Recent Enhancements in GAMS

Toni Lastusilta tlastusilta@gams.com

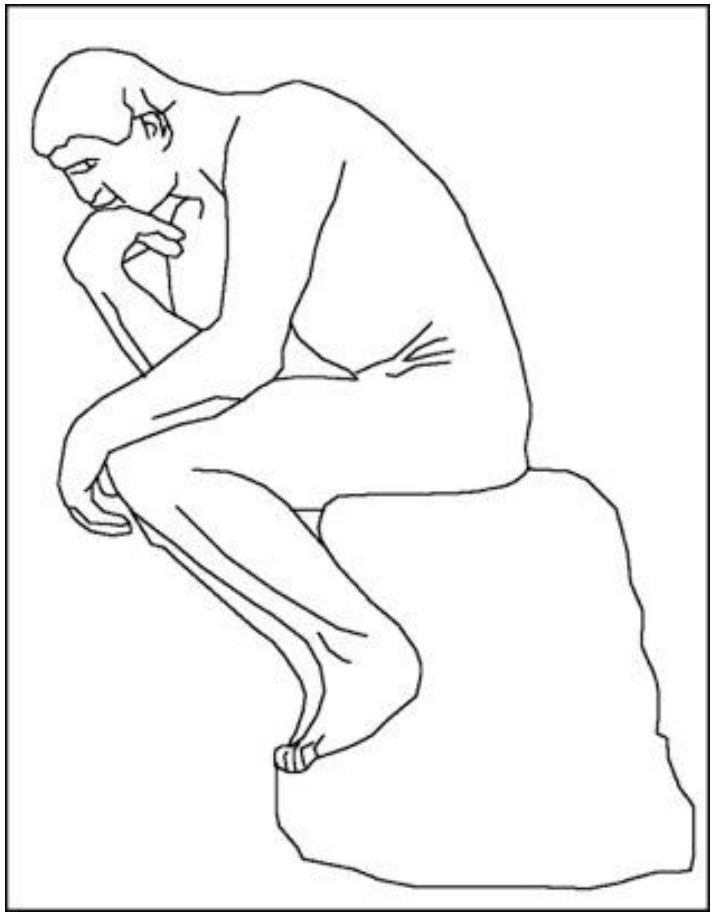
GAMS Software GmbH

GAMS Development Corporation www.gams.com

Agenda

- GAMS at a Glance
- Overview of enhancements
- API:s
- GDXRRW
- Concluding remarks

GAMS

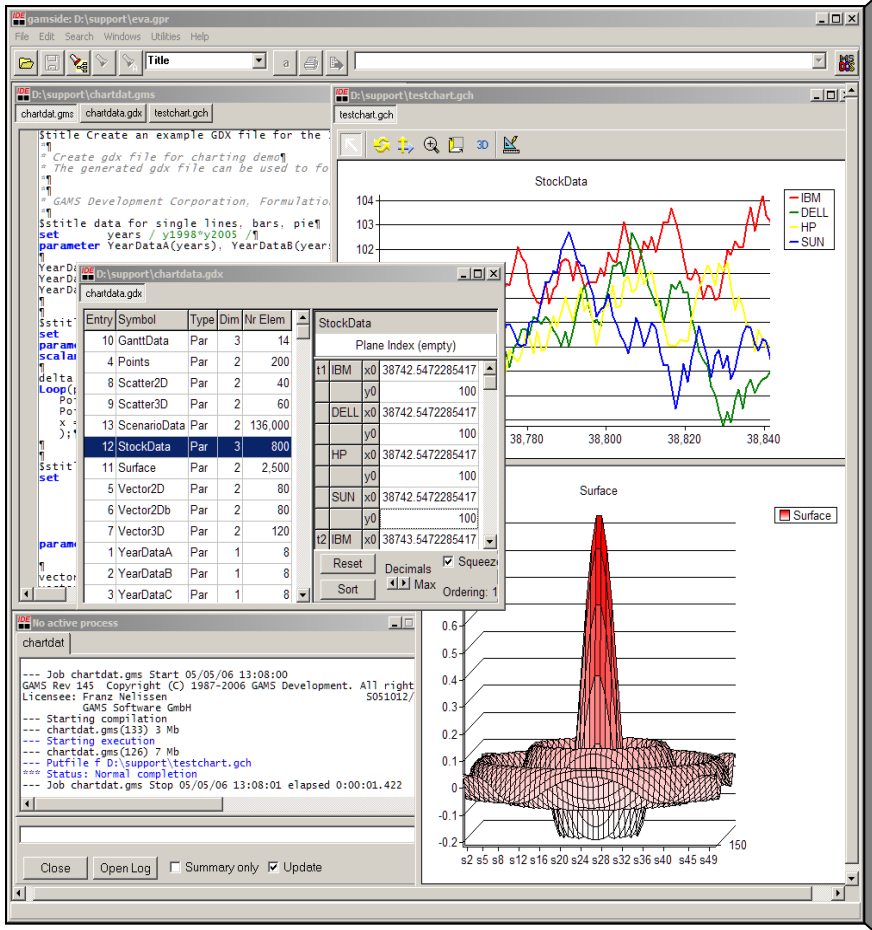


What does this modeler have to think about?

- Application
- Mathematics
- Computer Code

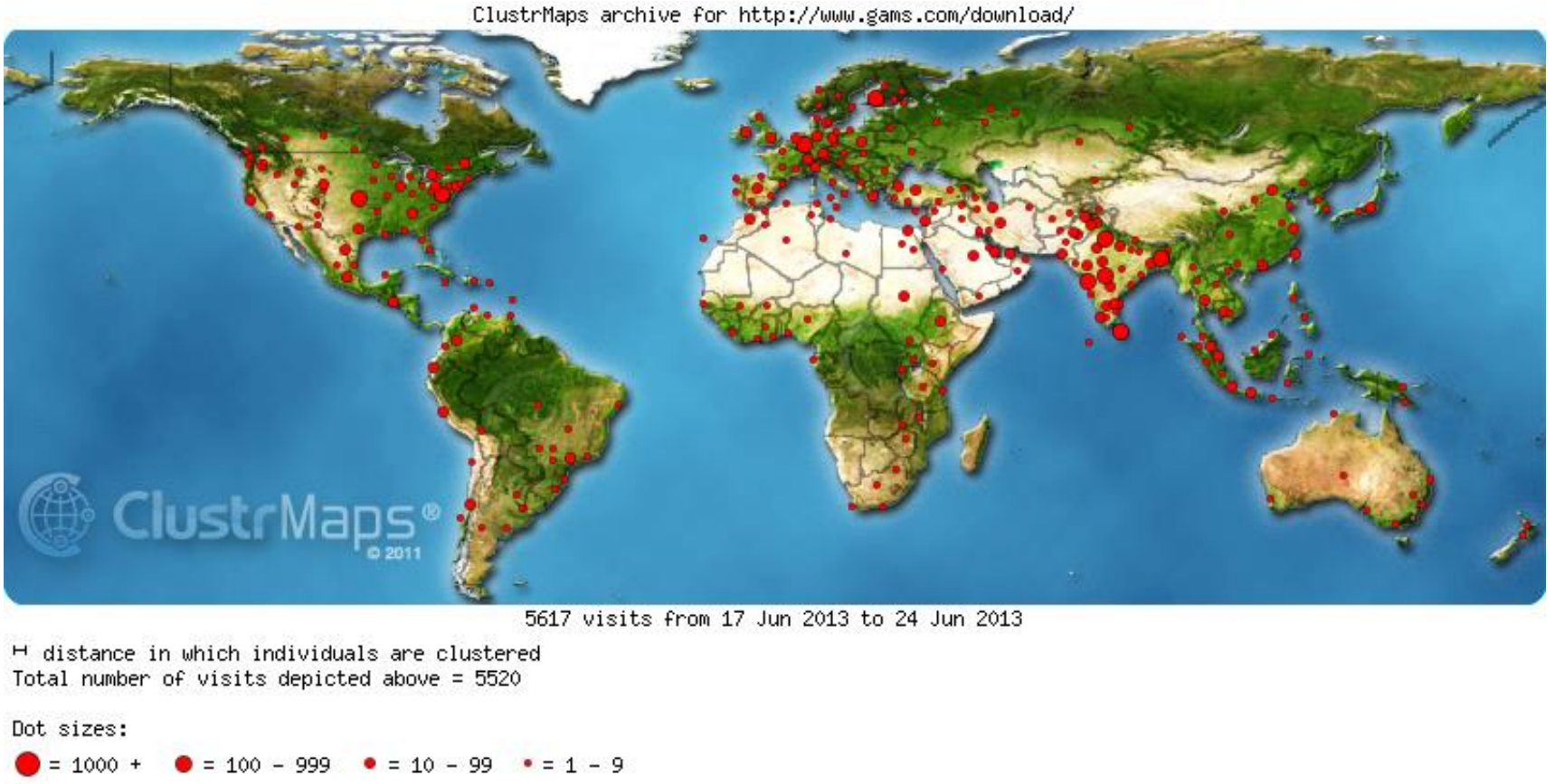
GAMS eases the transitions between these domains

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

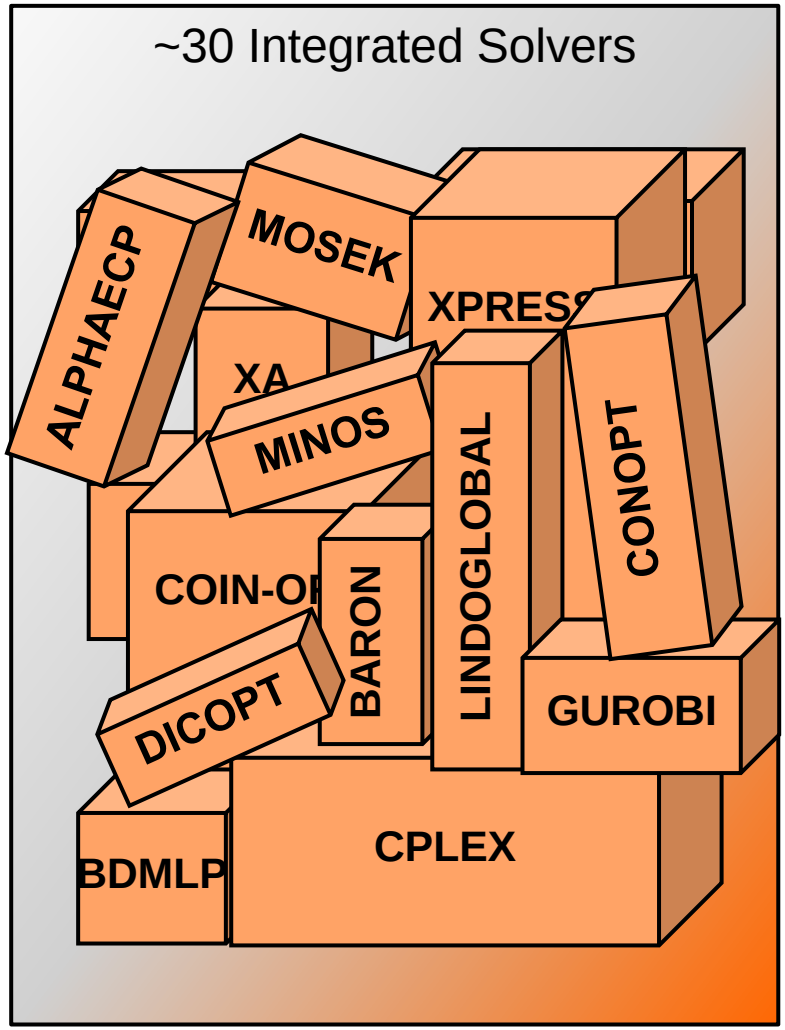
Broad Network



GAMS at a Glance

General **A**lgebraic **M**odeling **S**ystem

- 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
  - …



Agenda

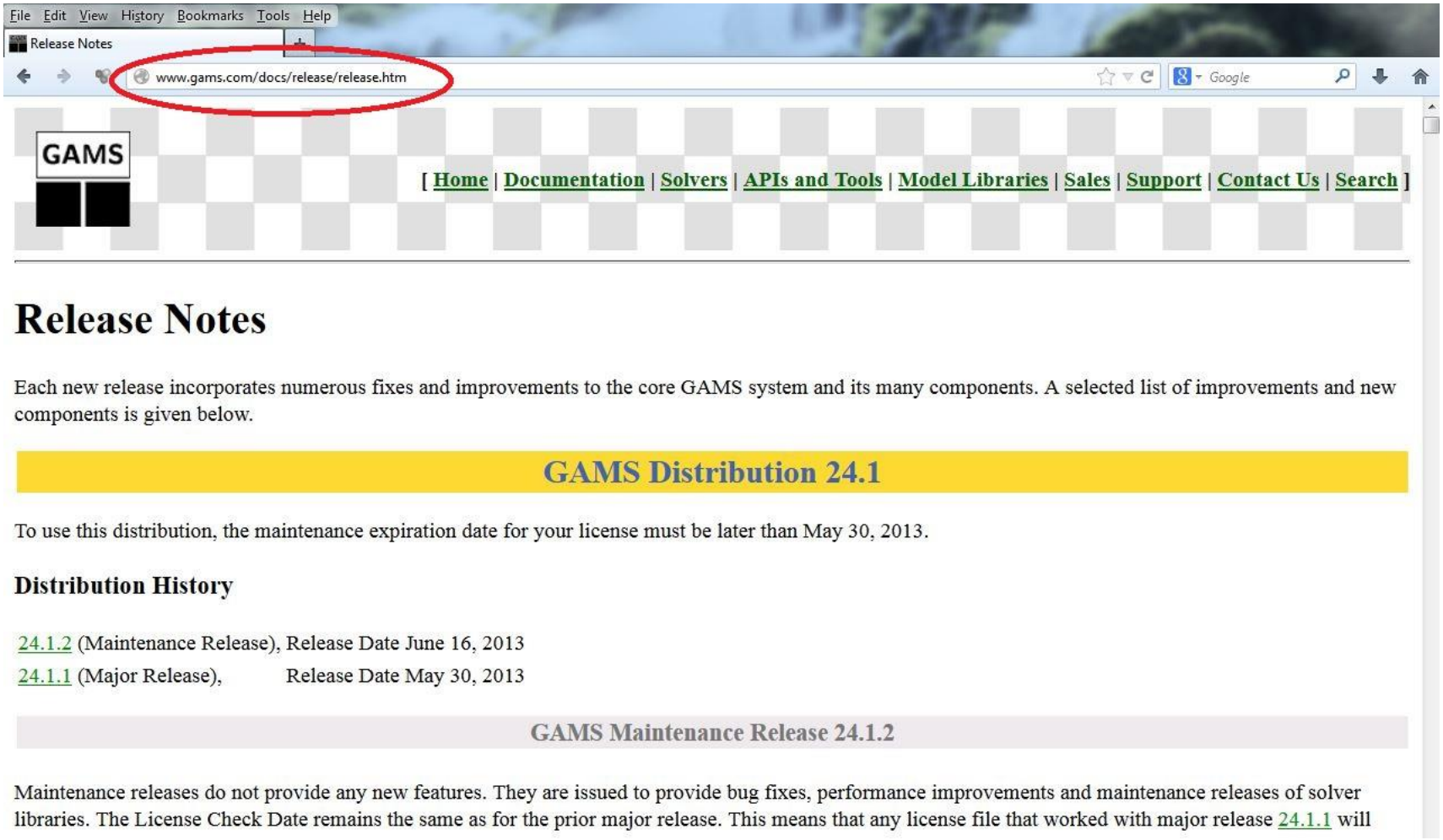
- GAMS at a Glance
- **Overview of enhancements**
- API:s
- GDXRRW
- Concluding remarks

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

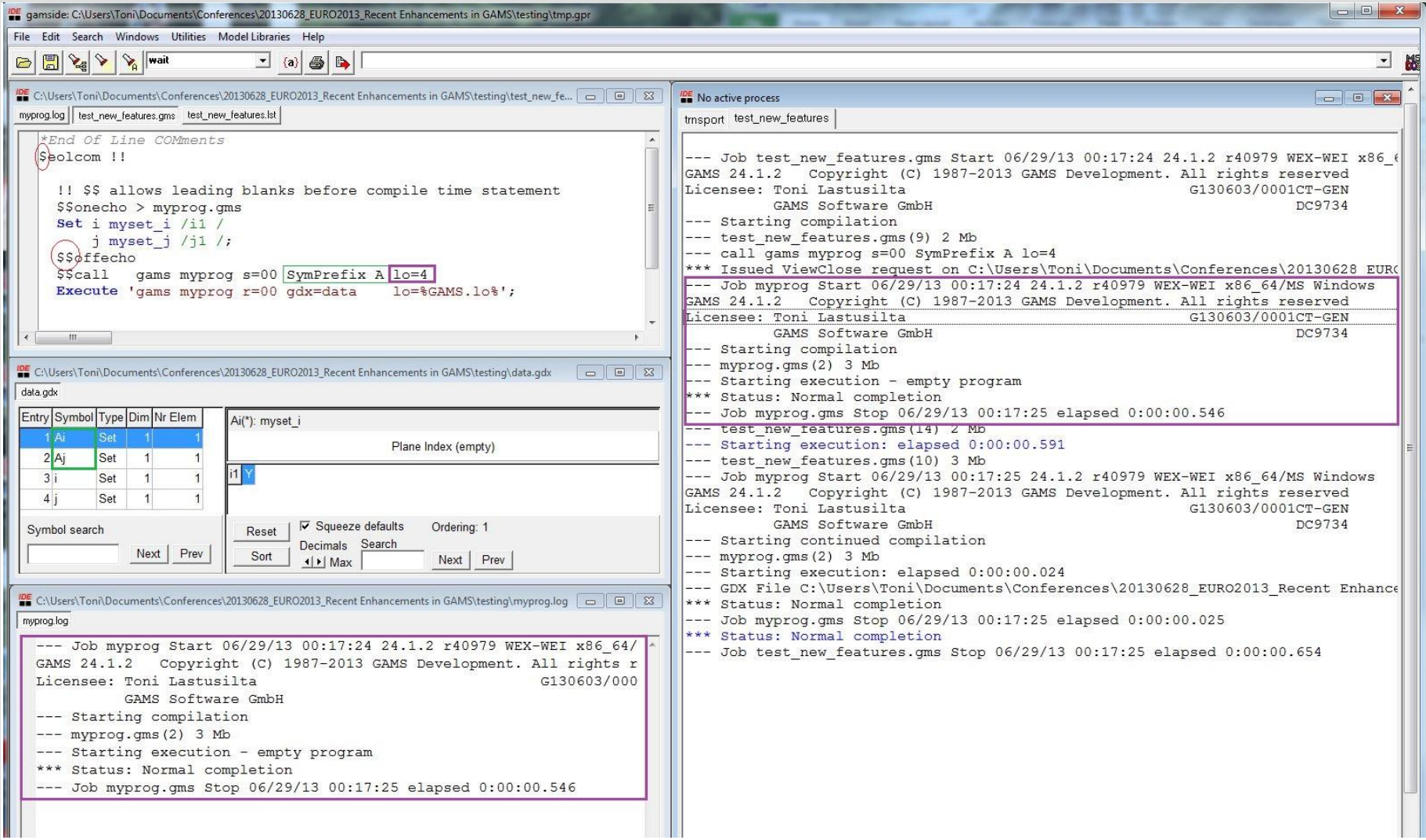


Recent Enhancements

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

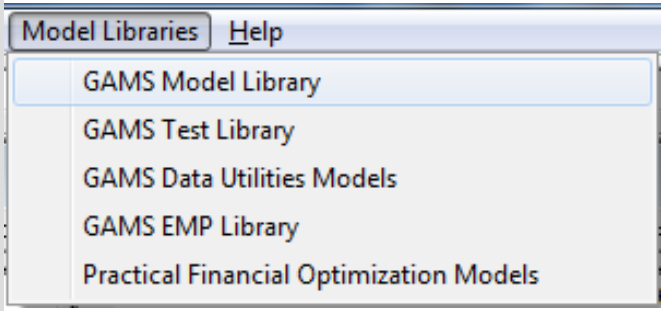
New tools and updates

- **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
- 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) Trnsxcll: Excel Spreadsheet in Charge of GAMS

#84) Spawn an arbitrary model from Excel

#85) Testing CSV file conversions

EMP Library

#93) Equilbrium model consisting of two VIs , one of which has a non-trivial constraint set

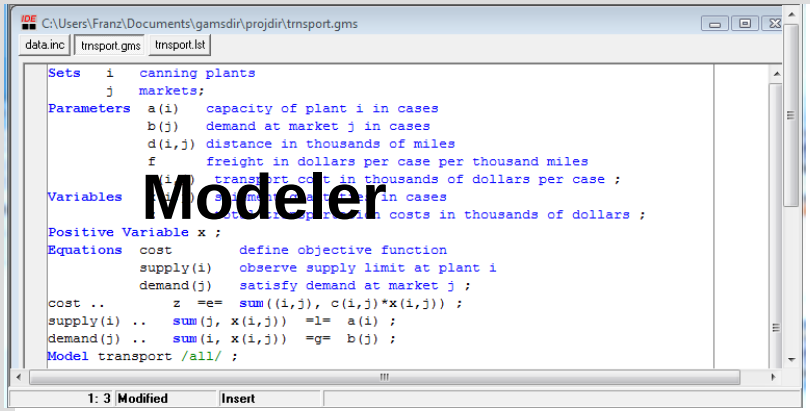
#94) A Stochastic Transportation Problem

#95) Outer Approximation for Convex Minimization Problem with Binary Variables

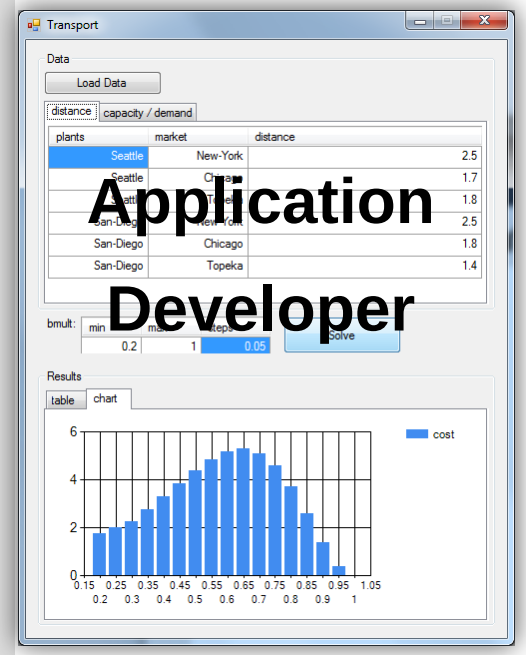
Agenda

- GAMS at a Glance
- Overview of enhancements
- **API:s**
- GDXRRW
- Concluding remarks

Bridging The Gap



Modeler

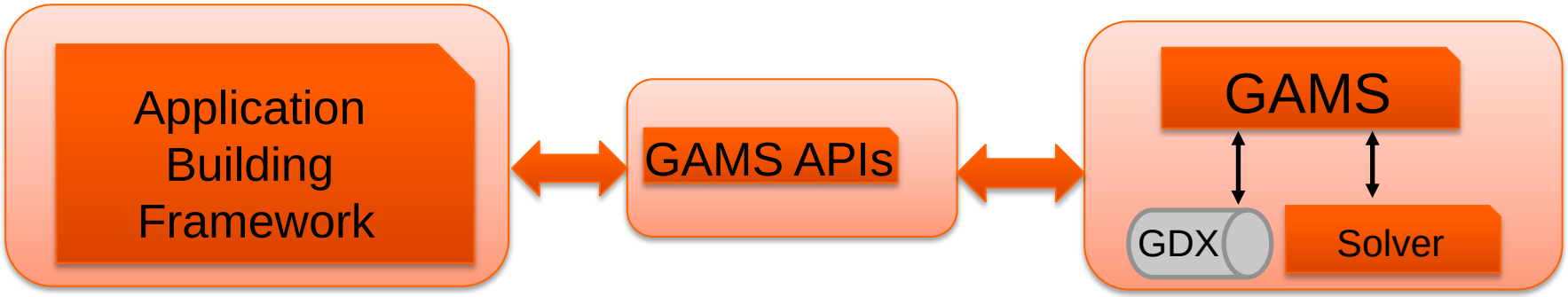


Application Developer

GAMS OO API

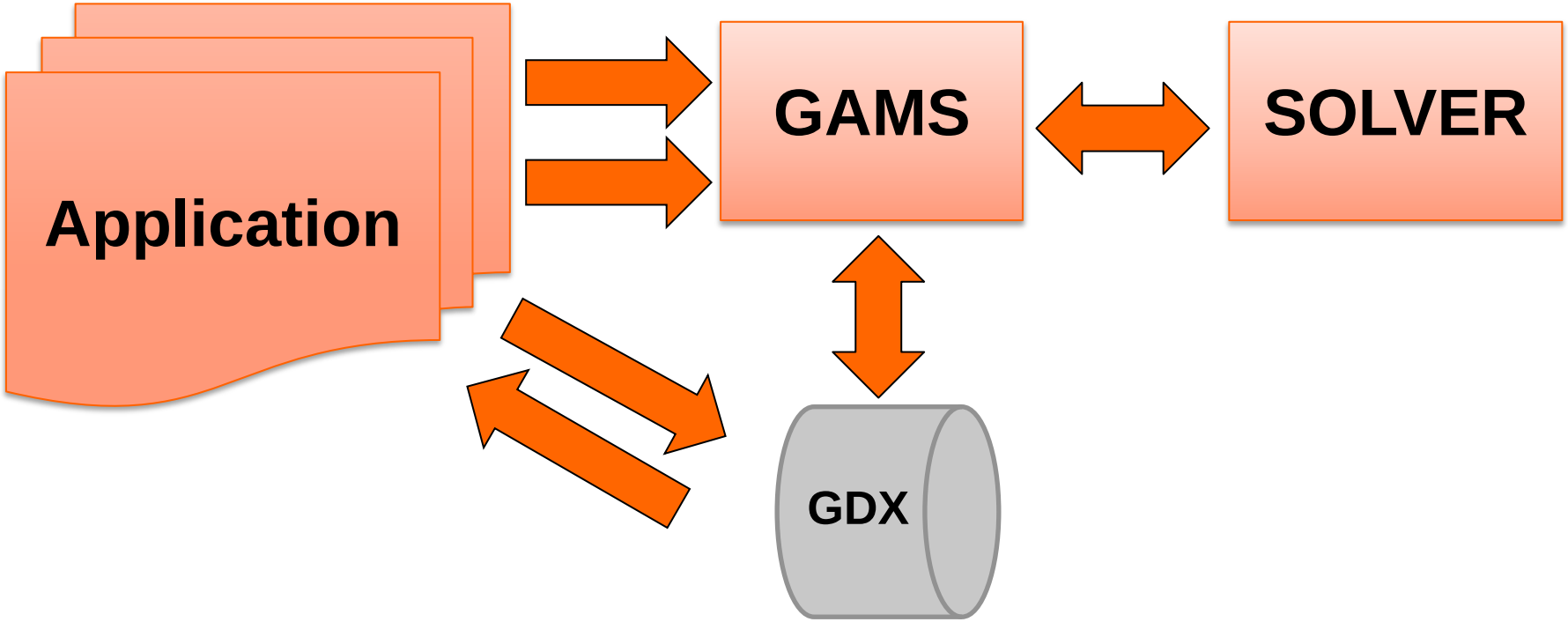
Concept: Separation of Tasks

- 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



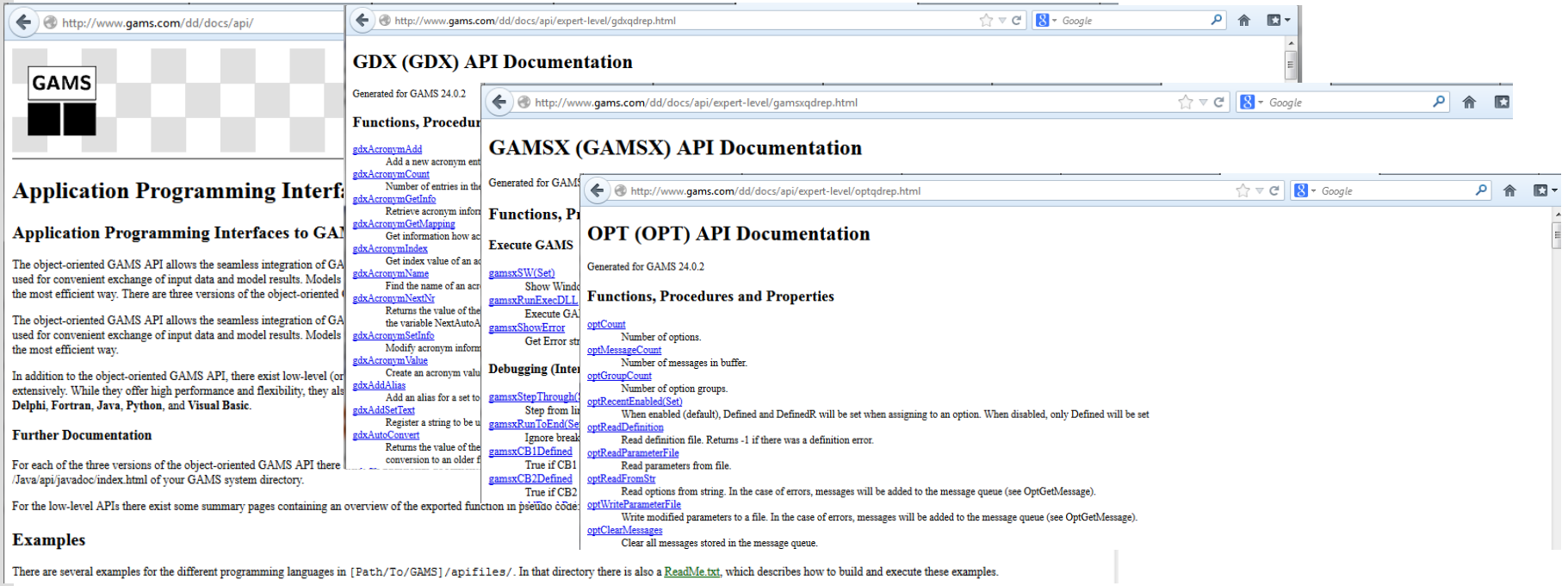
GAMS API: Basic Functionality

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



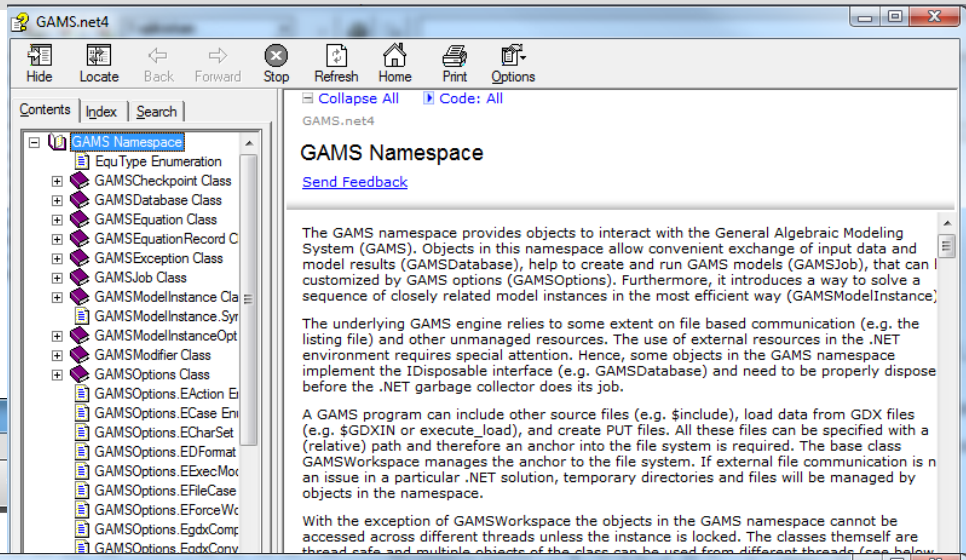
Low level GAMS APIs

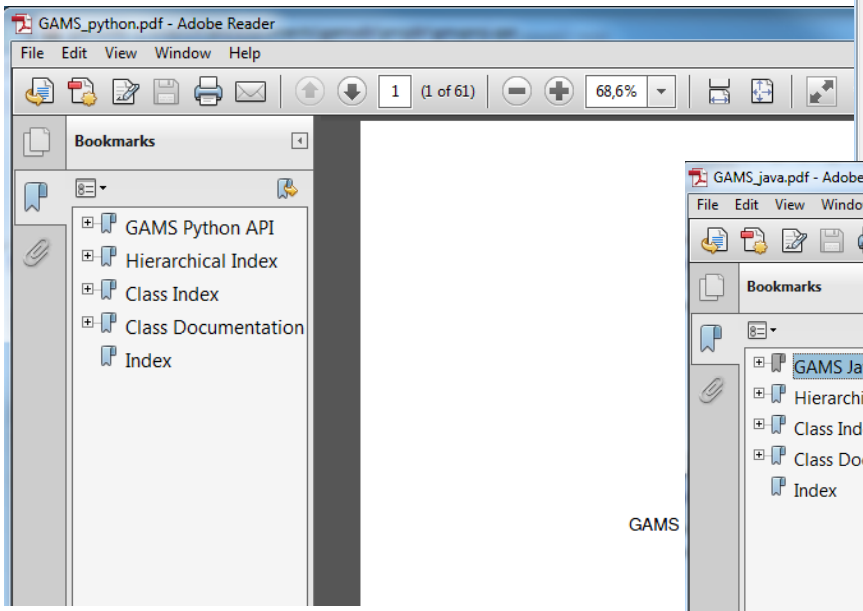
- High performance and flexibility
- Automatically generated APIs for several languages (C, Delphi, Java, Python, C#, …)
- Data Exchange (GDX), job control (GAMSX), options (OPT)
- Part of any GAMS distribution, no license required

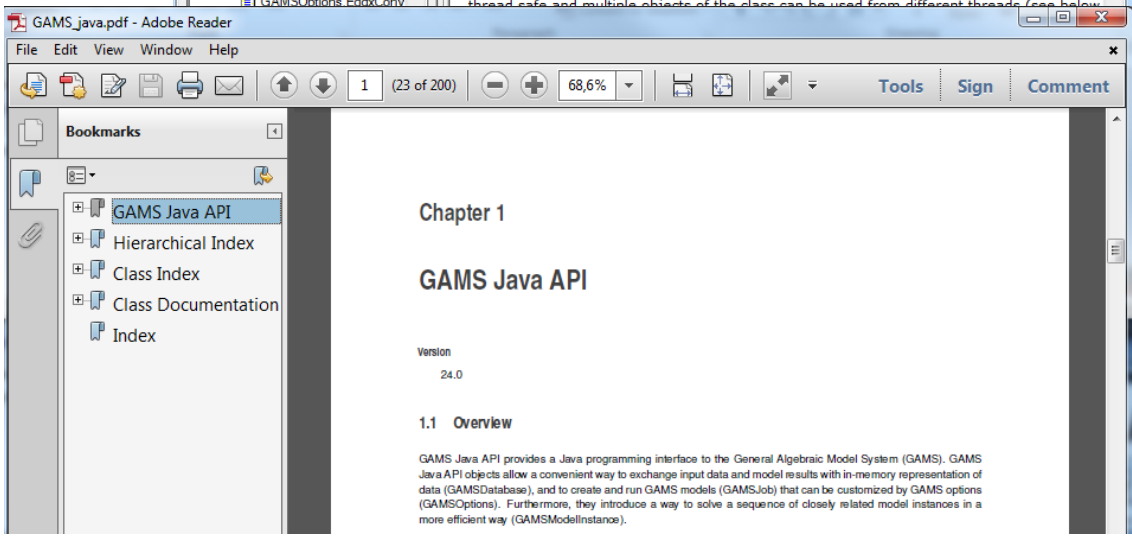


Object-oriented GAMS API

- 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);
            }
        }
```

Agenda

- GAMS at a Glance
- Overview of enhancements
- API:s
- **GDXRRW**
- Concluding remarks

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

GDXRRW 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"
```

Agenda

- GAMS at a Glance
- Overview of enhancements
- API:s
- GDXRRW
- **Concluding remarks**

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 !

USA

GAMS Development Corp.
1217 Potomac Street, NW
Washington, DC 20007
USA

Phone: +1 202 342 0180
Fax: +1 202 342 0181

sales@gams.com

Europe

GAMS Software GmbH
P.O. Box 40 59
50216 Frechen
Germany

Phone: +49 221 949 9170
Fax: +49 221 949 9171

info@gams.de

http://www.gams.com