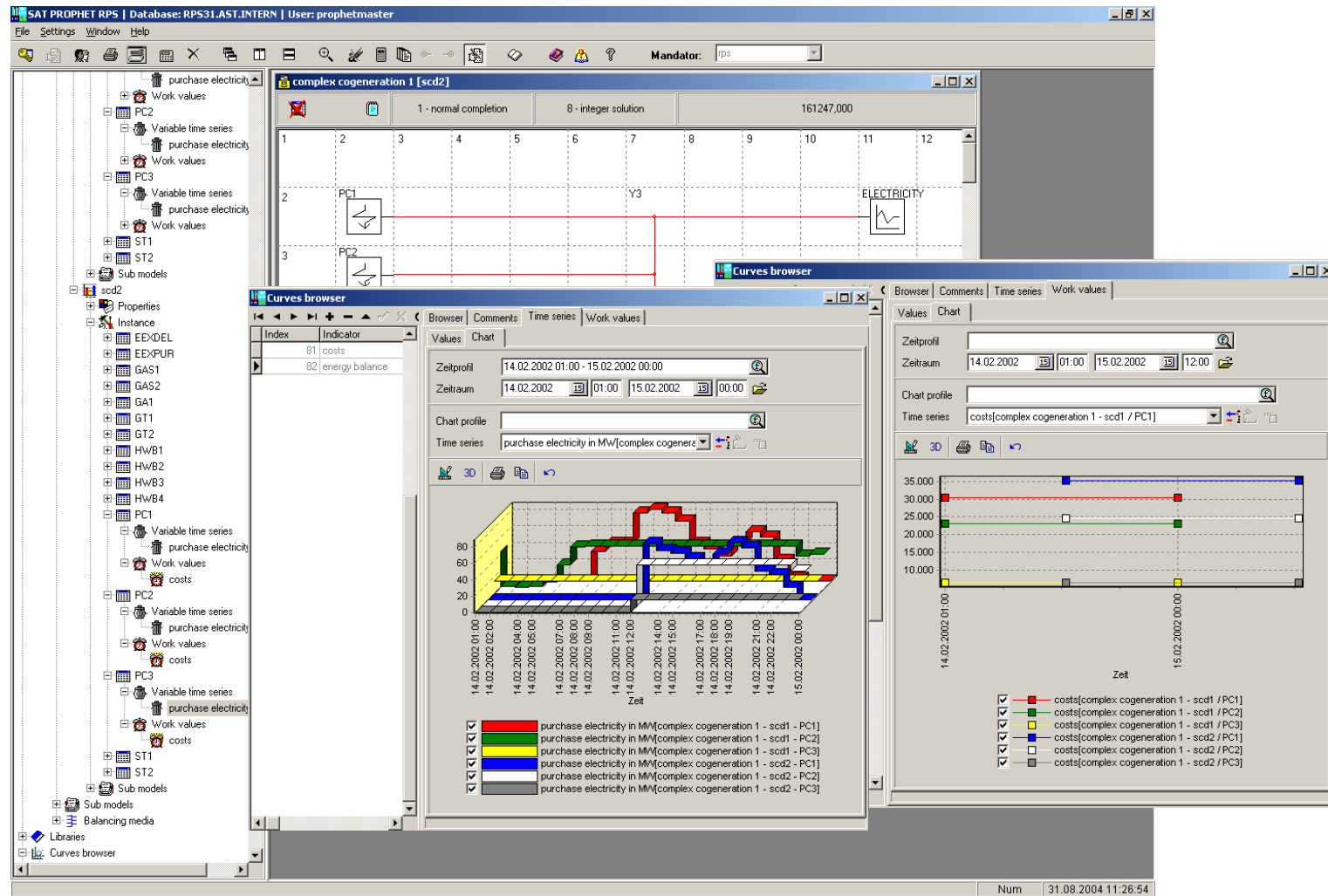
Course Hours

OK

Close



Interfacing with Individual Front Ends



GAMS



Interfacing with MS Office / VBA

Microsoft Excel interface showing a crossword puzzle grid and a VBA macro interface.

The Excel window title is "samurai.xls [Compatibility Mode] - Microsoft Excel". The ribbon includes Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, and Add-Ins. The Review ribbon is active, showing options for Spelling, Research, Thesaurus, Translate, New Comment, Delete, Previous, Next, Show/Hide Comment, Show All Comments, Show Ink, Protect and Share Workbook, Unprotect Sheet, Protect Workbook, Share Workbook, Allow Users to Edit Ranges, and Track Changes.

The crossword puzzle grid is displayed in the worksheet area. The grid is 32 rows high and 26 columns wide. The grid contains numbers and letters, indicating a crossword puzzle.

Below the grid, there are four buttons labeled "Samurai 1", "Samurai 2", "Samurai 3", and "Samurai 4". A "Solve" button is also present.

On the right side of the worksheet, there is a VBA macro interface with the following text:

GAMS Directory: c:\program files\gams22.8\
Working Directory: c:\tmp2\



GAMS Talks at INFORMS 2008

Software Demonstration – Rapid Application Prototyping with GAMS

Steven Dirkse

Sunday Oct 12, 08:00am - 09:30am

Scenario Tree Generation for Stochastic Programming Models using GAMS/SCENRED

Holger Heitsch

Tuesday Oct 14, 04:30pm - 06:00pm



GAMS Talks at INFORMS 2008

Session: Using COIN-OR via GAMS

Sunday Oct 12, 01:30pm - 03:00pm

- **Open-source Quality Assurance and Performance Analysis Tools**
Alex Meeraus
- **GAMS Branch-and-Cut & Heuristic Facility**
Michael Bussieck
- **Hooking Your Solver to GAMS**
Stefan Vigerske



GAMS on the Web

Download www.gams.de www.gams.com

Help and Support

Support Wiki <http://support.gams-software.com>
Interfaces Wiki <http://interfaces.gams-software.com>
McCarl's News <http://www.gams.com/maillist/newsletter.htm>
User Group http://www.gams.com/maillist/gams_l.htm
Google Group <http://groups.google.de/group/gamsworld>

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Websites <http://www.gams.com/search.htm>



Free INFORMS 2008 Evaluation License

- Windows:
<http://www.gams.com/evals/dc/w/gamslice.txt>
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<http://www.gams.com/evals/dc/l/gamslice.txt>
- Macintosh:
<http://www.gams.com/evals/dc/m/gamslice.txt>



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