



Recent Enhancements in GAMS

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Agenda

GAMS at a Glance

Overview of enhancements

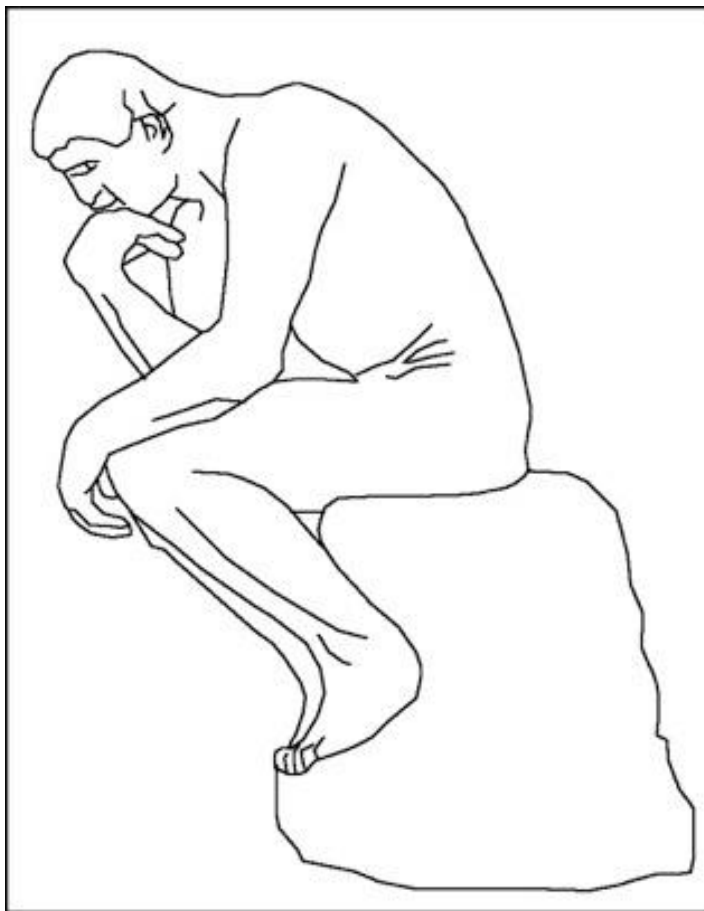
API:s

GDXRRW

Concluding remarks

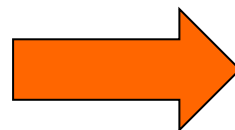


GAMS



What does this modeler have to think about?

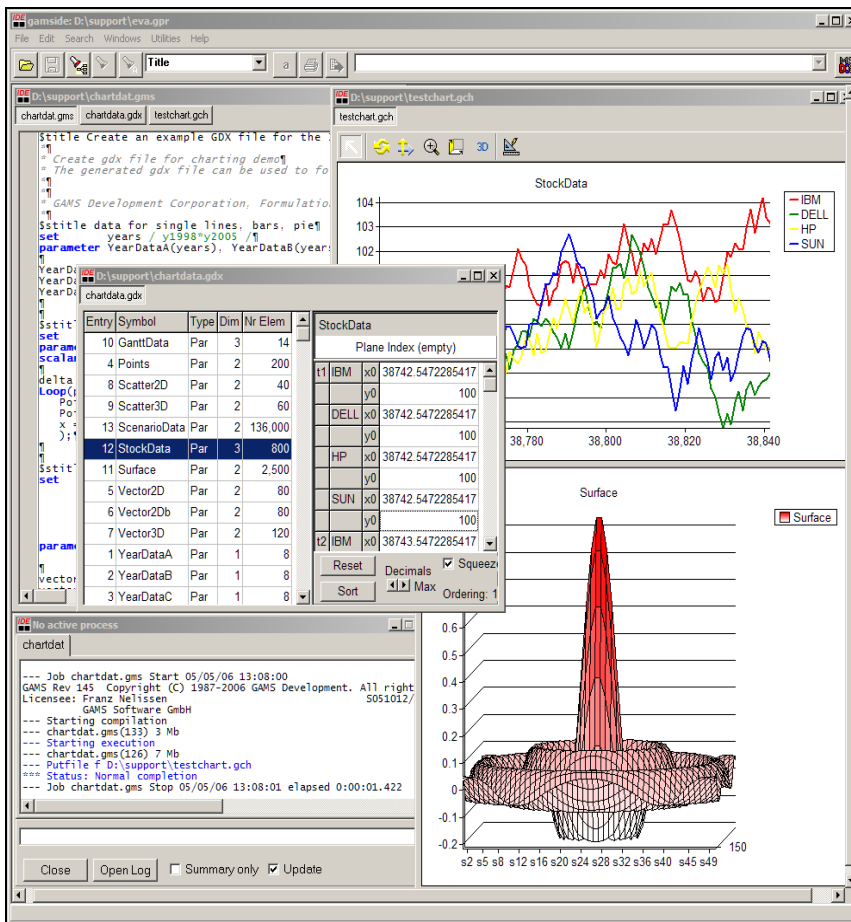
- Application
- Mathematics
- Computer Code



GAMS eases the transitions between these domains



GAMS Development / Software at a Glance



- Roots: World Bank, 1976
- Went commercial in 1987
- GAMS Development Corp. (US)
- GAMS Software GmbH (Europe)
- Technical tool provider (Software)
- Broad academic & commercial user community and network
 - GAMS is used in more than 120 countries
 - Half of licenses commercially used



Broad Network



5617 visits from 17 Jun 2013 to 24 Jun 2013

H distance in which individuals are clustered

Total number of visits depicted above = 5520

Dot sizes:

● = 1000 + ● = 100 - 999 ● = 10 - 99 ● = 1 - 9

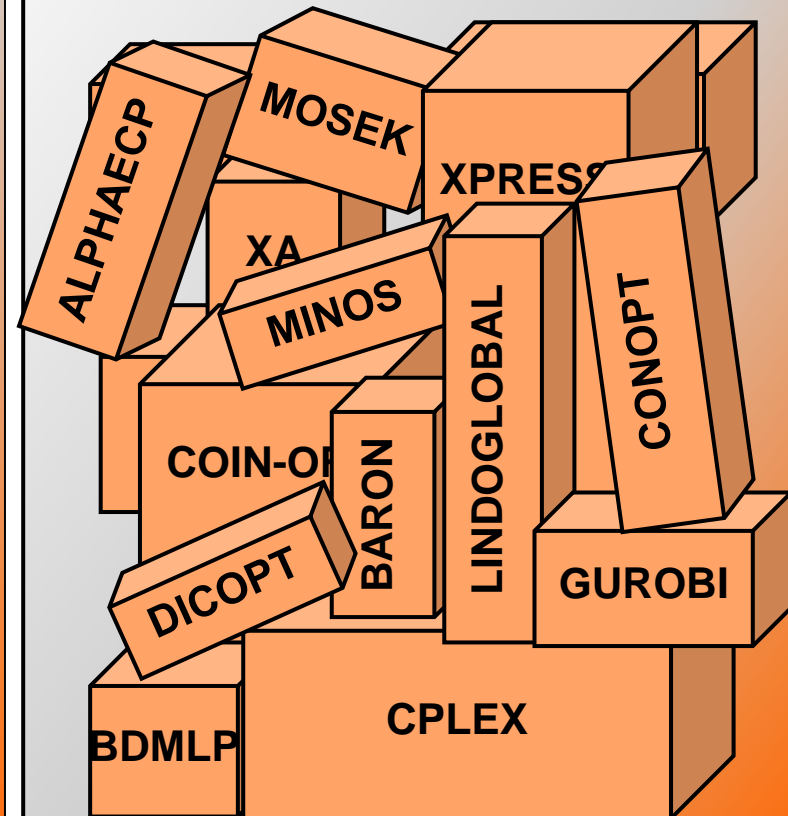


GAMS at a Glance

General Algebraic Modeling System

- Algebraic Modeling Language
- ~30 Integrated Solvers
- 10+ Supported MP classes
- 9 Supported Platforms
- Connectivity- & Productivity Tools
 - IDE
 - Model Libraries
 - GDX, Interfaces & Tools
 - Grid Computing
 - Benchmarking
 - Compression & Encryption
 - Deployment System
 - ...

~30 Integrated Solvers





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Recent Enhancements (Overview)

- Current release 24.1.2 (June 16, 2013)
- Enhancements during the last year
 - GAMS System Updates
 - New solvers and updates
 - Development of Application Programming Interfaces
 - New tools and updates
 - New model library examples



Recent Enhancements

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



Release Notes

Each new release incorporates numerous fixes and improvements to the core GAMS system and its many components. A selected list of improvements and new components is given below.

GAMS Distribution 24.1

To use this distribution, the maintenance expiration date for your license must be later than May 30, 2013.

Distribution History

[24.1.2](#) (Maintenance Release), Release Date June 16, 2013

[24.1.1](#) (Major Release), Release Date May 30, 2013

GAMS Maintenance Release 24.1.2

Maintenance releases do not provide any new features. They are issued to provide bug fixes, performance improvements and maintenance releases of solver libraries. The License Check Date remains the same as for the prior major release. This means that any license file that worked with major release [24.1.1](#) will



Recent Enhancements

GAMS System Updates

- GAMS installer for Windows is now digitally signed.
- **SymPrefix** command line parameter prefixes all symbols.
- **\$\$** allows compile time commands to have leading blanks.
- option **lo=4** writes simultaneously to log file and stdout.
- put_utility can send Windows message to a window
- \$offOrder lead/lag operations for dynamic unordered sets.
- The IDE can now compare two text files for differences
- ...



Recent Enhancements

IDE gamside: C:\Users\Toni\Documents\Conferences\20130628_EURO2013_Recent Enhancements in GAMS\testing\tmp.gpr

File Edit Search Windows Utilities Model Libraries Help

wait

IDE C:\Users\Toni\Documents\Conferences\20130628_EURO2013_Recent Enhancements in GAMS\testing\test_new_fe...
myprog.log test_new_features.gms test_new_features.lst

```

*End Of Line Comments
$eolcom !!

!! $$ allows leading blanks before compile time statement
$$onecho > myprog.gms
Set i myset_i /i1 /
    j myset_j /j1 /;
$$offecho
$$call gams myprog s=00 SymPrefix A lo=4
Execute 'gams myprog r=00.gdx=data lo=%GAMS.lo%';
  
```

IDE C:\Users\Toni\Documents\Conferences\20130628_EURO2013_Recent Enhancements in GAMS\testing\data.gdx
data.gdx

Entry	Symbol	Type	Dim	Nr Elem
1	Ai	Set	1	1
2	Aj	Set	1	1
3	i	Set	1	1
4	j	Set	1	1

Symbol search

Reset ☒ Squeeze defaults Ordering: 1

Decimals Search

Sort

IDE C:\Users\Toni\Documents\Conferences\20130628_EURO2013_Recent Enhancements in GAMS\testing\myprog.log
myprog.log

```

--- Job myprog Start 06/29/13 00:17:24 24.1.2 r40979 WEX-WEI x86_64/
GAMS 24.1.2 Copyright (C) 1987-2013 GAMS Development. All rights r
Licensee: Toni Lastusilta G130603/000
GAMS Software GmbH
--- Starting compilation
--- myprog.gms(2) 3 Mb
--- Starting execution - empty program
*** Status: Normal completion
--- Job myprog.gms Stop 06/29/13 00:17:25 elapsed 0:00:00.546
  
```

IDE No active process
transport test_new_features

```

--- Job test_new_features.gms Start 06/29/13 00:17:24 24.1.2 r40979 WEX-WEI x86_64/
GAMS 24.1.2 Copyright (C) 1987-2013 GAMS Development. All rights reserved
Licensee: Toni Lastusilta G130603/0001CT-GEN
GAMS Software GmbH DC9734
--- Starting compilation
--- test_new_features.gms(9) 2 Mb
--- call gams myprog s=00 SymPrefix A lo=4
*** Issued ViewClose request on C:\Users\Toni\Documents\Conferences\20130628_EURO2013_Recent Enhancements in GAMS\testing\myprog.log
--- Job myprog Start 06/29/13 00:17:24 24.1.2 r40979 WEX-WEI x86_64/MS Windows
GAMS 24.1.2 Copyright (C) 1987-2013 GAMS Development. All rights reserved
Licensee: Toni Lastusilta G130603/0001CT-GEN
GAMS Software GmbH DC9734
--- Starting compilation
--- myprog.gms(2) 3 Mb
--- Starting execution - empty program
*** Status: Normal completion
--- Job myprog.gms Stop 06/29/13 00:17:25 elapsed 0:00:00.546
--- test_new_features.gms(14) 2 Mb
--- Starting execution: elapsed 0:00:00.591
--- test_new_features.gms(10) 3 Mb
--- Job myprog Start 06/29/13 00:17:25 24.1.2 r40979 WEX-WEI x86_64/MS Windows
GAMS 24.1.2 Copyright (C) 1987-2013 GAMS Development. All rights reserved
Licensee: Toni Lastusilta G130603/0001CT-GEN
GAMS Software GmbH DC9734
--- Starting continued compilation
--- myprog.gms(2) 3 Mb
--- Starting execution: elapsed 0:00:00.024
--- GDY File C:\Users\Toni\Documents\Conferences\20130628_EURO2013_Recent Enhancements in GAMS\testing\myprog.log
*** Status: Normal completion
--- Job myprog.gms Stop 06/29/13 00:17:25 elapsed 0:00:00.025
*** Status: Normal completion
--- Job test_new_features.gms Stop 06/29/13 00:17:25 elapsed 0:00:00.654
  
```




Recent Enhancements (New solvers)

- **ANTIGONE** (Algorithms for coNTinuous / Integer Global Optimization of Nonlinear Equations), developed at Princeton University and Imperial College London by Christodoulos A. Floudas and Ruth Misener.
- **Sulum (Beta)** a new LP/MIP Solver from Sulum Optimization ApS. Sulum offers a good cost-benefit ratio for LP and MIP solution technology.



Recent Enhancements (Solver updates)

- BARON comes with a wealth of new branching, relaxation, convexity exploitation, local search, and range reduction techniques.
- CplexD supports the Cplex remote object 'ComputeServer'.
- Gurobi support to Gurobi's Compute Server.
- Lindo supports now multithreading
- Xpress: New platform supported: Mac OSX 64-bit
- ...



Recent Enhancements (API:s)

Development of Application Programming Interfaces

Object Oriented GAMS API for

- **.NET (VB.NET, C++, C#)**
- **Java**
- **Python**



Recent Enhancements

New tools and updates

- **GDXRRW**: The software gives R users the ability to use all the optimization capabilities of GAMS, and allows visualization and other operations on GAMS data directly within R
- **CSV2GDX**: New utility to convert a CSV file to a GDX file
- **GDXXRW** works now with Excel Binary Workbook files (file extension .xlsb)
-



Recent Enhancements

New examples to:

- Model Library = 18
- Test Library = 55
- Data Utilities = 3
- EMP Library = 3

Model Library:

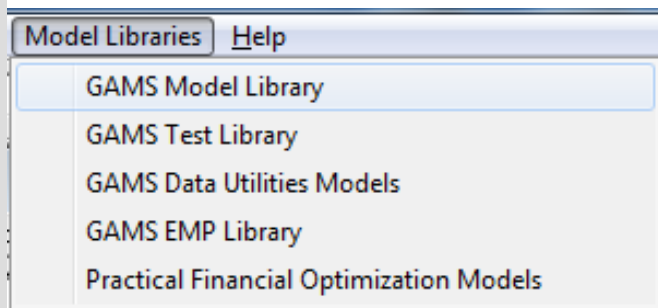
- #379) Linear Phase Lowpass Filter Design
- #382) Linearization techniques for extremal-Nash equilibria
- #389) Stable Marriage Problem

Data Utilities Models:

- #83) Trnscell: Excel Spreadsheet in Charge of GAMS
- #84) Spawn an arbitrary model from Excel
- #85) Testing CSV file conversions

EMP Library

- #93) Equilibrium model consisting of two VIs , one of which has a non-trivial constraint set
- #94) A Stochastic Transportation Problem
- #95) Outer Approximation for Convex Minimization Problem with Binary Variables





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Bridging The Gap

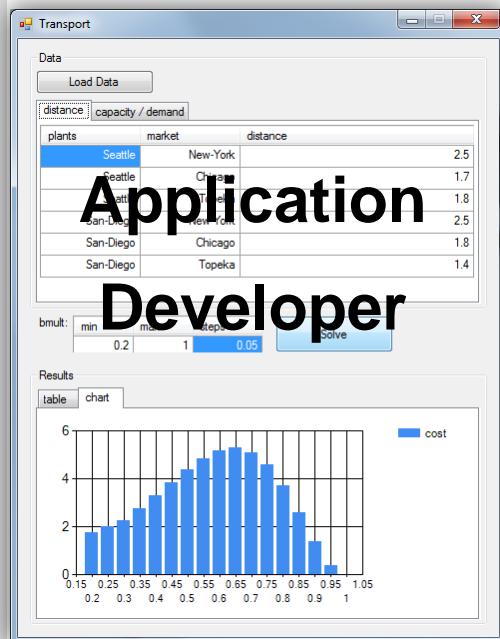
IDE C:\Users\Franz\Documents\gamsdir\projdir\trnsport.gms
data.inc | trnsport.gms | trnsport.lst

```

Sets
  i  canning plants
  j  markets;
Parameters
  a(i)  capacity of plant i in cases
  b(j)  demand at market j in cases
  d(i,j) distance in thousands of miles
  f     freight in dollars per case per thousand miles
  c(i,j) transport cost in thousands of dollars per case ;
Variables
  x(i,j)  amount shipped from plant i to market j in cases
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/ ;
  
```

1: 3 Modified Insert

Modeler



Application

Developer

**GAMS
OO API**



Concept: Separation of Tasks

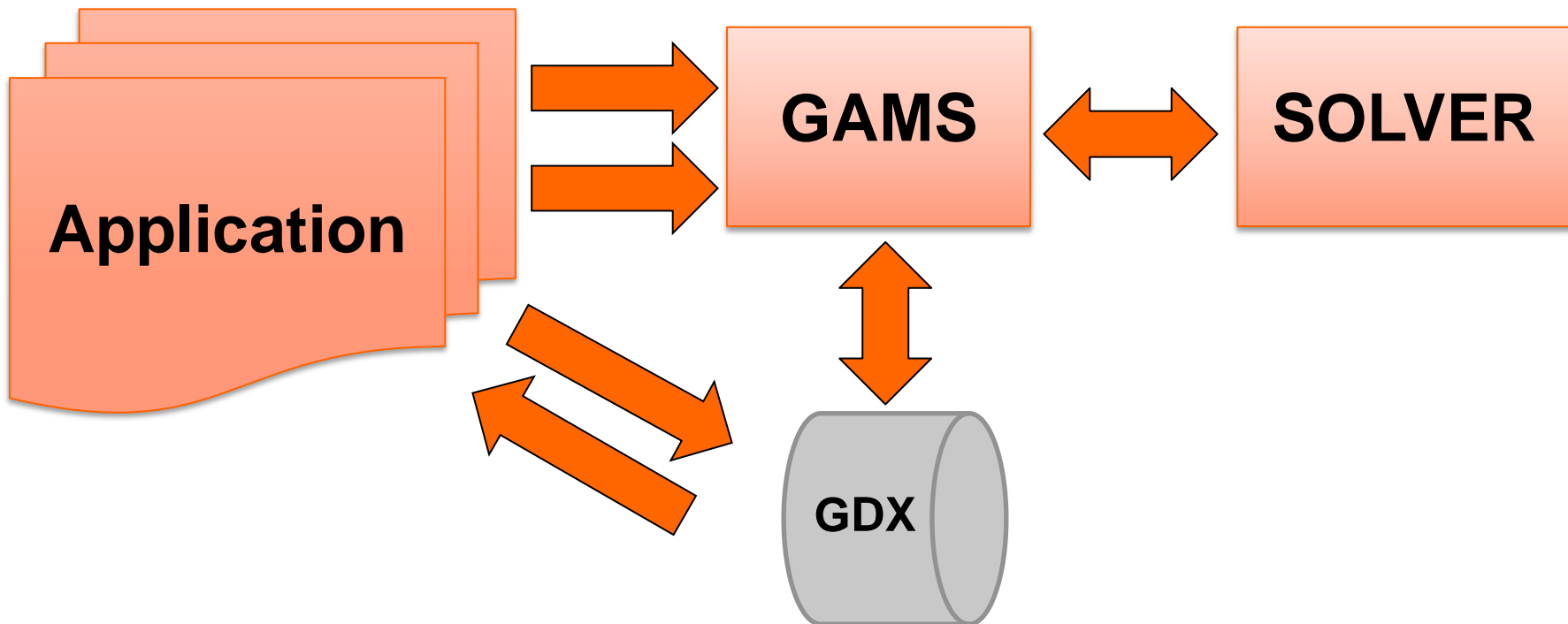
- Use GAMS for modeling and optimization tasks
- Programming languages like .NET(VB.NET, C++, C#), Java and Python are well-suited for developing applications (GUI, Web, ...)
- Frameworks available for a wide range of specific tasks, e.g GUI and Web development
- Communication between GAMS and application through GAMS APIs





GAMS API: Basic Functionality

1. GDX API: Create Input for GAMS Model
2. Callout to GAMS
 - Option API: GAMS option settings
 - GAMSX API: Start GAMS
3. GDX API: Get Solution from GAMS Model





Low level GAMS APIs

- High performance and flexibility
- Automatically generated APIs for several languages (C, Delphi, Java, Python, C#, ...)
- Data Exchange (GDX), job control (GAMSX), options (OPT)
- Part of any GAMS distribution, no license required

GAMS

Application Programming Interfaces to GAMS

The object-oriented GAMS API allows the seamless integration of GAMS into other applications. It is used for convenient exchange of input data and model results. Models are the most efficient way. There are three versions of the object-oriented GAMS API: the Java API, the C++ API, and the C API.

The object-oriented GAMS API allows the seamless integration of GAMS into other applications. It is used for convenient exchange of input data and model results. Models are the most efficient way.

In addition to the object-oriented GAMS API, there exist low-level (or extensively) APIs. While they offer high performance and flexibility, they also require more programming effort. They are available for Delphi, Fortran, Java, Python, and Visual Basic.

Further Documentation

For each of the three versions of the object-oriented GAMS API there is a separate documentation page. For the low-level APIs there exist some summary pages containing an overview of the exported functions in pseudo code.

Examples

There are several examples for the different programming languages in `[Path/To/GAMS]/apifiles/`. In that directory there is also a [ReadMe.txt](#), which describes how to build and execute these examples.

GDX (GDX) API Documentation

Generated for GAMS 24.0.2

Functions, Procedures and Properties

- [gdxAcronymAdd](#): Add a new acronym entry.
- [gdxAcronymCount](#): Number of entries in the acronym table.
- [gdxAcronymGetInfo](#): Retrieve acronym information.
- [gdxAcronymGetMapping](#): Get information how an acronym is mapped to a variable.
- [gdxAcronymIndex](#): Get index value of an acronym.
- [gdxAcronymName](#): Find the name of an acronym.
- [gdxAcronymNextNr](#): Returns the value of the next available acronym number.
- [gdxAcronymSetInfo](#): Modify acronym information.
- [gdxAcronymValue](#): Create an acronym value.
- [gdxAddAlias](#): Add an alias for a set.
- [gdxAddSetText](#): Register a string to be used as a set name.
- [gdxAutoConvert](#): Returns the value of the conversion to an older version.

GAMSX (GAMSX) API Documentation

Generated for GAMS 24.0.2

Functions, Procedures and Properties

- [gamsxSW\(Set\)](#): Show window.
- [gamsxRunExecDLL](#): Execute GAMS.
- [gamsxShowError](#): Get error string.
- [gamsxShowMsg](#): Get message string.
- [gamsxStepThrough](#): Step from line to line.
- [gamsxRunToEnd](#): Run to end of file.
- [gamsxRunToLine](#): Run to line number.
- [gamsxRunToText](#): Run to text string.
- [gamsxRunToDef](#): Run to definition.
- [gamsxRunToDefR](#): Run to definition and return.
- [gamsxRunToDefR](#): Run to definition and return.
- [gamsxRunToDefR](#): Run to definition and return.

OPT (OPT) API Documentation

Generated for GAMS 24.0.2

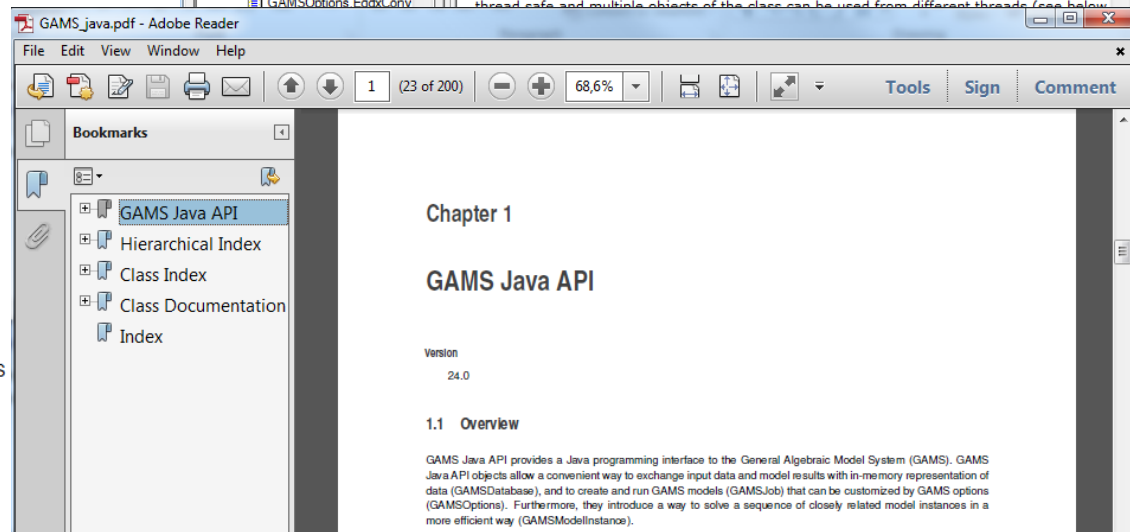
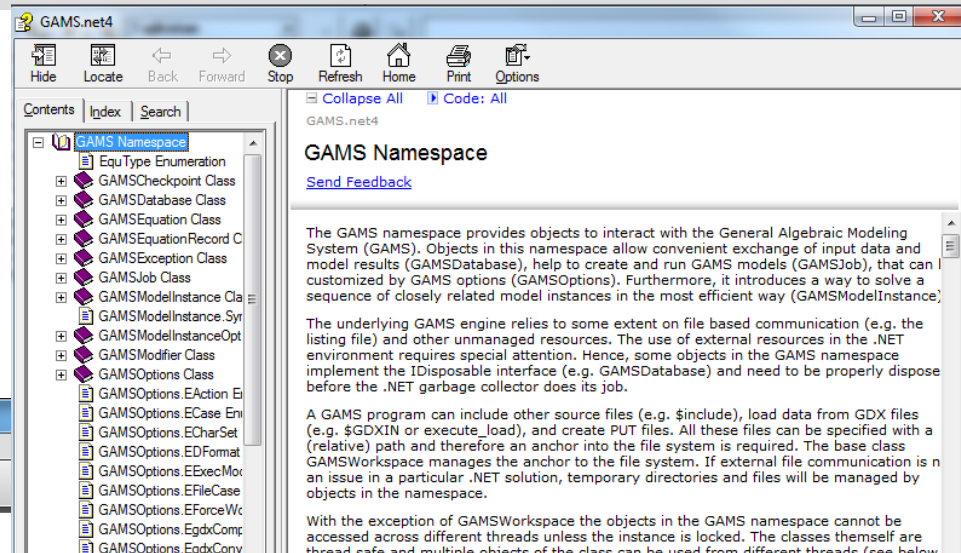
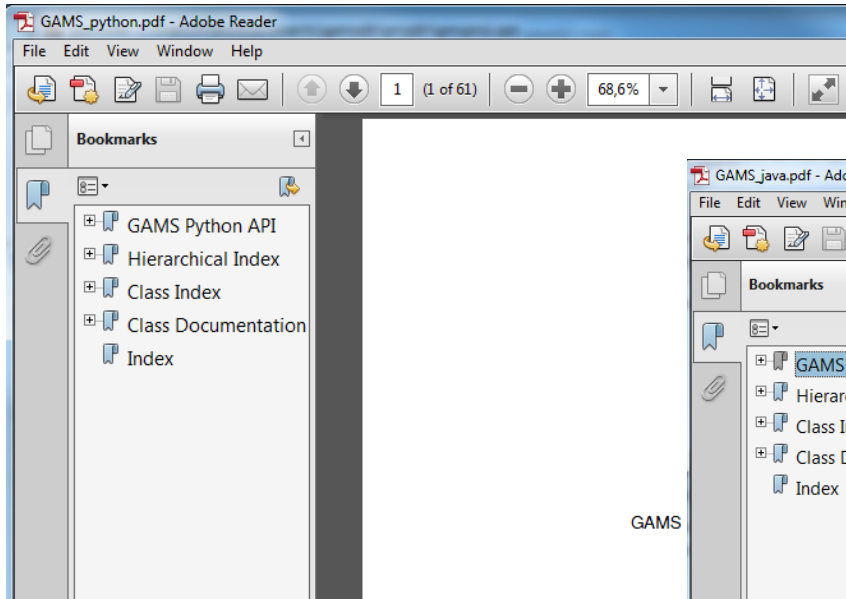
Functions, Procedures and Properties

- [optCount](#): Number of options.
- [optMessageCount](#): Number of messages in buffer.
- [optGroupCount](#): Number of option groups.
- [optRecentEnabled\(Set\)](#): When enabled (default), Defined and DefinedR will be set when assigning to an option. When disabled, only Defined will be set.
- [optReadDefinition](#): Read definition file. Returns -1 if there was a definition error.
- [optReadParameterFile](#): Read parameters from file.
- [optReadFromStr](#): Read options from string. In the case of errors, messages will be added to the message queue (see [OptGetMessage](#)).
- [optWriteParameterFile](#): Write modified parameters to a file. In the case of errors, messages will be added to the message queue (see [OptGetMessage](#)).
- [optClearMessages](#): Clear all messages stored in the message queue.



Object-oriented GAMS API

- Additional layer on top of the low level APIs
- Object-oriented: .NET, Java, and Python
- Part of any GAMS distribution, no license required





Features of the object oriented API

- No modeling capability, model is still written in GAMS
- Prepare input data and retrieve results in a convenient way → *GAMSDatabase Class*
- Set GAMS and Solver Options → *GAMSOptions Class*
- Control GAMS execution → *GAMSJob Class*
- Scenario Solving: Feature to solve multiple very similar models in a dynamic and efficient way
→ *GAMSModelInstance Class*



Small Example - C#

```
static String GetModelText()
{
    String model = @"
Sets
    i    canning plants    / seattle, san-diego /
    j    markets           / new-york, chicago, topeka / ;
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 / ;

    < . . . >

Solve transport using lp minimizing z ;";

    return model;
}
}
```




Small Example - C#

Transport.cs

```
using System;
using GAMS;

namespace TransportSeq
{
    class Transport1
    {
        static void Main(string[] args)
        {
            GAMSWorkspace ws = new GAMSWorkspace();
            GAMSJob t1 = ws.AddJobFromString(GetModelText())

            t1.Run();
            foreach (GAMSVariableRecord rec in t1.OutDB.GetVariable("x"))
            {
                Console.WriteLine("x(" + rec.Keys[0] + ", "
                                + rec.Keys[1] + "):");
                Console.WriteLine("    level=" + rec.Level);
                Console.WriteLine("    marginal=" + rec.Marginal);
            }
        }
    }
}
```



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What is R

- R is a powerful, feature-packed software package
 - Statistics
 - Data analysis, manipulation, and visualization
 - Programming - prototyping and development
 - Application-specific packages: thousands available
 - More statistics
 - Finance
 - Computational biology / bioinformatics (Bioconductor)
- R is free and easy to install, update, and augment





GDXRW package contains

- `igdx(...)` gives information on the linkage between this package and the GDX library.
- **`rgdx("gdxfile", ...)`** and related functions read from GDX
- **`wgdx("gdxfile", ...)`** and related functions write to GDX
- **`gams("gmsfile and args", ...)`** runs gams with the arguments provided
- `gdxInfo("gdxfile", ...)` dumps GDX content or returns GDX metadata (list of symbols, etc.)



GAMS Advantages

Reading from trans.gdx
in GAMS: Scalar f 'freight' /90/;

```
> library(gdxrrw)
> igdx()
```

```
The GDX library has been loaded
GDX library load path: C:/GAMS/win32/24.1.2
```

```
> rgdx("?")
```

```
R-file source info: Id: gdxrrw.c 40555 2013-05-23 15:00:21Z sdirkse
```

```
> (fdf <- rgdx.scalar("trans", "f"))
```

```
[1] 90
attr(,"symName")
[1] "f"
```



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Concluding remarks

- Object Oriented GAMS API provides an convenient way in a application development environment to use GAMS for optimization tasks.
- GDXRRW connects the R-System with GAMS.
- You can download the latest release from:
<http://www.gams.com/download/>
- Search all GAMS Websites
<http://www.gams.com/search.htm>



Thank You !

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