

GAMS



GAMS

General Algebraic Modeling System

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Optimization Models - Solution

- Problem Representation
 - Matrix Generators
 - Program using callable library
 - Algebraic Modeling Languages
- Available Solution Algorithms
 - Simplex, Interior Point
 - Branch-and-Bound, Branch-and-Cut
 - Sequential Quadratic Programming (SQP)
 - è Powerful Implementations (Solvers)
- Powerful Computer Hardware



Algebraic Modeling Languages

- High-level programming languages for large scale mathematical optimization problems
- Algebraic formulation
 - § Syntax similar to mathematical notation
 - § Does not contain any hints how to process it
- Do not solve optimization problems directly, but call appropriate external algorithms



Goals

- Efficient handling of mathematical optimization problems
- Simplify model building and solution process
- Increase productivity and support maintainable models
- Support of decision making process



GAMS

- Roots: Research project World Bank, 1976
- Pioneer in Algebraic Modeling Systems
- Went commercial in 1987
- GAMS Development Corp. (Washington, D.C)
- GAMS Software GmbH (Cologne)

- Used for economic modeling
- Professional software tool provider, not a consulting company
- Operating in a segmented niche market
- Broad academic & commercial user base and network



Downloads

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Sorted by Platform:

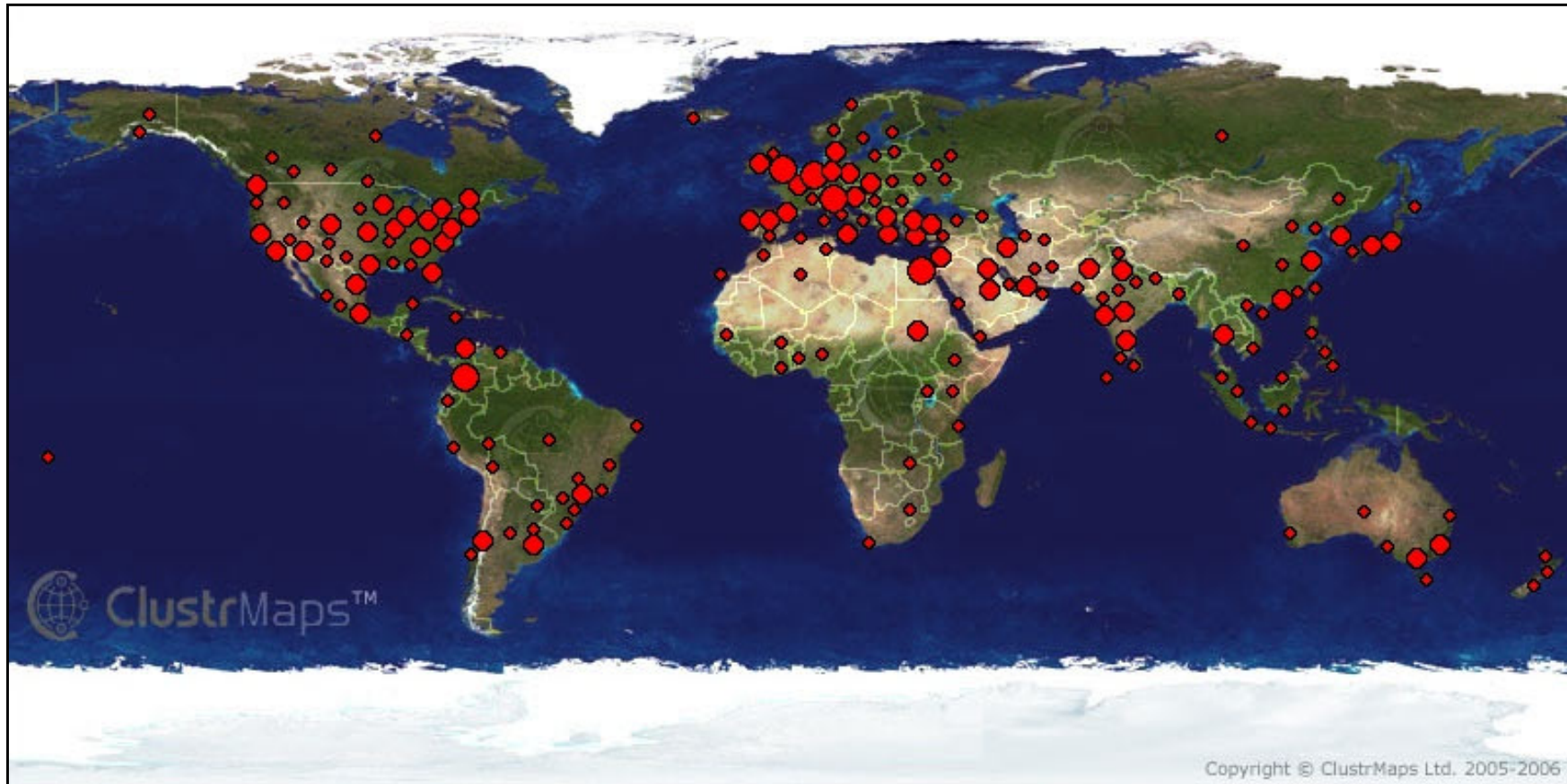
- 23 AIX
- 36 AXU
- 189 Darwin
- 133 Linux64
- 337 Linux32
- 74 Solaris (x86)
- 35 Solaris (Sparc)
- 8436 Windows32
- 1316 Windows64

**~ 500 downloads
per Week**

GAMS



Academic + Commercial Users Worldwide



GAMS



GAMS Solutions Specialists Network



Companies with wide experience in GAMS modeling
à Details at: <http://www.gams.com/specialists/>



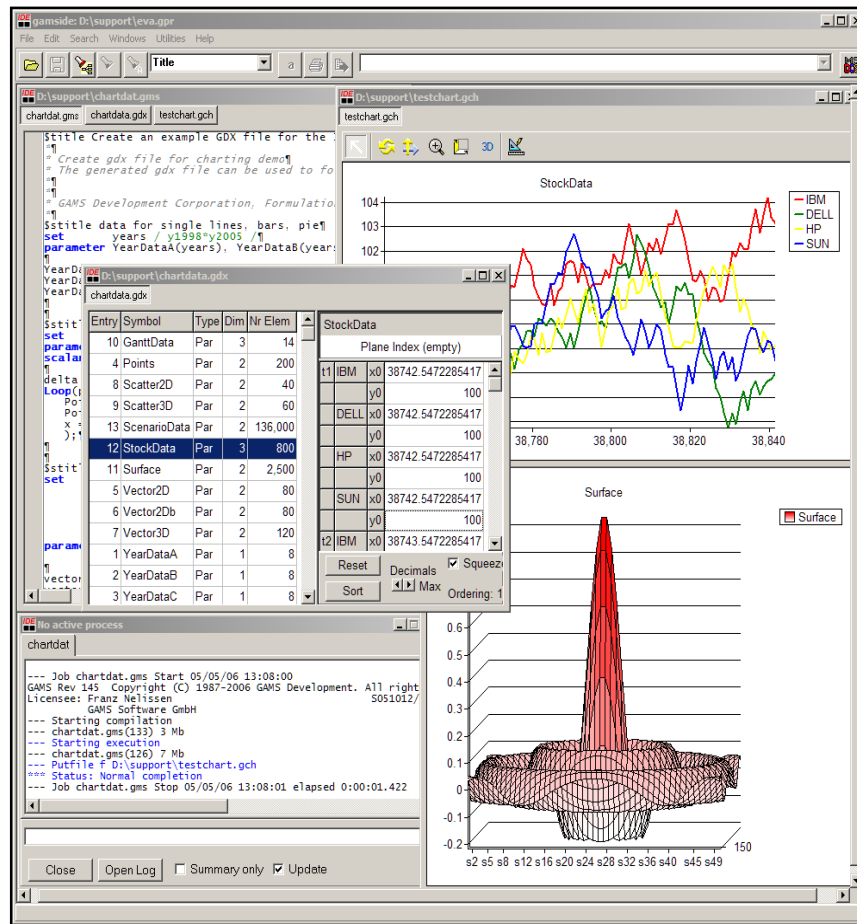
Typical Application Areas *

-
- Agricultural Economics
 - Applied General Equilibrium
 - Chemical Engineering
 - Economic Development
 - Econometrics
 - Energy
 - Environmental Economics
 - Engineering
 - Finance
 - Forestry
 - International Trade
 - Logistics
 - Macro Economics
 - Military
 - Management Science/OR
 - Mathematics
 - Micro Economics
 - Physics
-

* Illustrative examples in the GAMS Model Library



GAMS at a Glance



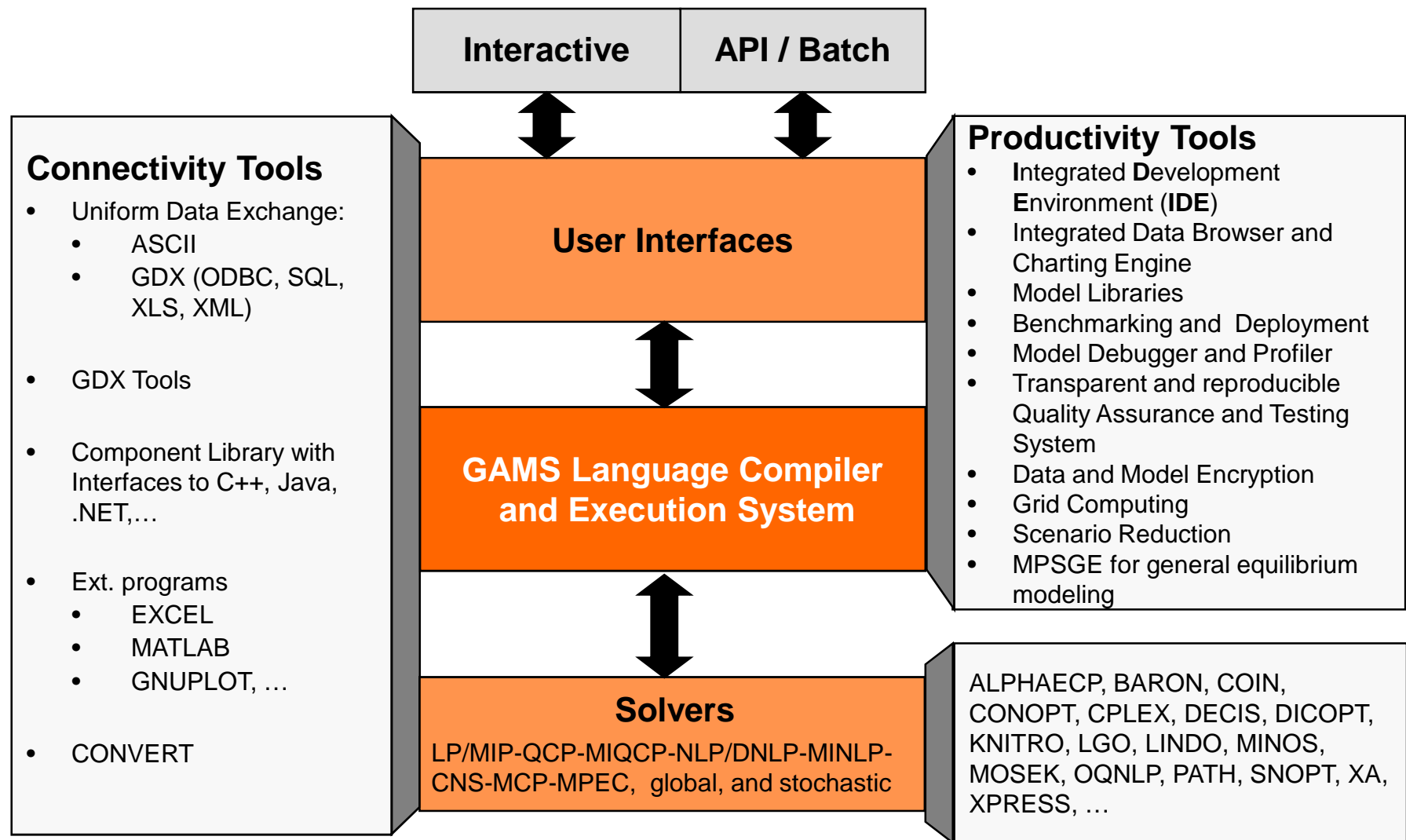
General Algebraic Modeling System:
 Algebraic Modeling Language,
 Integrated Solver, Model Libraries,
 Connectivity- & Productivity Tools

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



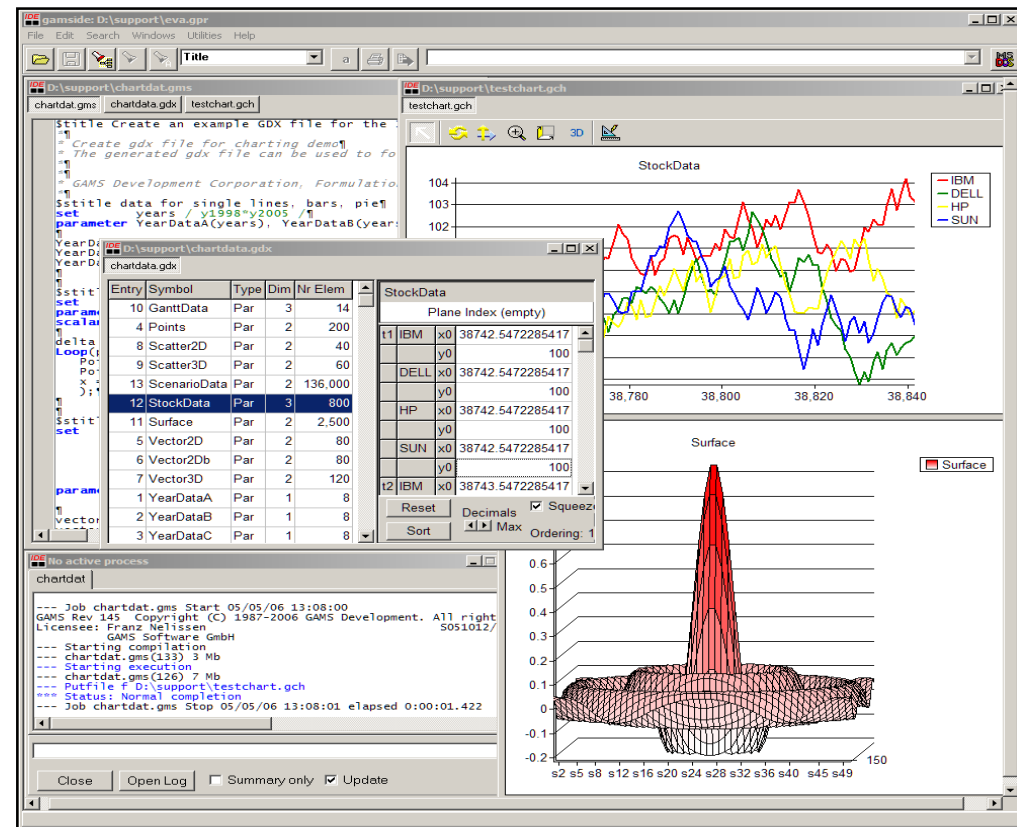
System Overview





Integrated Development Environment

- Project Management
- Documentation
 - User's Guide
 - McCarl User's Guide
 - Solver Manuals
- Model Library
- Solver Selection
- Option Editor
- Listing file
 - Tree view
 - Error navigation
- Spell checking





Multiple Model Types

- LP Linear Programs
- MIP Mixed Integer Programs
- QCP Quadratically Constrained Programs
- MIQCP Quadratically Constrained MIPs
- NLP Nonlinear Programs
- DNLP NLP with Discontinuous Derivatives
- MINLP Mixed Integer Nonlinear Programs
- MCP Mixed Complementarity Programs
- MPEC NLP with Complementarity Constraints
- CNS Constrained Nonlinear Systems
- Stochastic Optimization
- Global Optimization



Multiple Solver & Model Types

Solver/Model type availability - 22.5 June 1, 2007												
	LP	MIP	NLP	MCP	MPEC	CNS	DNLP	MINLP	QCP	MIQCP	Stock.	Global
ALPHAECF								✓		✓		
BARON 7.8	✓	✓	✓				✓	✓	✓	✓		✓
BDMLP	✓	✓										
COIN	✓	✓										
CONOPT 3	✓		✓			✓	✓		✓			
CPLEX 10.2	✓	✓							✓	✓		
DECIS	✓										✓	
DICOPT								✓				
KNITRO 5.1	✓		✓				✓		✓			
LINDOGLOBAL 4.1	✓	✓	✓				✓	✓	✓	✓		
LGO	✓		✓				✓		✓			✓
MILES				✓								
MINOS	✓		✓				✓		✓			
MOSEK 4	✓	✓	✓				✓		✓	✓		
MPSGE												
MSNLP			✓				✓		✓			✓
NLPEC				✓	✓							
OQNLP			✓				✓	✓	✓	✓		✓
OSL V3	✓	✓										
OSLSE	✓										✓	
PATH				✓		✓						
SBB								✓		✓		
SNOPT	✓		✓				✓		✓			
XA	✓	✓										
XPRESS 17.10	✓	✓							✓			
Contributed Plug&Play solvers												
AMPLwrap	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DEA	✓	✓										
Kestrel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

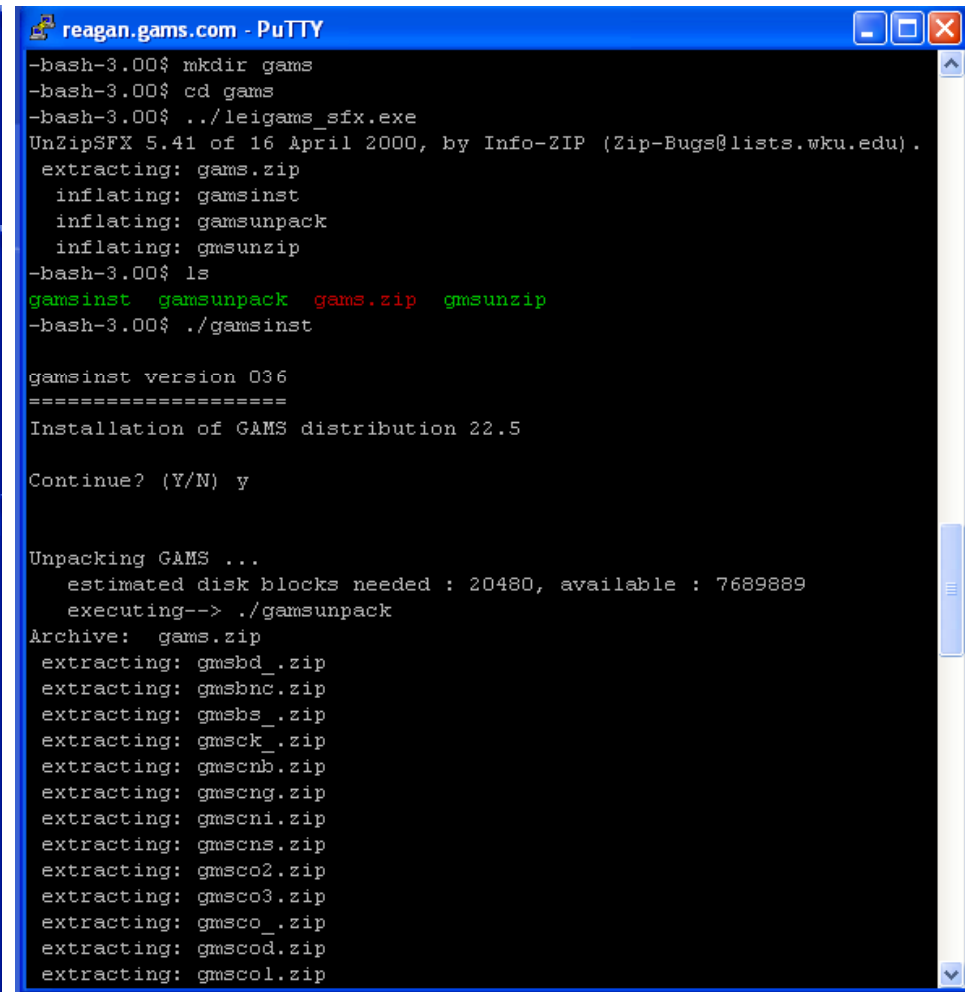
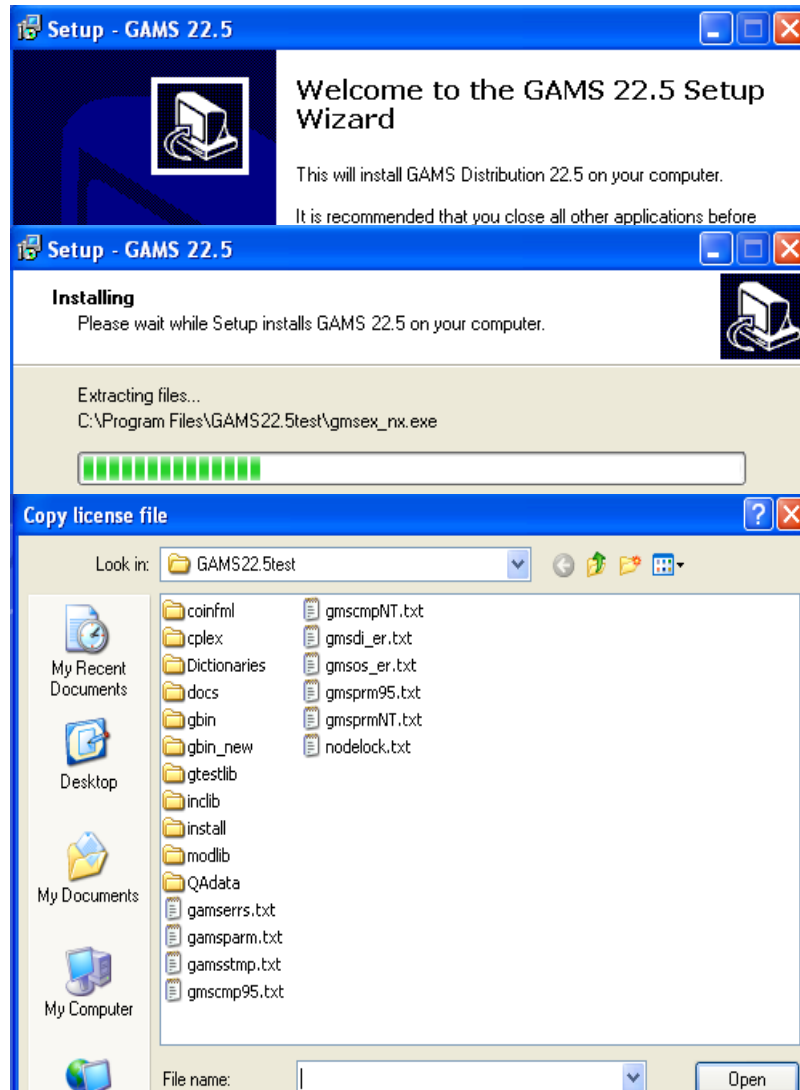


Multiple Solvers & Platforms

	Solver/Platform availability - 22.5 June 1, 2007										
	x86	x86_64	x86	x86_64	Sun Sparc	Sun Intel	HP 9000	DEC Alpha	IBM RS-6000	Mac PowerPC	SGI
	MS Windows	MS Windows	Linux	Linux	SOLARIS	SOLARIS	HP-UX 11 ¹	Digital Unix 4.0	AIX 4.3	Darwin	IRIX ²
ALPHAECP	✓	✓	✓	✓	✓	✓		✓	✓	✓	
BARON 7.8	✓	32bit	✓	32bit					✓		
BDMLP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
COIN	✓	32bit	✓	✓						✓	✓
CONOPT 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPLEX 10.2	✓	✓	✓	✓	✓	✓	10.0	8.1	✓		9.1
DECIS	✓	✓	✓	✓	✓		✓	✓	✓		✓
DICOPT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KNITRO 5.1	✓	32bit	✓	✓						✓	✓
LINDOGLOBAL 4.1	✓	✓	✓	✓	✓					✓	✓
LGO	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
MILES	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MINOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MOSEK 4	✓	✓	✓	✓	✓		3.2			✓	✓
MPSGE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MSNLP	✓	✓	✓	✓	✓		✓			✓	✓
NLPEC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
OQNLP	✓	32bit	✓	32bit						✓	✓
OSL V3	✓	32bit	✓	32bit	✓		V2		✓		V2
OSLSE	✓	32bit	✓	32bit	✓				✓	✓	✓
PATH	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SBB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SNOPT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
XA	✓	32bit	✓	✓	✓		✓	✓	✓	✓	✓
XPRESS 17.10	✓	32bit	✓	32bit	✓		16.10		✓		



Hands-on! Installing GAMS





Hands-on! Testing the installation

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

- File Menu:** Shows options like New, Open, Save, and Run. The 'Model Library' option is selected, opening the GAMS Model Library window.
- GAMS Model Library Version 27.0:** A table listing various models and their details.
- Parameter Window:** Shows the definition of parameters for a transportation model, including capacity, demand, distance, and freight.
- Console Window:** Shows the execution log for the 'transport' job, including start time, copyright information, and execution progress.

Seq#	Name	Application Area	Type	Contributor	Description
001	TRANSPORT	Management Science and OR	LP	Dantzig, G B	A Transportation Problem
002	BLEND	Management Science and OR	LP	Dantzig, G B	Blending Problem I
003	PRODMIX	Management Science and OR	LP	Dantzig, G B	A Production Mix Problem
004	WHHOUSE	Management Science and OR	LP	Dantzig, G B	Simple Warehouse Problem
005	JOBTR	Management Science and OR	LP	Dantzig, G B	On-the-Job Training
006	SRROUTE	Management Science and OR	LP	Dantzig, G B	The Shortest Route Problem
007	DIET	Micro Economics	LP	Dantzig, G B	Sigler's Nutrition Model
008	AIRCRAFT	Management Science and OR	LP	Dantzig, G B	Aircraft Allocation Under Uncertain Demand
009	PRODSCH	Management Science and OR	MIP	CDC	APEX - Production Scheduling Model
010	PDI	Management Science and OR	LP	ARCNET	ARCNET - Production Distribution and Inventory
011	UIMP	Management Science and OR	LP	Elison, E F	UIMP - Production Scheduling Problem
012	MAGIC	Management Science and OR	MIP	Garver, L L	Magic Power Scheduling Problem
013	FERTS	Micro Economics	LP	Chokis, A M	Egypt - Static Fertilizer Model
014	FERTD	Micro Economics	MIP	Chokis, A M	Egypt - Dynamic Fertilizer Model
015	MEXSS	Micro Economics	LP	Kendrick, D	Mexico Steel - Small Static
016	MEXSD	Micro Economics	MIP	Kendrick, D	Mexico Steel - Small Dynamic
017	MEXLS	Micro Economics	LP	Kendrick, D	Mexico Steel - Large Static
018	WEAPONS	Management Science and OR	NLP	Bracken, J	Weapons Assignment
019	BID	Micro Economics	MIP	Bracken, J	Bid Evaluation
020	PROCESS	Chemical Engineering	NLP	Bracken, J	Alkylation Process Optimization
021	CHEM	Chemical Engineering	NLP	Bracken, J	Chemical Equilibrium Problem
022	SHIP	Engineering	NLP	Bracken, J	Structural Optimization
023	LINEAR	Econometrics	DNLP	Bracken, J	Linear Regression with Various Criteria
024	LEAST	Econometrics	NLP	Bracken, J	Nonlinear Regression Problem
025	LIKE	Econometrics	NLP	Bracken, J	Maximum Likelihood Estimation
026	CHANCE	Agricultural Economics	NLP	Bracken, J	Chance Constrained Feed Mix Problem
027	SAMPLE	Statistics	NLP	Bracken, J	Stratified Sample Design
028	PINDYCK	Energy Economics	NLP	Pindyck, R S	Optimal Pricing and Extraction for OPEC
029	ZLOOF	Management Science and OR	GAMS	Zloof, M M	Relational Database Example
030	VIETNAM	Micro Economics	MIP	Manne, A S	Vietnam's Mainline Fertilizer Model 1961
031	ALUMIN	International Trade	MIP	Brown, M	World Aluminum Model
032	MARCO	Micro Economics	LP	Aronofsky, J	Mini Oil Refining Model

```

Parameters
  a(i) capacity of plant i in cases
      / seattle 350
        san-diego 600 /

  b(j) demand at market j in cases
      / new-york 325
        chicago 300
        topeka 275 / ;

Table d(i,j) distance in thousands of miles
      new-york    chicago    topeka
seattle    2.5        1.7        1.8
san-diego  2.5        1.8        1.4 ;

Scalar f freight in dollars per case per thousand miles /90/ ;

Parameter c(i,j) transport cost in thousands of dollars per case
    
```

```

--- Job transport.gms Start 07/03/07 10:25:45
GAMS Rev 148 Copyright (C) 1987-2007 GAMS Development. All rights reserved.
Licensee: Jan-Hendrik Jagla G070418/0001C
GAMS Software GmbH
--- Starting compilation
--- transport.gms(69) 3 Mb
--- Starting execution
--- transport.gms(45) 4 Mb
--- Generating LP model transport
--- transport.gms(66) 4 Mb
--- 6 rows 7 columns 19 non-zeroes
--- Executing CPLEX

GAMS/Cplex Jun 1, 2007 WIN.CP.CP 22.5 034.037.041.VIS For Cplex 10
Cplex 10.2.0, GAMS Link 34
    
```




Hands-on! Testing the installation

```

reagan.gams.com - PuTTY
-bash-3.00$ gamslib trnsport
Model trnsport.gms retrieved
-bash-3.00$ gams trnsport
--- Job trnsport Start 07/03/07 10:33:08
GAMS Rev 148 Copyright (C) 1987-2007 GAMS Development. All rights reserved
Licensee: GAMS Development Corporation, Washington, DC G871201/0000CA-ANY
Free Demo, 202-342-0180, sales@gams.com, www.gams.com DC0000
--- Starting compilation
--- trnsport.gms(69) 3 Mb
--- Starting execution
--- trnsport.gms(45) 4 Mb
--- Generating LP model transport
--- trnsport.gms(66) 4 Mb
--- 6 rows 7 columns 19 non-zeroes
--- Executing CPLEX

GAMS/Cplex Jun 1, 2007 LEX.CP.NA 22.5 034.037.041.LEI For Cplex 10.2
Cplex 10.2.0, GAMS Link 34

Reading data...
Starting Cplex...
Tried aggregator 1 time.
LP Presolve eliminated 1 rows and 1 columns.
Reduced LP has 5 rows, 6 columns, and 12 nonzeros.
Presolve time = 0.00 sec.

Iteration      Dual Objective          In Variable          Out Variable
1              73.125000      x(seattle.new-york) demand(new-york) slack
2             119.025000      x(seattle.chicago) demand(chicago) slack
3             153.675000      x(san-diego.topeka) demand(topeka) slack
4             153.675000      x(san-diego.new-york) supply(seattle) slack

```



Sources of GAMS Information

Download: <http://download.gams-software.com/>

Release Notes: <http://www.gams.com/docs/release/release.htm>

Contributed Documentation: <http://www.gams.com/docs/contributed>

Contributed Software: <http://www.gams.com/contrib/contrib.htm>

Presentations: <http://www.gams.com/presentations>

Workshops: <http://www.gams.com/courses.htm>

Bruce McCarl's Newsletter: <http://www.gams.com/maillist/newsletter.htm>

GAMS User Group: http://www.gams.com/maillist/gams_1.htm

GAMS Google Group: <http://groups.google.de/group/gamsworld>

Other relevant sites on the Web: <http://www.gams.com/hotlinks.htm>



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