



GAMS

How can I make this work...
arrgghh?

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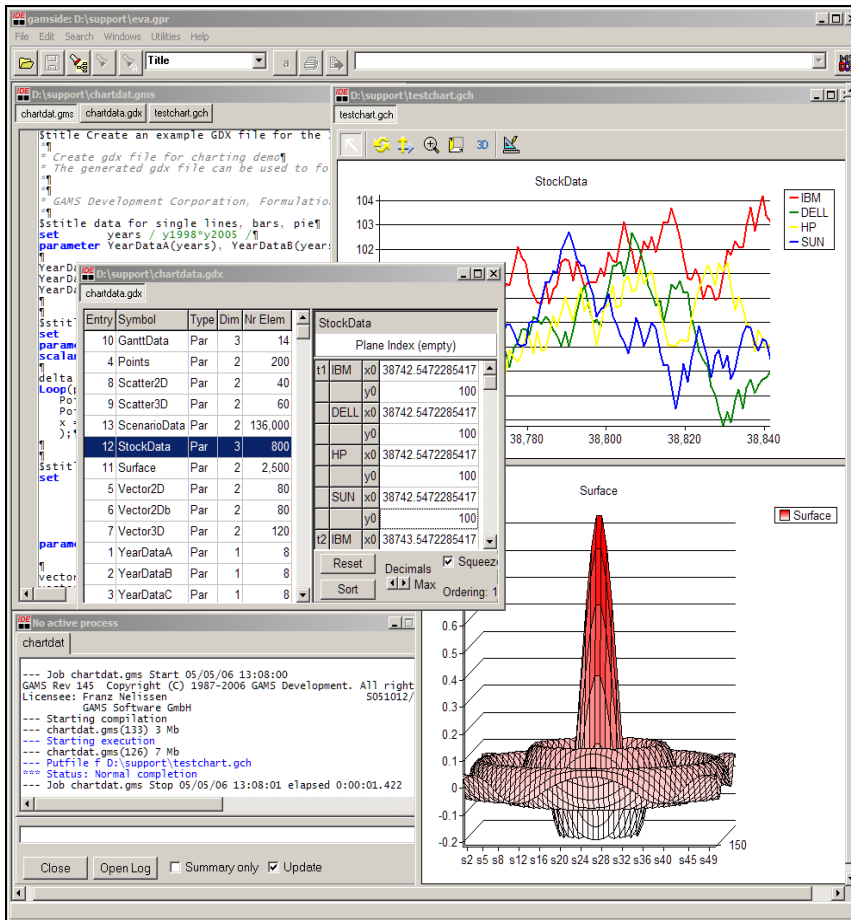
EURO XXIV LISBON



Introduction



GAMS at a Glance

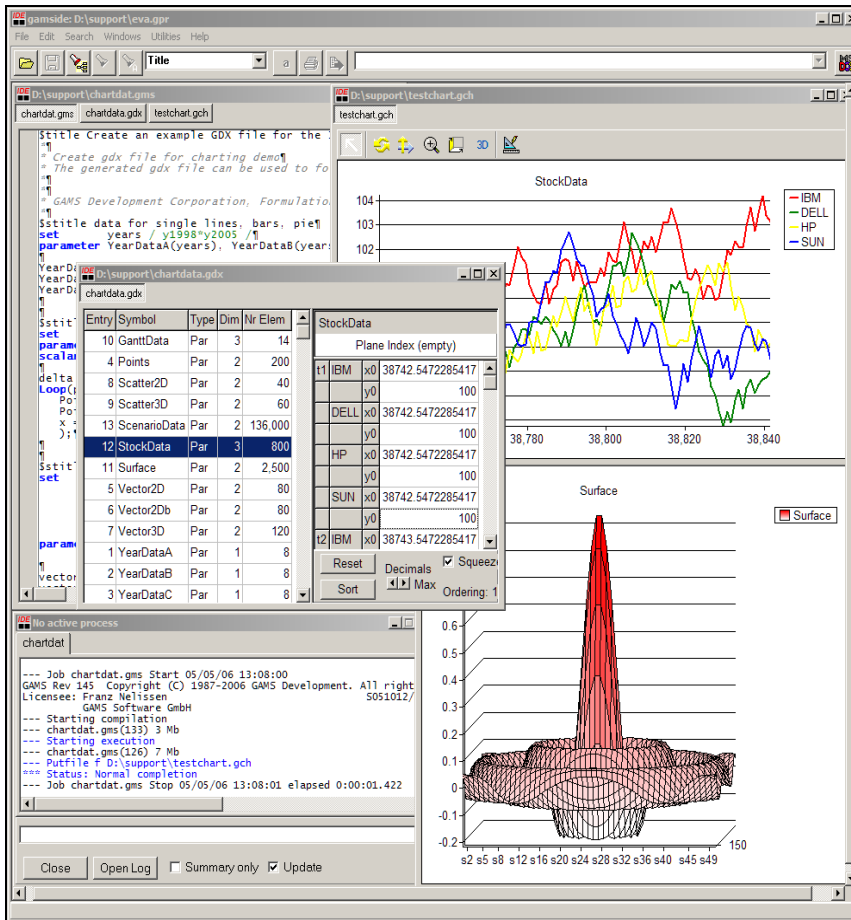


Algebraic Modeling System

- 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



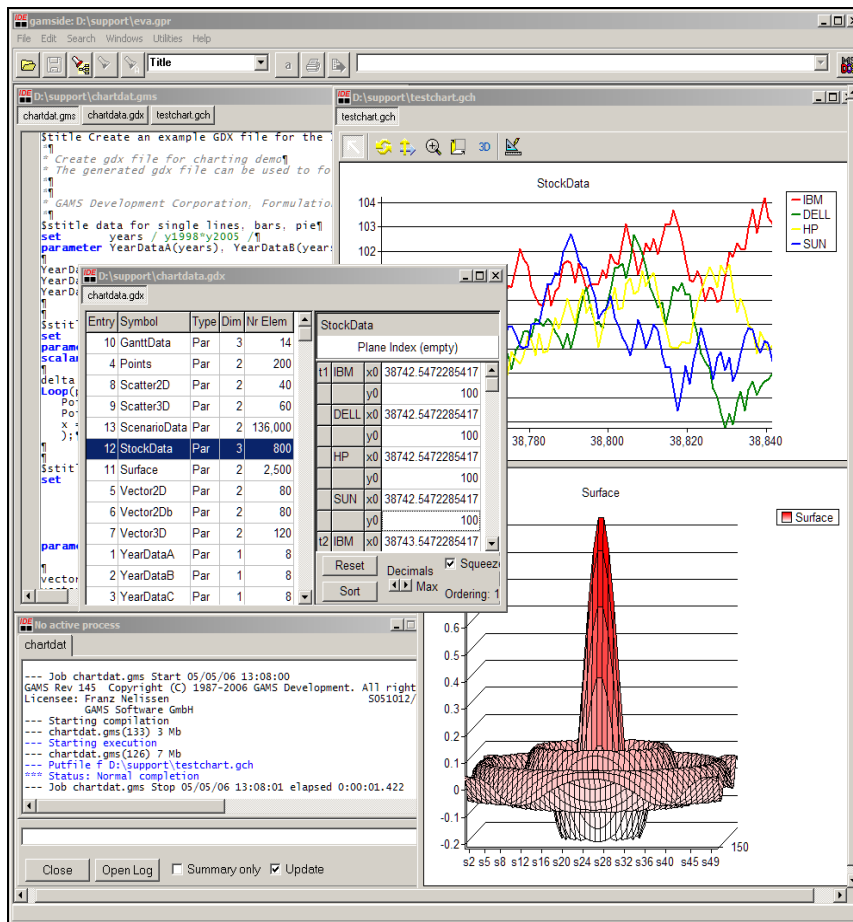
General Algebraic Modeling System

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

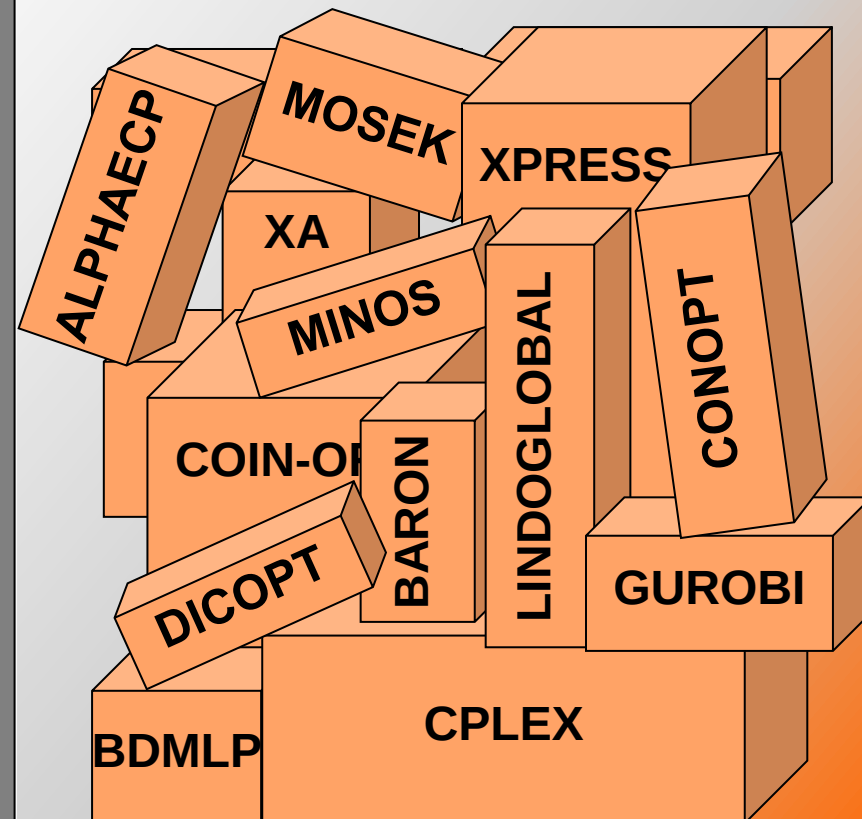




GAMS at a Glance

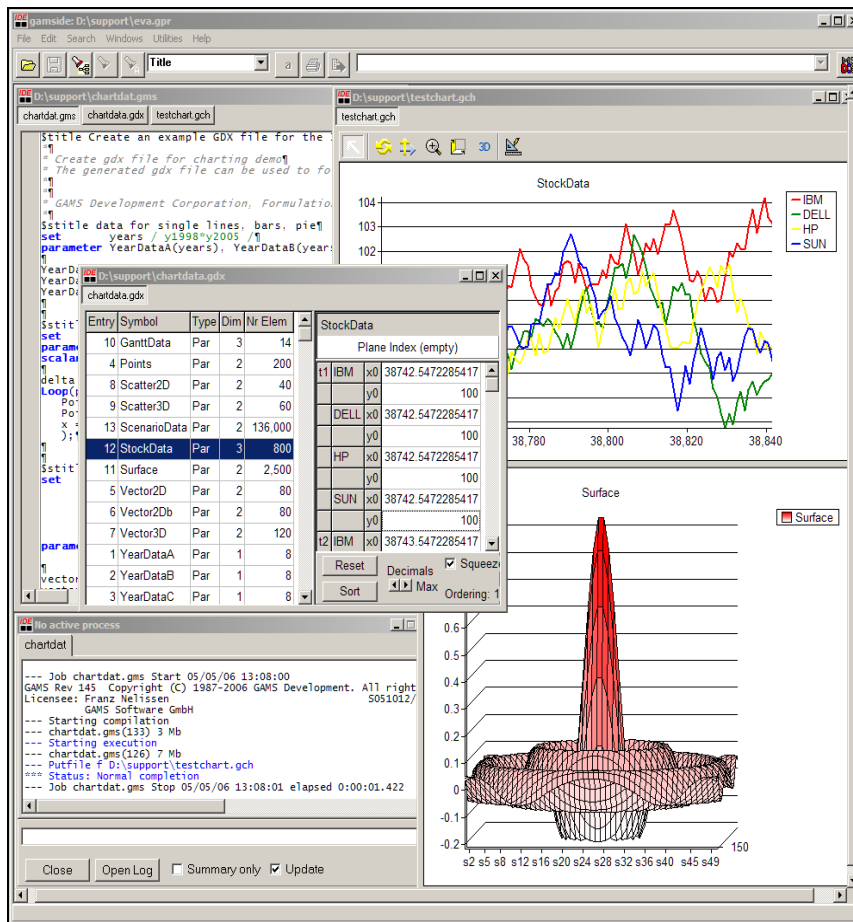


25+ Integrated Solvers

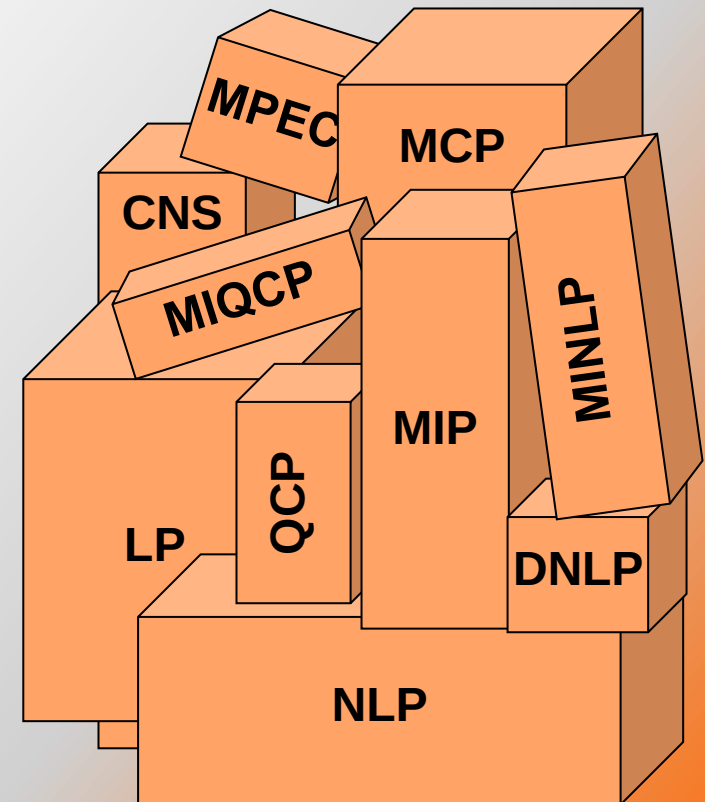




GAMS at a Glance

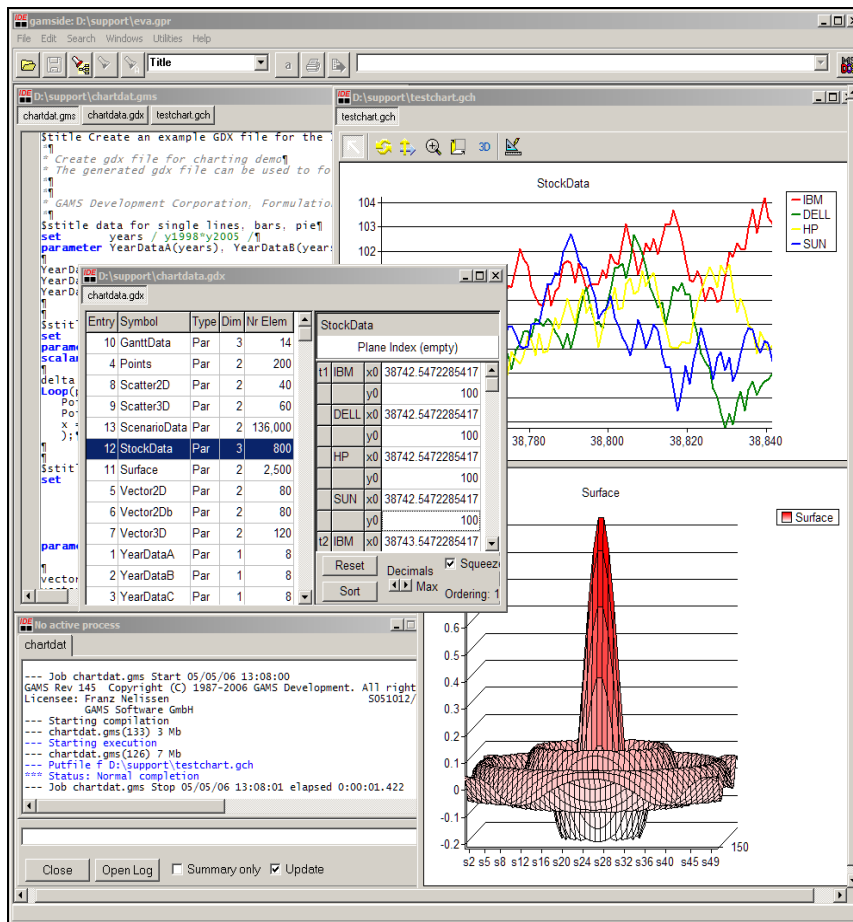


10+ Supported MP classes

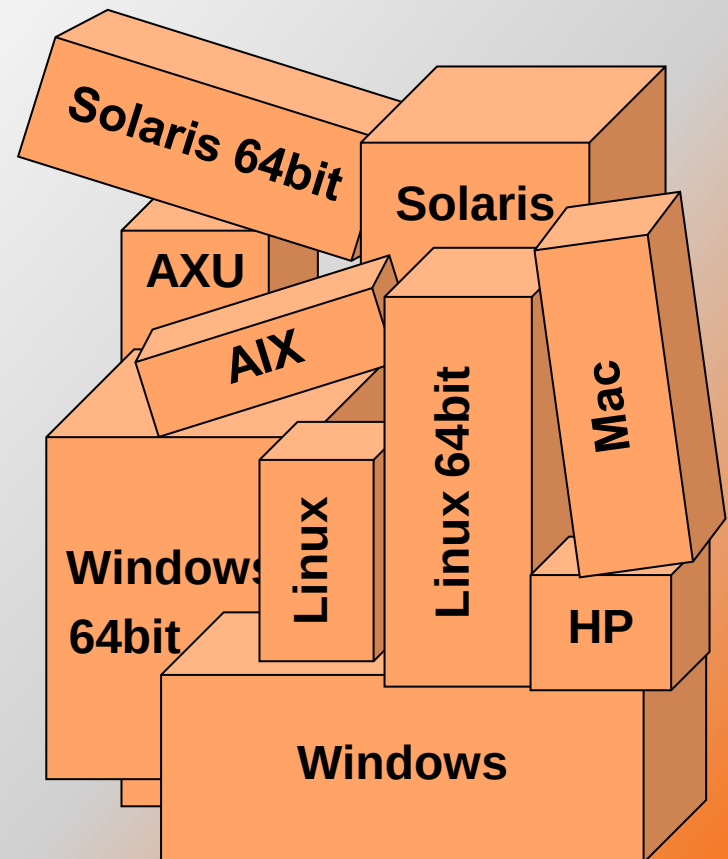




GAMS at a Glance



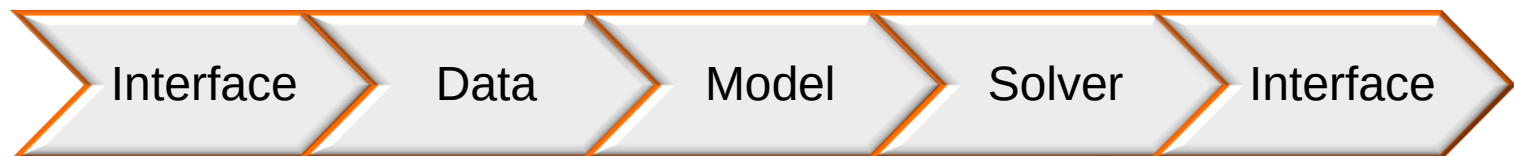
10+ Supported Platforms





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**





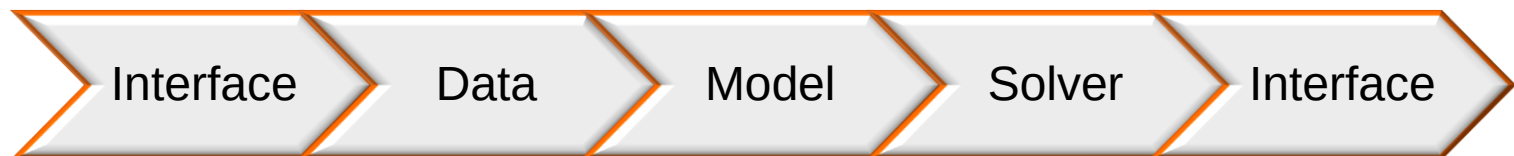
GAMS' Fundamental concepts

- **Different layers with separation of**

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

→ **Models benefit from**

- advancing hardware
- enhanced / new solver technology
- improved / upcoming interfaces to other systems





New GAMS Distribution 23.5

Released July, 4th !

www.gams.com/download

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Download GAMS Distribution 23.5.1 - July 4, 2010

Note: To deliver GAMS with the best performance we are using the [Amazon CloudFront](#) web service, a global network of edge locations for content delivery.

Please consult the [release notes](#) before downloading a system. The installation notes for [Windows](#) and [UNIX](#) and the complete [system documentation](#) are included in any system.

Windows	
Windows 32 bit	Windows 7, Windows Vista, Windows XP, Windows Server 2008, Windows Server 2003, and compatible on AMD- or Intel-based (x86_32) architectures
Windows 64 bit	Windows 7 x64, Windows Vista x64, Windows XP x64, Windows Server 2008 x64, Windows Server 2003 x64, and compatible on AMD- or Intel-based (x64_64) architectures.
Unix	
AIX	AIX 5.3 or higher, PowerPC chip, 64 bit (ppc_64)
Digital UNIX	Digital Unix 4 or higher on DEC Alpha (asp_64). Please note that the current GAMS distribution for Digital Unix is 22.7
HP-UX	HP-UX 11 or higher on HP PA-RISC (hpux_32). Please note that the current GAMS distribution for HP-UX is 22.1
Linux 32 bit	AMD- or Intel-based (x86_32) Intel-based 32-bit Linux systems. Most likely, these will have a 2.4.X kernel or higher. The software was built with Intel's Linux compilers, ver 11.1 or higher.
Linux 64 bit	AMD- or Intel-based (x64_64) Linux systems. These were built on a 2.6 kernel with Intel's Linux compilers, ver 11.1 or higher.
IRIX	IRIX 6.2 or higher on SGI MIPS (sgi_32). Please note that the current GAMS distribution for IRIX is 22.3
Mac OS X Intel 32 bit	Macintosh Intel-based systems (x86_32) built on Darwin 9. Please note that this is a Mac OS X Terminal application and must be installed and executed using the command line interface. → Additional Information
Mac OS X Intel 64 bit	Macintosh Intel-based systems (x64_64) built on Darwin 9. Please note that this is a Mac OS X Terminal application and must be installed and executed using the command line interface. Additional Information
Mac OS X PPC	Macintosh PowerPC-based systems for G4/G5 processors (ppc_fat) built on Darwin 8.4. Please note that the current GAMS distribution for Mac OS X PPC is 23.3.3 and that this is a Mac OS X Terminal application and must be installed and executed using the command line interface. Additional Information
Solaris SPARC 32 bit	Solaris 2.8 or higher on SUN Sparc (sparc_32). Missing Fortran Run-Time Environment?
Solaris SPARC 64 bit	Solaris 2.8 or higher on SUN Sparc (sparc_64)
Solaris x64 64 bit	Solaris 10 or higher on AMD- or Intel-based 64-bit (x64_64)

Please also visit the information about the [distribution history, changes, and incremental updates](#). For older distributions please follow [this link](#). There are some [mailing lists](#), which will inform you about



GAMS Talks at EURO 2010

MONDAY

Session: Optimization Modeling I

(Room 6.2.47, 12:20-13:40)

- **Stochastic Optimization: Recent Enhancements in Algebraic Modeling Systems**

Lutz Westermann

Session: Optimization Modeling II

(Room 6.2.47, 14:00-15:20)

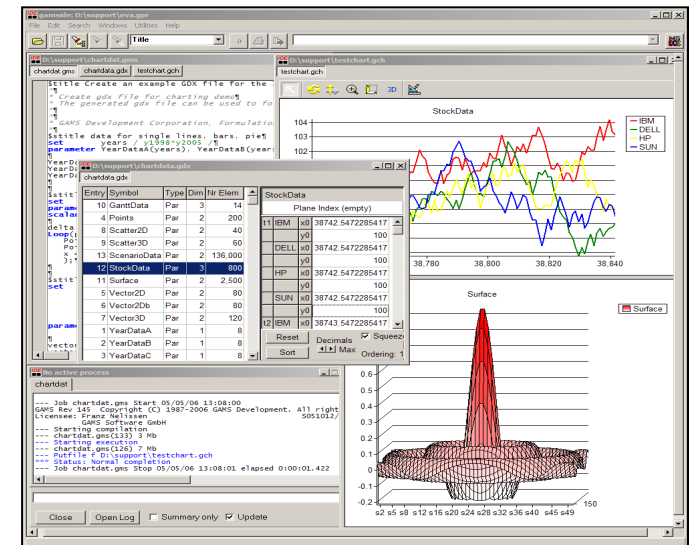
- **Recent Enhancements in GAMS**

Jan-Hendrik Jagla



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
- Model libraries
- Documentation





Tânia Ramos



Sequential GAMS Runs

From Tânia Ramos:

Is it possible to schedule sequential runs in GAMS? For instance, I have 3 models to run for 8 hours each; when the first model stops, is it possible to start another model automatically? Is it possible to create a kind of queuing line for independent models?



Sequential GAMS runs

```
IDE gamside: C:\presentation\2010_EURO_Lisabon\WS\euro2010ws.gpr - [C:\presentation\2010_EURO_Lisabon\WS\sequential
IDE File Edit Search Windows Utilities Model Libraries Help
[Icons: Folder, Save, Print, Run, Stop, etc.]
sequential.gms

set mdl / transport
      blend
      prodmix /

      slv(mdl) / transport    cplex
                  blend      gurobi
                  prodmix     xpress  /;

file fx; put fx;

loop(mdl,
  put_utility 'shell' / 'gamslib -q ' mdl.tl:0 ;
  put_utility 'shell' / 'gams ' mdl.tl:0 ' lp=' slv.te(mdl) ' lo=%GAMS.lo%';
  if(errorlevel,
    put_utility 'log' / '*** Error while running Model ' mdl.tl:0
                      ' with Solver ' slv.te(mdl) ;
  );
);
```



Deterministic Results with multiple Threads

From Tânia Ramos:

When we use more than 1 thread, the results obtained are not always the same. For instance, if I run a model today with 8 threads, and tomorrow I run it again, the results obtained could not be the same; the results are always the same if I ran with just 1 thread, but with more than 1 thread I couldn't replicate the results. It is possible to have the same results when using more than 1 thread?



Deterministic Results with multiple Threads

```

set runs /0*9/;
execute 'gamslib -q dice';
execute 'echo threads=2 > cplex.opt';

loop(runs,
  put_utility 'log' / '*** Starting dice: ' runs.tl:0;
  put_utility 'shell' / 'gams dice lp=cplex lo=2 optfile=1 gdx=diceOpp' runs.tl:0;
  if(errorlevel,
    put_utility 'log' / '*** Error while running dice: ' runs.tl:0
  );
);

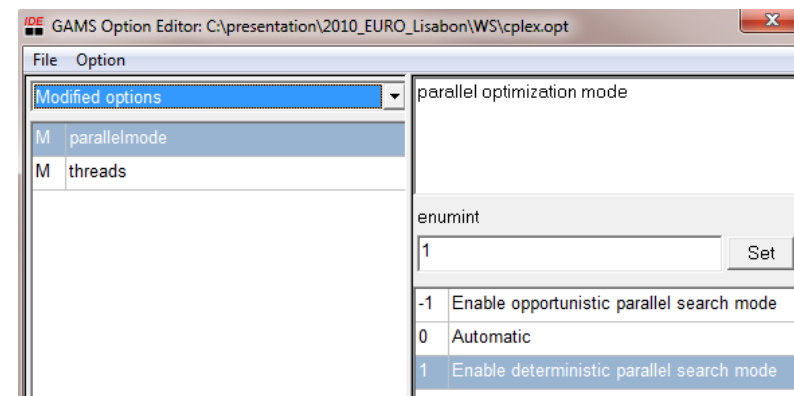
execute 'gdxmerge diceOpp* id=wnx output=opportunistic';

execute 'echo parallelmode=1 >> cplex.opt';

loop(runs,
  put_utility 'log' / '*** Starting dice: ' runs.tl:0;
  put_utility 'shell' / 'gams dice lp=cplex lo=2 optfile=1 gdx=diceDet' runs.tl:0;
  if(errorlevel,
    put_utility 'log' / '*** Error while running dice: ' runs.tl:0
  );
);

execute 'gdxmerge diceDet* id=wnx output=deterministic';

```





**Dra. Marian G.
Marcovecchio**



Dra. Marian G. Marcovecchio

I work in global optimization techniques, then I try to develop global optimization algorithms. I have implemented them in GAMS environment, using the GAMS solvers.

Specifically, I use local solvers for each iteration of my algorithms. As most of the deterministic global optimization algorithms, a convex (or linear) problem must be solved in different regions. These problems underestimate the global optimum of the original non-convex problem.

.....



Dra. Marian G. Marcovecchio

...

However, I have experimented troubles with problems having lots of variables and constraints. Specifically, I solve a convex or linear problem and sometimes the state is 'unfeasible' when actually the problem is feasible. As I implement loops (while, for), I need guaranties that the feasibility or unfeasibility of the problem is well determined in any region, since I can't provide a good initial point valid for any general region, beforehand.

...



Dra. Marian G. Marcovecchio

...

Furthermore, I solve a linear problem with CPLEX and the result is: 'Optimal solution found, but with infeasibilities after unscaling', the Model Status is 1 but the Solver Status is 4. I would like to have some guaranties when a convex or linear problem is solved. That means: the feasibility or unfeasibility is well determined and it is not dependent of the initial point. Otherwise, I would like to know the Solver limitations in these cases.



Dra. Marian G. Marcovecchio

- Algorithm implemented in GAMS to solve non-convex models to global optimality
- A sequence of convex/linear models that underestimate the global optimum
- Submodel have a lot of variables/equations
- GAMS Solver (CPLEX) declares submodel 'Infeasible' or 'Optimal solution found, but with infeasibilities after unscaling'



Dra. Marian G. Marcovecchio

- Why does the solver report infeasibilities although I know the model is feasible?
- Solvers have a hard time if model is scaled badly due to tolerances
- Keep coefficients in a reasonable range, best $[1e-3, 1e3]$
- You can use '*modelname.scaleopt*' and '*var.scale*'



Scaling

How do I find out?

1. Capture an instance with dumpopt=11
 - `gams mymodel dumpopt=11`
→ `mymodel.dmp` with all source and data
2. Capture an instance with Convert
 - `gams mymodel modeltype=convert`
or
 - `option nlp=convert;`
`solve m4 using nlp minimizing z;`
 - various options:
`gams (scalar), dict, jacobian, hessian`



Scaling

How do I find out?

3. Check the equation listing:

---- E1 =E=

E1. - (2.581140E+7)*X - Y =E= 0 ;

(LHS = 4.1541556E+9, INFES = 4.1541556E+9 ***)

4. Let CPLEX write some statistics about the quality of the solution

‘quality 1’

Solution Quality Statistics:

	unscaled		scaled	
	max	sum	max	sum
primal infeasibility	1.066e-014	1.599e-014	1.066e-014	1.599e-014
dual infeasibility	1.137e-013	2.443e-013	1.137e-013	2.443e-013
primal residual	6.366e-012	5.885e-011	2.387e-012	5.885e-011
dual residual	1.979e-012	1.314e-011	1.979e-012	1.314e-011
primal solution vector	2.253e+004	5.598e+005	4.621e+003	3.815e+005
dual solution vector	1.580e+004	2.902e+005	2.916e+004	4.591e+005
slacks	2.170e+004	6.722e+005	3.800e+003	6.101e+004
reduced costs	1.000e+006	6.252e+008	6.553e+007	1.078e+009

Condition number of the scaled basis matrix = 2.754e+006



Scaling

Dra. Marian G. Marcovecchio

- Are there any guarantees when a convex or linear problem is solved?
 - No, there are no general guarantees since each solver has its tolerances
 - Solver status will be accurate if model is scaled reasonably



GAMS Support



Cplex Error 1001: Out of Memory

From GAMS Support:

Hi,

We are using GAMS here at our university. In the process of building a very large scale LP model, we have encountered a problem of CPLEX Error 1001: Out of memory.

Is there any advice you can give to overcome this issue?

Best regards,

...



Cplex Error 1001: Out of Memory

Potential resolutions:

- Use the GAMS option solvelink 0 (and not 1, 2, 3, 4 or 5)
- Save memory by not passing on names to the solver:
model_name.dictfile=0
- Use a Cplex option file:
 - Do not load GAMS names (names no)
 - Do not use multiple threads (threads 1)
 - Conserve memory where possible (memoryemphasis 1)
 - Use the Simplex algorithm (lpmethod 1 or 2) instead of the Barrier algorithm (lpmethod 4)
 - MIP: Let Cplex store information on disk (nodefileind 2/3)
- Add more memory (and/or upgrade to 64 Bit OS)
- Reduce the size of the model



GAMS user list



Java Interface to GAMS

From GAMS user list:

Hello,

is there a Java interface for GAMS?

Thanks.

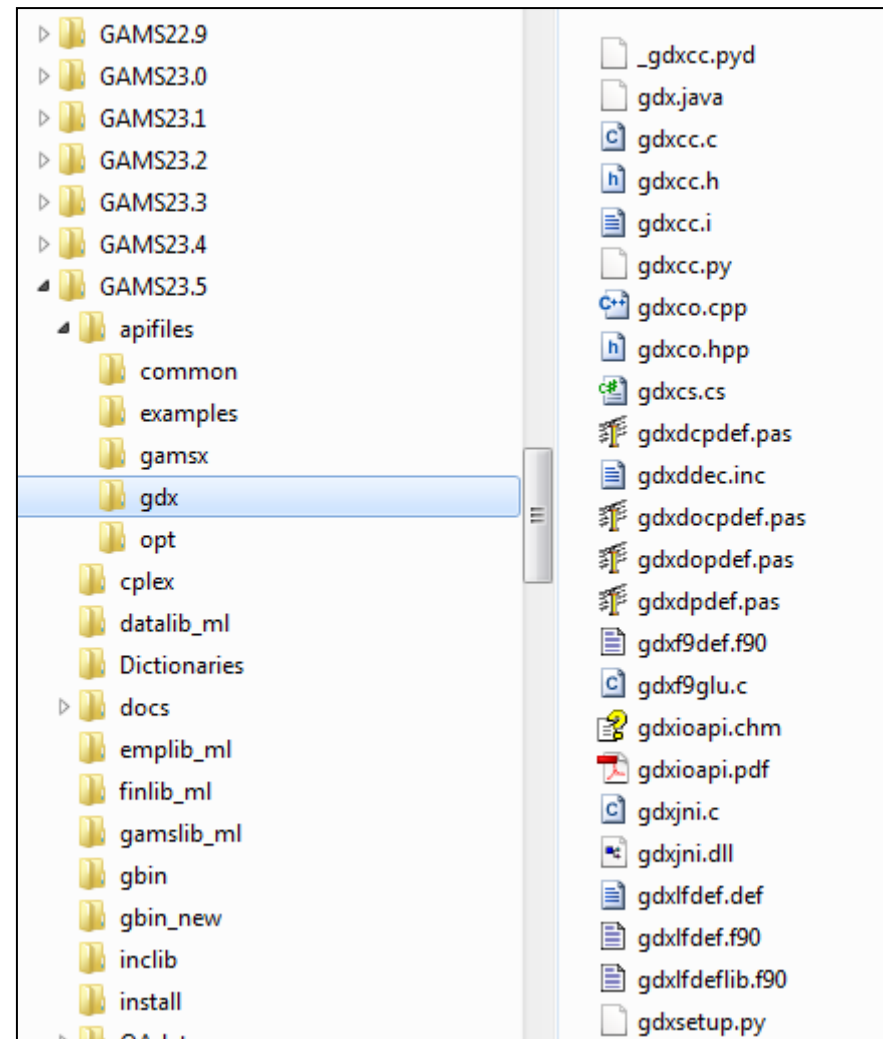
Regards,

...



Distributed GAMS APIs

- Component Libraries
 - GAMS
 - GDX
 - Option
- Supported languages
 - C, C++, C#
 - Delphi
 - Fortran
 - Java
 - VBA, VB.Net
 - Python
- Examples/Documentation





Calling GAMS from your Application

Creating Input for GAMS Model

→ Data handling using **GDX** API

Callout to GAMS

→ GAMS option settings using **Option** API

→ Starting GAMS using **GAMS** API

Reading Solution from GAMS Model

→ Data handling using **GDX** API



Calling GAMS from Java

```
if(gdx.Created(SysDir, Msg) != 1) {  
    System.out.println("Cannot create GDX object: " + Msg[0]);  
    ok = false;  
}  
  
if(ok && gamsx.Created(SysDir, Msg) != 1) {  
    System.out.println("Cannot create GAMSX object: " + Msg[0]);  
    ok = false;  
}  
  
if(ok && opt.Created(SysDir, Msg) != 1) {  
    System.out.println("Cannot create Option object: " + Msg[0]);  
    ok = false;  
}
```

```
if(ok && !WriteModelData(fngdxinp)){  
    System.out.println("Model data not written");  
    ok = false;  
}
```

Creating Input for GAMS Model

```
if(ok && !CallGams(SysDir)){  
    System.out.println("Call to GAMS failed");  
    ok = false;  
}
```

Callout to GAMS

```
if(ok && !ReadSolutionData("results.gdx"))  
    System.out.println("Could not read solution back");
```

Reading Solution from GAMS Model



Calling GAMS from Java cont'd

Creating Input for GAMS Model

```
static boolean WriteModelData(String fngdxfile){
    String[] Msg = new String[1];
    int[] ErrNr = new int[1];

    gdx.OpenWrite(fngdxfile, "Example1", ErrNr);
    if(ErrNr[0] != 0){
        gdx.ErrorStr(ErrNr[0], Msg);
        if(Msg[0].compareTo("") != 0) System.out.println("*** Error gdxOpenWrite: " + Msg[0]);
        return false;
    }
    if(gdx.DataWriteStrStart("Demand", "Demand data", 1, gamsglobals.dt_par, 0) == 0){
        ReportGDSError("DataWriteStrStart");
        return false;
    }

    WriteData("New-York", 324.0);
    WriteData("Chicago", 299.0);
    WriteData("Topeka", 274.0);

    if(gdx.DataWriteDone() == 0)
        ReportGDSError("WriteData");
    ErrNr[0] = gdx.GetLastError();
    if(ErrNr[0] != 0){
        gdx.ErrorStr(ErrNr[0], Msg);
        if(Msg[0].compareTo("") != 0) System.out.println("*** Error while writing GDX File: " + Msg[0]);
        return false;
    }

    ErrNr[0] = gdx.Close();
    if(ErrNr[0] != 0){
        gdx.ErrorStr(ErrNr[0], Msg);
        if(Msg[0].compareTo("") != 0) System.out.println("*** Error gdxClose: " + Msg[0]);
        return false;
    }
    return true;
}
```



Calling GAMS from Java cont'd

Callout to GAMS

```
static boolean CallGams(String SysDir){
    String[] Msg = new String[1];
    int[] ErrNr = new int[1];
    int n;

    if(opt.ReadDefinition(SysDir + "/optgams.def") != 0){
        System.out.println("*** Error ReadDefinition, cannot read def file:" + SysDir + "/optgams.def");
        return false;
    }

    n = opt.LookUp("SysDir") + 1;
    if(n<1) {
        System.out.println("*** Error LookUp: Cannot find option SysDir");
        return false;
    }
    opt.SetStrNr(n, SysDir);

    n = opt.LookUp("Input") + 1;
    if(n<1) {
        System.out.println("*** Error LookUp: Cannot find option Input");
        return false;
    }
    opt.SetStrNr(n, "model2.gms");

    n = opt.LookUp("LogOption") + 1;
    if(n<1) {
        System.out.println("*** Error LookUp: Cannot find option LogOption");
        return false;
    }
    opt.SetIntNr(n, 2); //write .log and .lst files

    ErrNr[0] = gamsx.RunExecDLL(opt.GetoptPtr(), SysDir, 1, Msg);
    if(ErrNr[0] != 0){
        System.out.println("*** Error RunExecDLL: Error in GAMS call = " + ErrNr[0]);
        return false;
    }
    return true;
}
```




Calling GAMS from Java cont'd

Reading Solution from GAMS Model

```
static boolean ReadSolutionData(String fngdxfile){
    int[] Dim = new int[1];
    String[] Msg = new String[1];
    int[] ErrNr = new int[1];
    int[] VarNr = new int[1];
    String[] VarName = new String[1];
    int[] VarTyp = new int[1];
    int[] NrRecs = new int[1];

   .gdx.OpenRead(fngdxfile, ErrNr);
    if(ErrNr[0] != 0){
       .gdx.ErrorStr(ErrNr[0], Msg);
        if(Msg[0].compareTo("") != 0) System.out.println("*** Error OpenWrite: " + Msg[0]);
        return false;
    }

    VarName[0] = "result";
    if(..gdx.FindSymbol(VarName[0], VarNr) == 0){
        System.out.println("*** Error FindSymbol: Could not find variable " + VarName[0]);
        return false;
    }

   .gdx.SymbolInfo(VarNr[0], VarName, Dim, VarTyp);
    if((Dim[0] != 2) || (VarTyp[0] != gamsglobals.dt_var)){
        System.out.println("*** Error SymbolInfo: " + VarName[0] + " is not a two dimensional variable");
        return false;
    }

    if(..gdx.DataReadStrStart(VarNr[0], NrRecs) == 0){
        ReportGDSError("DataReadStrStart");
        return false;
    }

    ReadData(Dim[0]);
   .gdx.DataReadDone();
   .gdx.Close();
    return true;
}
```



Sara Proença



Sara Proença

I'm a beginner with GAMS and I'm trying to build a dynamic CGE model in MPSGE. My problem is with the calibration process of the model. The model does not calibrate as can be seen in the following solution:

```
**** SOLVER STATUS      2 Iteration Interrupt
**** MODEL STATUS       6 Intermediate Infeasible
```

```
---- 1823 The precision of the benchmark dataset is:
      MODEL MPS_DYN.ObjVal      = 2.07061E+13
```

```
---- 1824 MPSGE model does not calibrate
```

```
**** Exec Error at line 1824: Execution halted: abort$1 'MPSGE model
does not calibrate'
```



How to keep Up To Date

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GAMS users worldwide use the list name GAMS-L to exchange information about GAMS. GAMS-L is open to everyone around the world and can easily be reached via the Internet.

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With his newsletter Bruce McCarl wants to provide some additional information on the use and features which emerge as GAMS develops. He intends to periodically issue a very short newsletter that informs people of things that are new and or under documented as well as opportunities to learn more about GAMS features and usage.

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