Recent Enhancements in GAMS

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## Agenda

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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

- 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

- ALPHAECP
- MOSEK
- XPRESS
- CONOPT
- COIN-OR
- MINOS
- BARON
- LINDOGLOBAL
- GUROBI
- CPLEX
- BDMLP
- DICOPT
Agenda

- GAMS at a Glance
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- Concluding remarks
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
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
  - #379) Linear Phase Lowpass Filter Design
  - #382) Linearization techniques for extremal-Nash equilibria
  - #389) Stable Marriage Problem

- **Test Library** = 55

- **Data Utilities** = 3
  - #83) Trnsxcll: Excel Spreadsheet in Charge of GAMS
  - #84) Spawn an arbitrary model from Excel
  - #85) Testing CSV file conversions

- **EMP Library** = 3
  - #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

GAMS OO API

Modeler

Application Developer
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

Application Programming Interfaces to GAMS

The object-oriented GAMS API allows the seamless integration of 
- GAMS with other languages
- used for convenient exchange of input data and model results. Models
- the most efficient way. There are three versions of the object-oriented
- GAMS API, allowing the seamless integration of GAMS with other
- languages for convenient exchange of input data and model results. Models
- the most efficient way.

In addition to the object-oriented GAMS API, there exist lower-level (non-object-oriented) APIs in 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 manual for each language. For example, GAMS User’s Guide

Examples

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

```csharp
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);
            }
        }
    }
}
```
# Agenda

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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
GDXRRRW 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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