GAMS

How can I make this work...

arrgghh?

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GAMS Software GmbH

GAMS Development Corporation www.gams.com

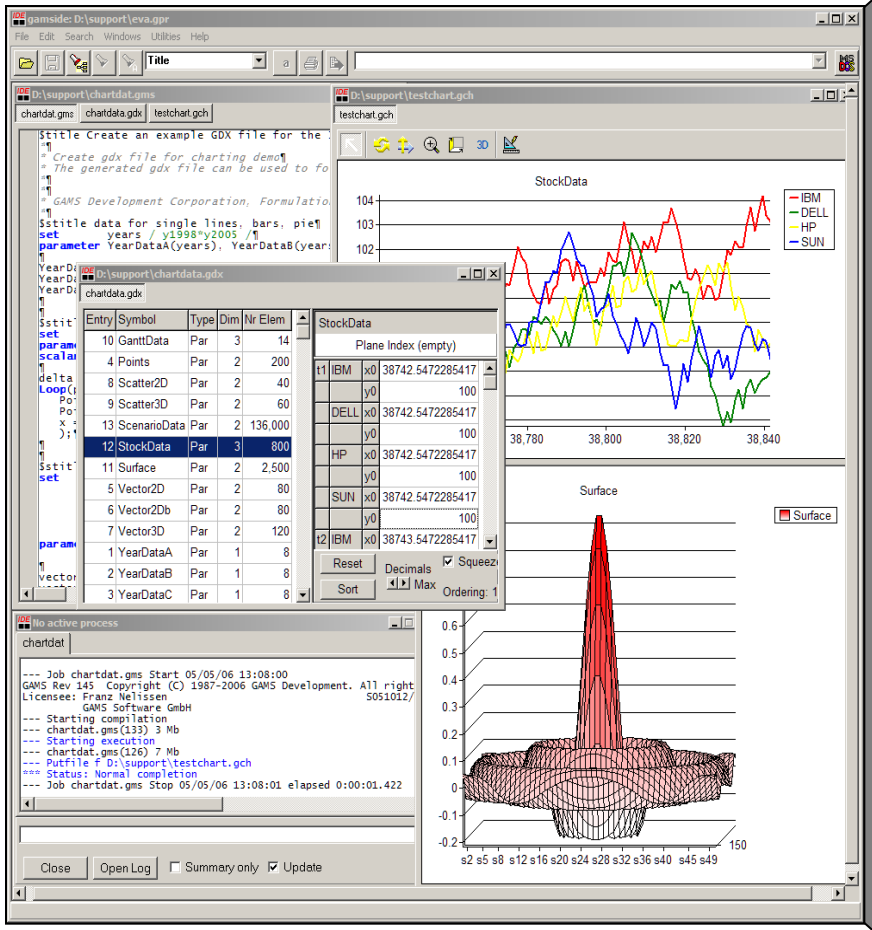
International Conference on Operations Research

MUNICH 2010

September 1st - 3rd

Introduction

GAMS at a Glance



Algebraic Modeling System

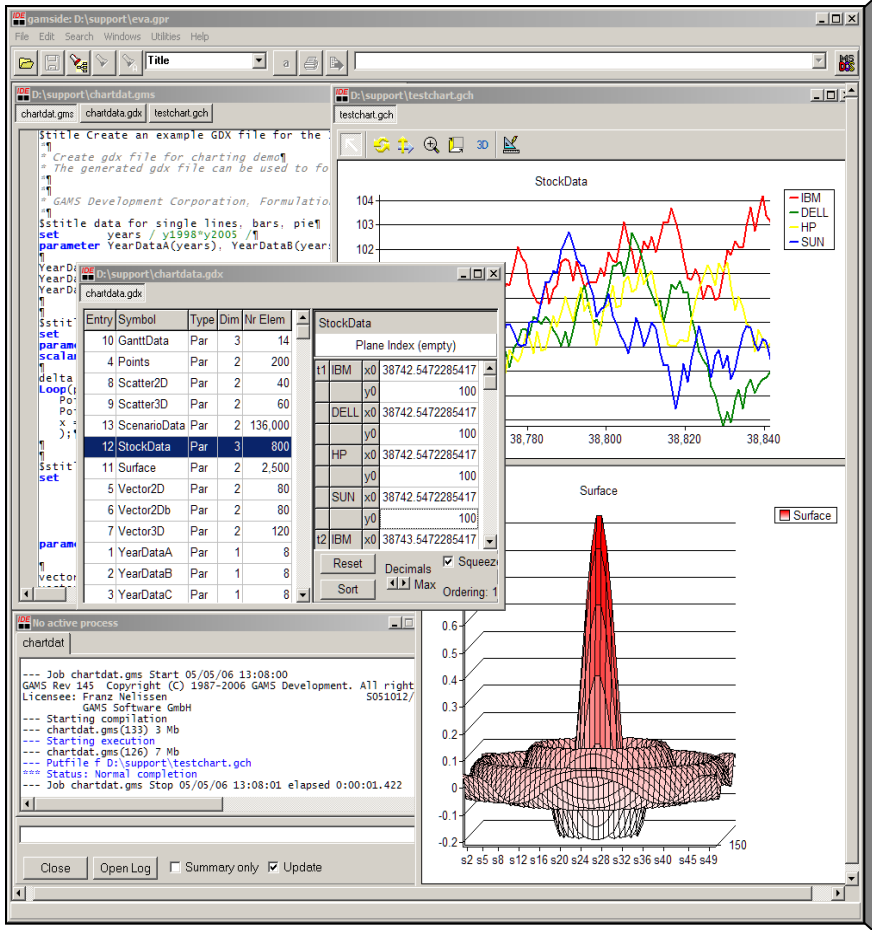
- Facilitates to formulate mathematical optimization problems similar to algebraic notation

  ➔ Simplified model building

- Provides links to appropriate state-of-the-art external algorithms

  ➔ Efficient solution process

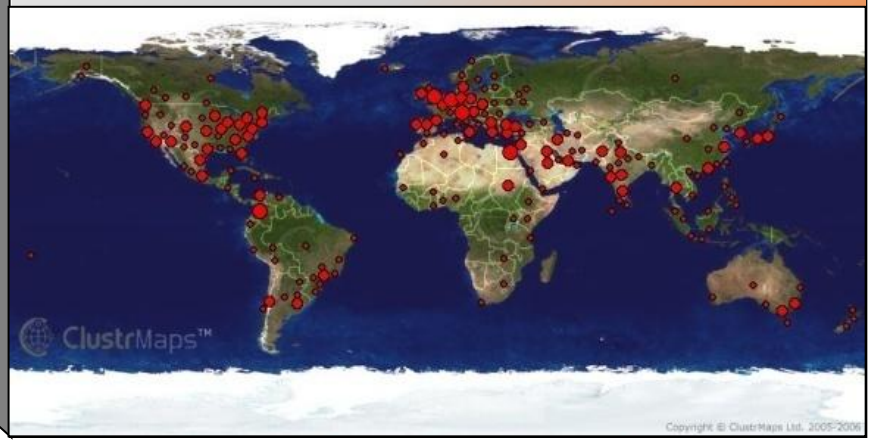
GAMS at a Glance



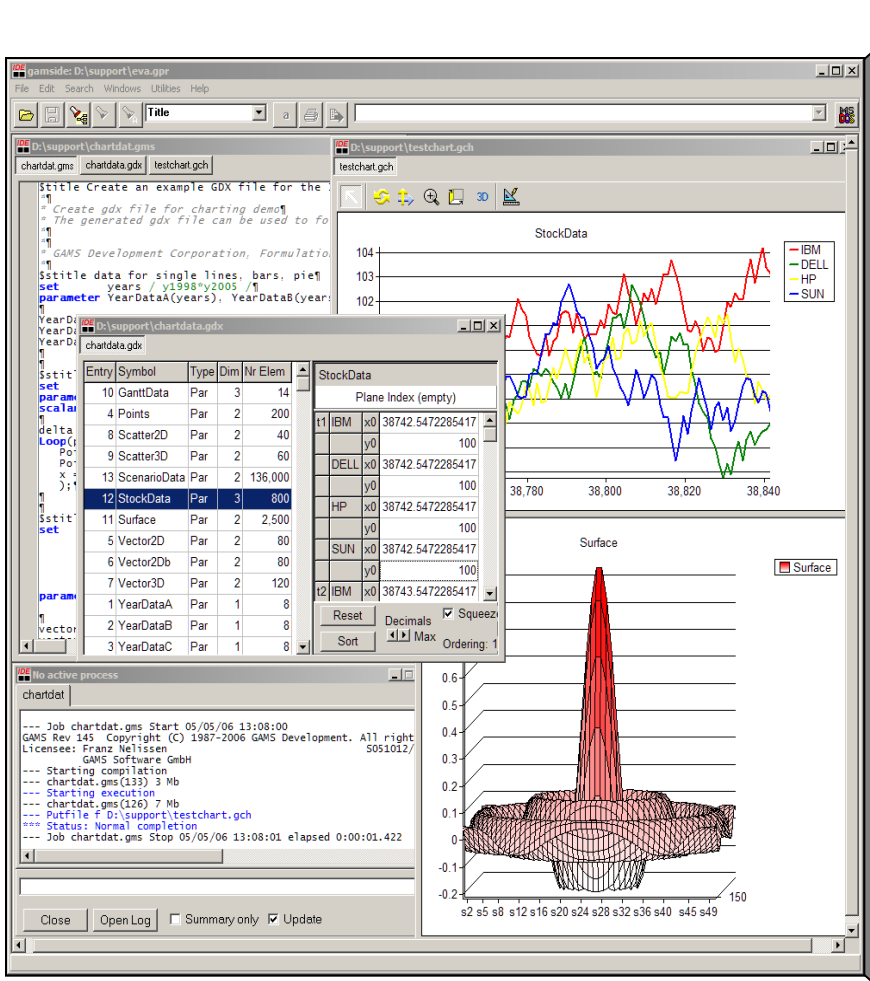
General **A**lgebraic **M**odeling **S**ystem

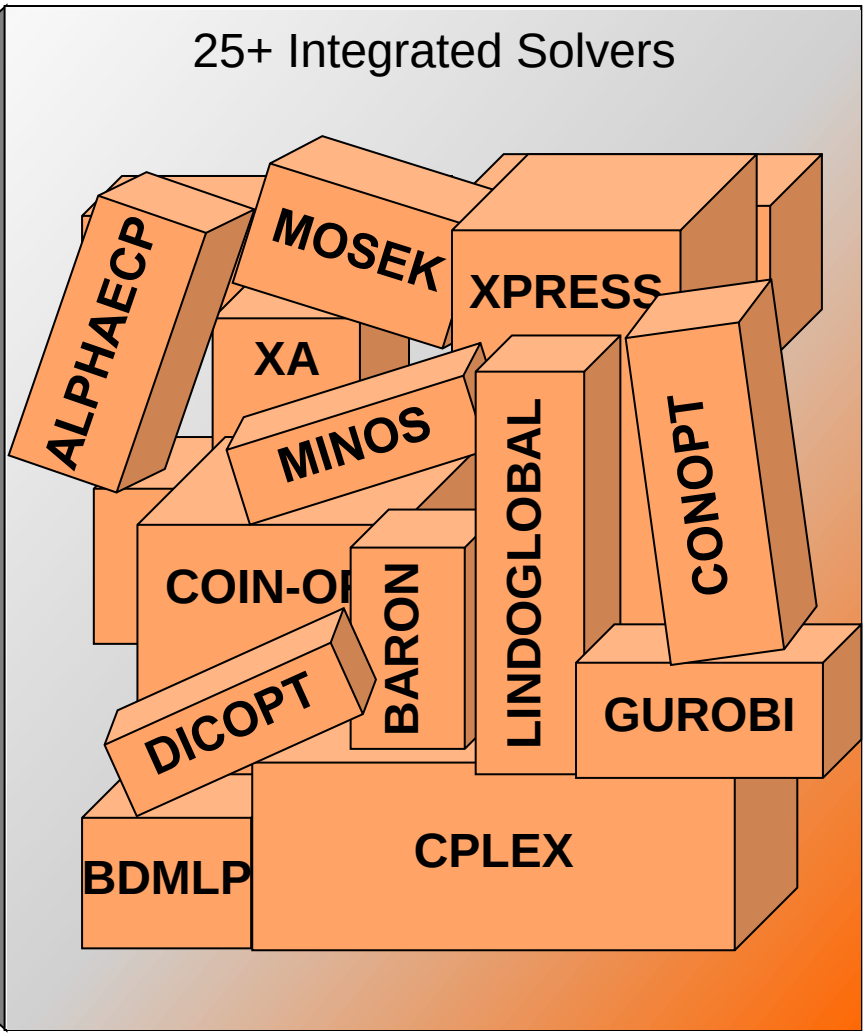
- Roots: World Bank, 1976
- Went commercial in 1987
- GAMS Development Corp.
- GAMS Software GmbH

- Broad academic & commercial user community and network

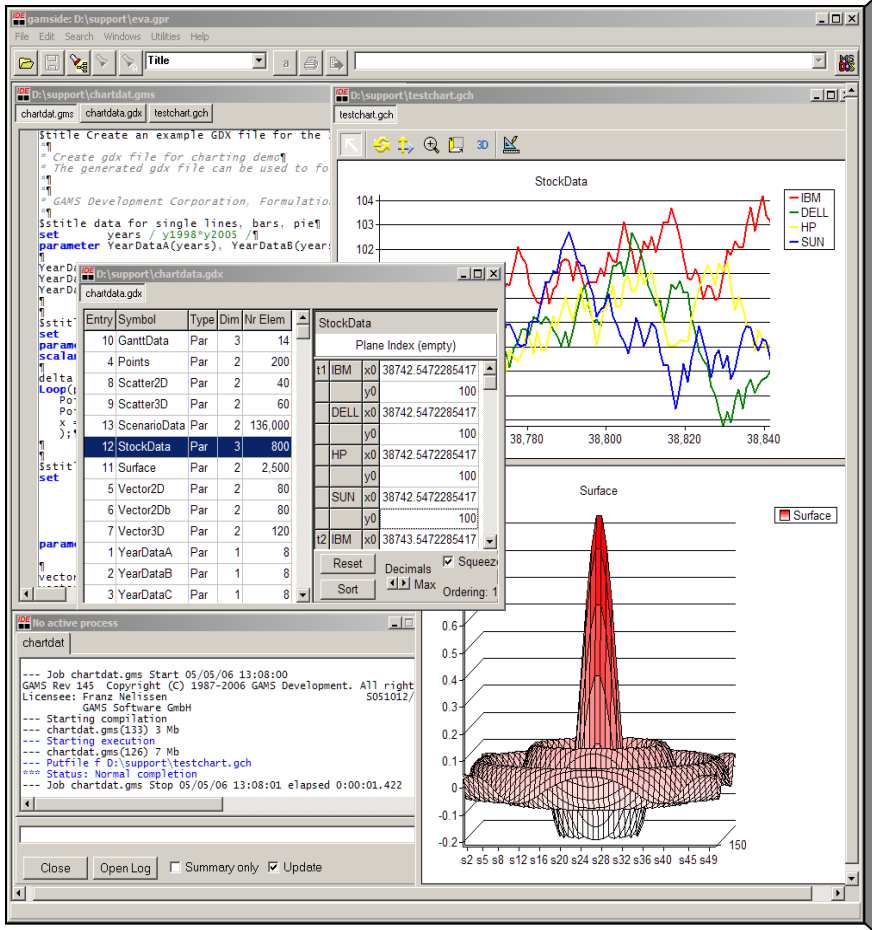


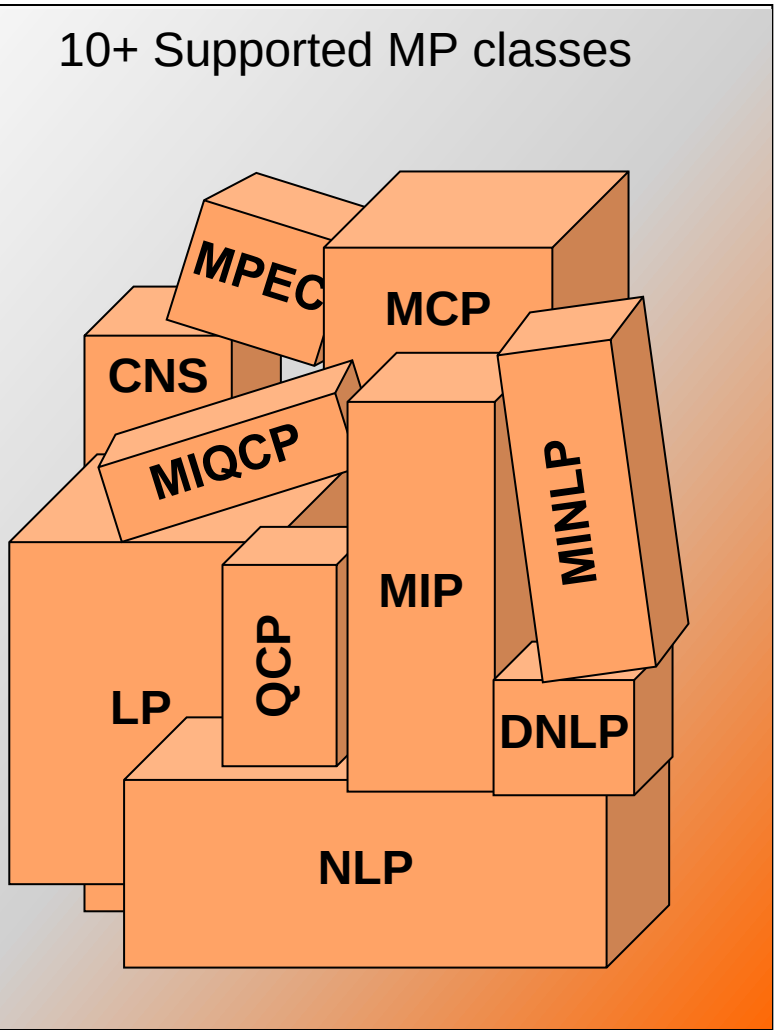
GAMS at a Glance



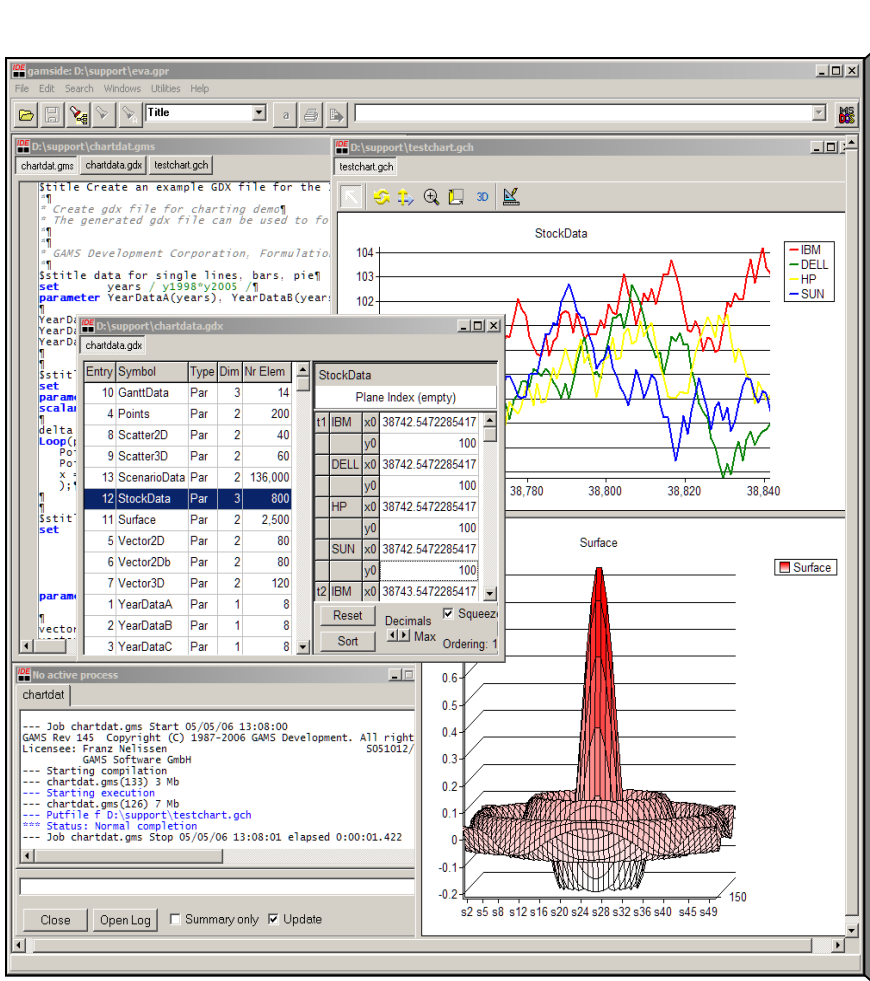


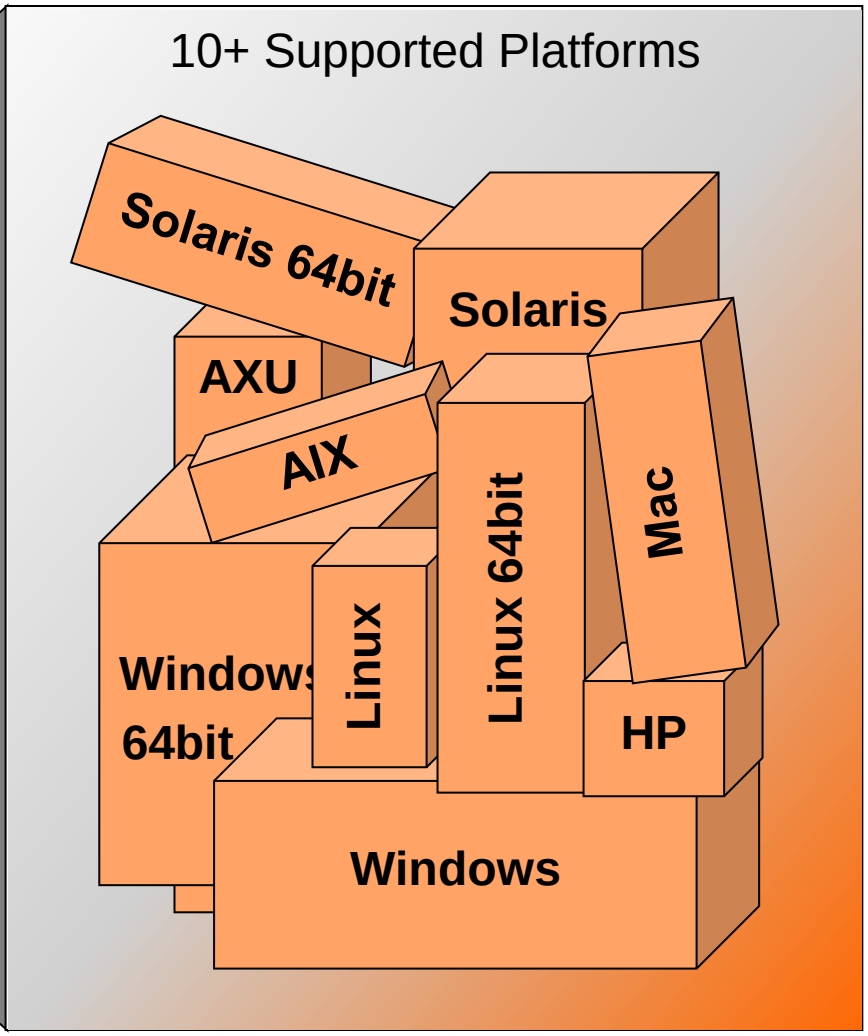
GAMS at a Glance





GAMS at a Glance





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, …

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 23.5.2

Released August, 18th

www.gams.com/download

Download GAMS Distribution 23.5.2 - August 18, 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 (axp_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 forthcoming releases, provide additional information, and are useful for questions about GAMS and modeling issues.

GAMS Talks at OR 2010

Wednesday

Session: Stochastic Programming Software

(WD-10, 14:30-16:00)

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

- **Stochastic Programming using Algebraic Modeling Languages**
  Timo Lohmann

GAMS Talks at OR 2010

Wednesday

Session: Software

(WD-11, 14:30-16:00)

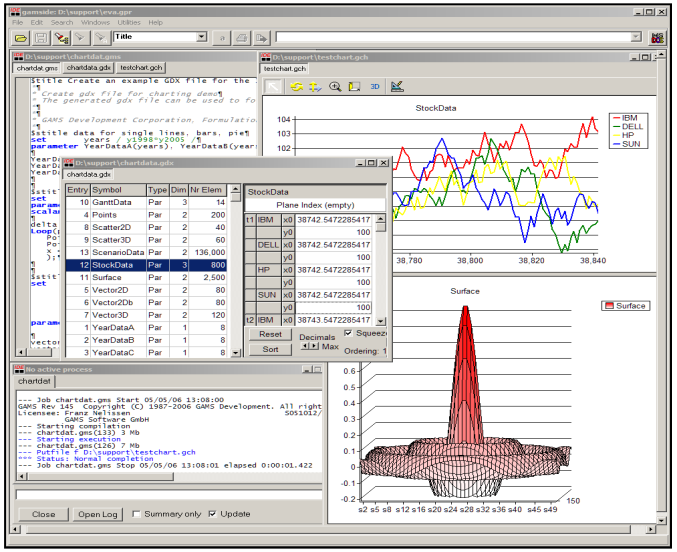
- **Recent Enhancements in GAMS**
  Lutz Westermann

- **Interactions between a Modeling System and Advanced Solvers**
  Jan-Hendrik Jagla

- **Using Utility Computing to provide Mathematical Programming Resources**
  Franz Nelissen

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

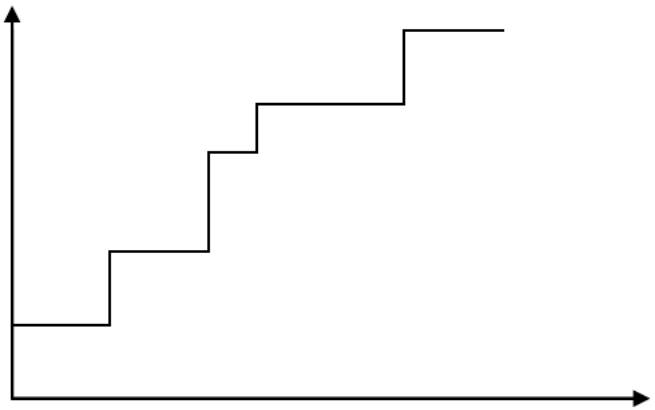


Gernot Nischler

Avoid Nonlinearity

From Gernot Nischler:

- Minimize costs
- Prize non-linear, discontinuous like this:



- Is it possible to model this as an LP? NLP is not acceptable, MIP will work for some instances.

Avoid Nonlinearity

gamside: C:\tmp\tmp.gpr - [C:\tmp\trnsportCst.gms]

File Edit Search Windows Utilities Model Libraries Help

VarCov

trnsportCst.gms

```
set       tcst    tranport capacity step /tc1*tc3/;

Parameter coststep(i,j,tcst);
coststep(i,j,'tc1') = 0.9*c(i,j);
coststep(i,j,'tc2') = 1.0*c(i,j);
coststep(i,j,'tc3') = 1.1*c(i,j);

Parameter capstep(i,j,tcst);
capstep(i,j,tcst) = 150;

Variables
     xst(i,j,tcst)  shipment quantities in cases
     zst            total transportation costs in thousands of dollars ;

Positive Variable xst ;

Equations
     costst         define objective function
     supplyst(i)    observe supply limit at plant i
     demandst(j)    satisfy demand at market j ;

costst ..        z  =e=  sum((i,j,tcst), coststep(i,j,tcst)*xst(i,j,tcst)) ;

supplyst(i) ..   sum((j,tcst), xst(i,j,tcst))  =l=  a(i) ;

demandst(j) ..   sum((i,tcst), xst(i,j,tcst))  =g=  b(j) ;

xst.up(i,j,tcst) = capstep(i,j,tcst);

Model transportst /costst, supplyst, demandst/ ;

Solve transportst using lp minimizing z ;

Display xst.l;
```

Benjamin Breen

GAMS and Excel, scenarios

From Benjamin Breen:

- How to export data to Excel
- Can I solve several scenarios in a loop using GAMS?

GAMS and Excel, scenarios

gamside: C:\tmp\tmp.gpr - [C:\tmp\trnsportScen.gms]

File Edit Search Windows Utilities Model Libraries Help

VarCov

trnsportScen.gms

```
set scen /s1*s3/;
parameter bscen(j,scen);
bscen(j,'s1') = 0.8*b(j);
bscen(j,'s2') = 0.9*b(j);
bscen(j,'s3') = 1.0*b(j);

parameter solscen(i,j,scen);

loop(scen,
  b(j) = bscen(j,scen);
  Solve transport using lp minimizing z ;
  solscen(i,j,scen) = x.l(i,j);
);

execute_unload 'solscen' solscen;
execute 'gdxxrw solscen.gdx o=sol.xlsx par solscen rng=sheet2!';
```

Steffen Kasper

GAMS and MySQL

From Steffen Kasper:

- How can one import data from an MySQL database?
- How can one export data to an MySQL database?

GAMS and MySQL

http://interfaces.gams-software.com

- This Wiki illustrates how GAMS can exchange data with other programs, and how GAMS can be called from familiar programming environments

http://interfaces.gams-software.com/doku.php?id=databases:databases

- DB2
- MS Access
- MySQL
- Oracle
- SQL Server
- Sybase

Quintus Hegie

Appointment Scheduling Problem

From Quintus Hegie :

- How to solve an appointment scheduling problem?
- 100 advisors in 80 locations
- 30 1-on-1 meeting requests each day
- Meetings are scheduled in advance
- 3*5=15 week slots and planning scope up to 4 weeks
- Each appointment takes 1 slot
- Not more than 2 appointments per day and advisor
- …

- How do GAMS solvers compare to Cplex?

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

gamside: C:\presentation\2010_EURO_Lisabon\WS\euro2010ws.gpr - [C:\presentation\2010_EURO_Lisabon\WS\sequentia

File Edit Search Windows Utilities Model Libraries Help

sequential.gms

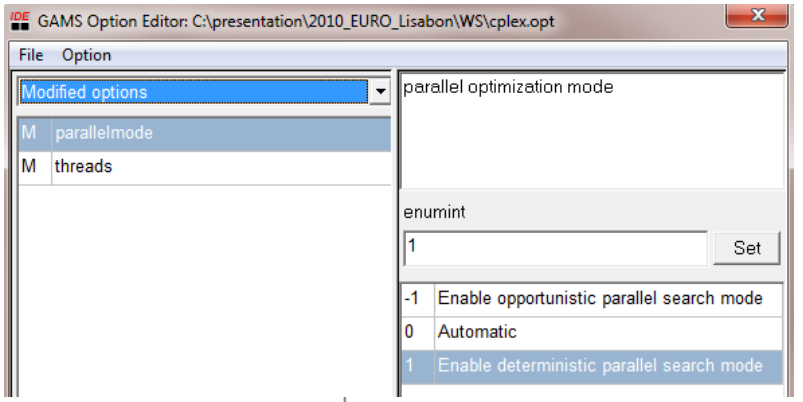
```
set mdl / trnsport
          blend
          prodmix /

    slv(mdl) / trnsport   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=deterministicistic';
```

GAMS user list

Java Interface to GAMS

From GAMS user list:

Hello,

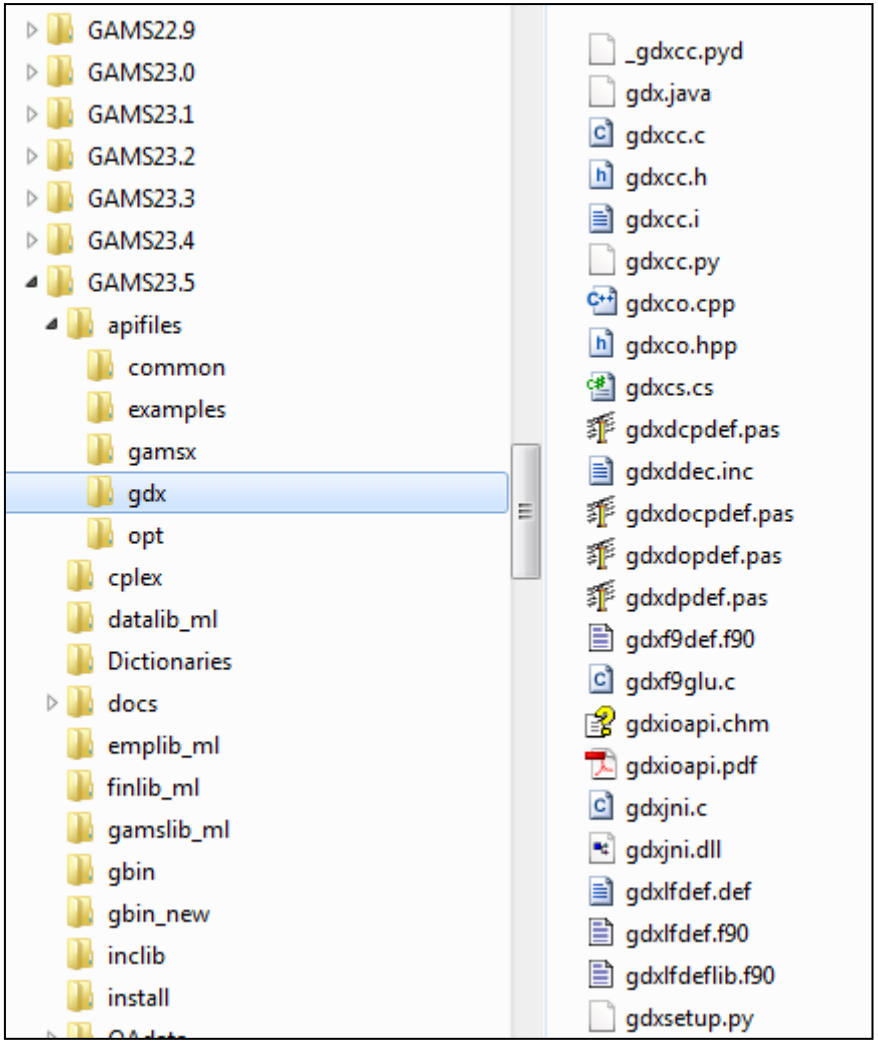
is there a Java interface for GAMS?

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){
        ReportGDXError("DataWriteStrStart");
        return false;
    }

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

    if(gdx.DataWriteDone() == 0)
        ReportGDXError("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){
        ReportGDXError("DataReadStrStart");
        return false;
    }

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

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,

…

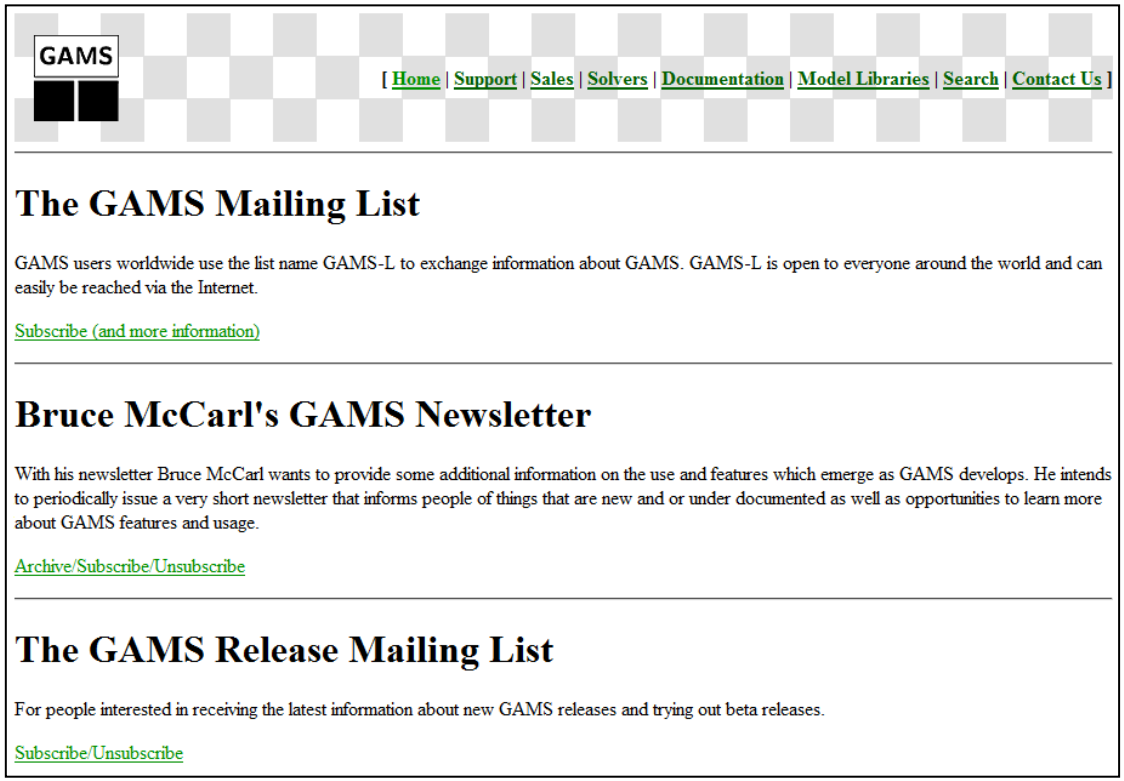
Cplex Error 1001: Out of Memory

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

How to stay Up To Date

http://www.gams.com/maillist/



GAMS

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The GAMS Mailing List

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.

Subscribe (and more information)

Bruce McCarl's GAMS Newsletter

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.

Archive/Subscribe/Unsubscribe

The GAMS Release Mailing List

For people interested in receiving the latest information about new GAMS releases and trying out beta releases.

Subscribe/Unsubscribe

Please visit us at our booth in the exhibit area!