General Algebraic Modeling System

Michael Bussieck and Alexander Meeraus

GAMS Development Corporation

ExxonMobil Optimization and Logistics Mini-Symposium
Annandale, NJ, August 2002

Introduction

Background and Motivation

GAMS Examples

MCPs and MPECS

www.gamsworld.org

Future

Change in Focus

Computation
Past

- **Algorithm limits** applications
- Problem representation is low priority
- Large costly projects
- Long development times
- Centralized expert groups
- High computational cost, mainframes
- **Users left out**

Model
Present

- **Modeling skill limits** applications
- Algebraic model representation
- Smaller projects
- Rapid development
- Decentralized modeling teams
- Low computational cost, workstations
- Machine independence
- **Users involved**

Application
Future

- **Domain expertise limits** application
- Off-the-shelf graphical user interfaces
- Links to other types of models
- Models embedded in business applications
- New computing environments
- Internet/web
- **Users hardly aware of model**

GAMS Overview

- Started as a Research Project at the World Bank 1976
- GAMS went commercial in 1987
- Opened European Office in Cologne, Germany 1996
- 10,000s of customers in over 100 countries

Basic Principles

- Separation of model and solution methods
- Models is a data base operator and/or object
- Balanced mix of declarative and procedural approaches
- Computing platform independence
- Multiple model types, solvers and platforms

Multiple model types

- LP Linear Programming
- MIP Mixed Integer Programming
- NLP Nonlinear Programming
- MCP Mixed Complementarity Programming
- MINLP Mixed Integer Nonlinear Programming
- MPEC NLP with Complementarity Constraints
- MPSGE General Equilibrium Models
- Stochastic Optimization

Supported Solvers

BDMLP	LP solver that comes with any GAMS system
CONOPT	Large scale NLP solver from ARKI Consulting and Development
CPLEX	High-performance LP/MIP solver from Ilog
DECIS	Large scale stochastic programming solver from Stanford University
DICOPT	Framework for solving MINLP models. Needs both an NLP solver and a MIP solver. From Carnegie M
MILES	MCP solver from University of Colorado at Boulder that comes with any GAMS system
MINOS	NLP solver from Stanford University
MPSGE	Modeling Environment for CGE models from University of Colorado at Boulder
OSL	High performance LP/MIP solver from IBM
OSLSE	OSL Stochastic Extension for solving stochastic models
PATH	Large scale MCP solver from University of Wisconsin at Madison
SBB	Branch-and-Bound algorithm from ARKI Consulting and Development for solving MINLP models, requi
SNOPT	Large scale SQP based NLP solver from Stanford University
XA	Large scale LP/MIP system from Sunset Software
XPRESS	High performance LP/MIP solver from Dash

Beta Solvers

BARON	Branch-And-Reduce Optimization Navigator for proven global solutions from The Optimization Firm
CONVERT	Frame work for translating models into scalar models of other languages
LGO	Lipschitz global optimizer from Pinter Consulting Services
MOSEK	Large scale LP/MIP plus conic and convex non-linear programming system from EKA Consulting
NLPEC	MPEC to NLP translator that uses other GAMS NLP solvers
OQMS	Multi-start method for global optimization from Optimal Methods Inc.
PATHNLP	Large scale NLP solver for convex problems from University of Wisconsin at Madison

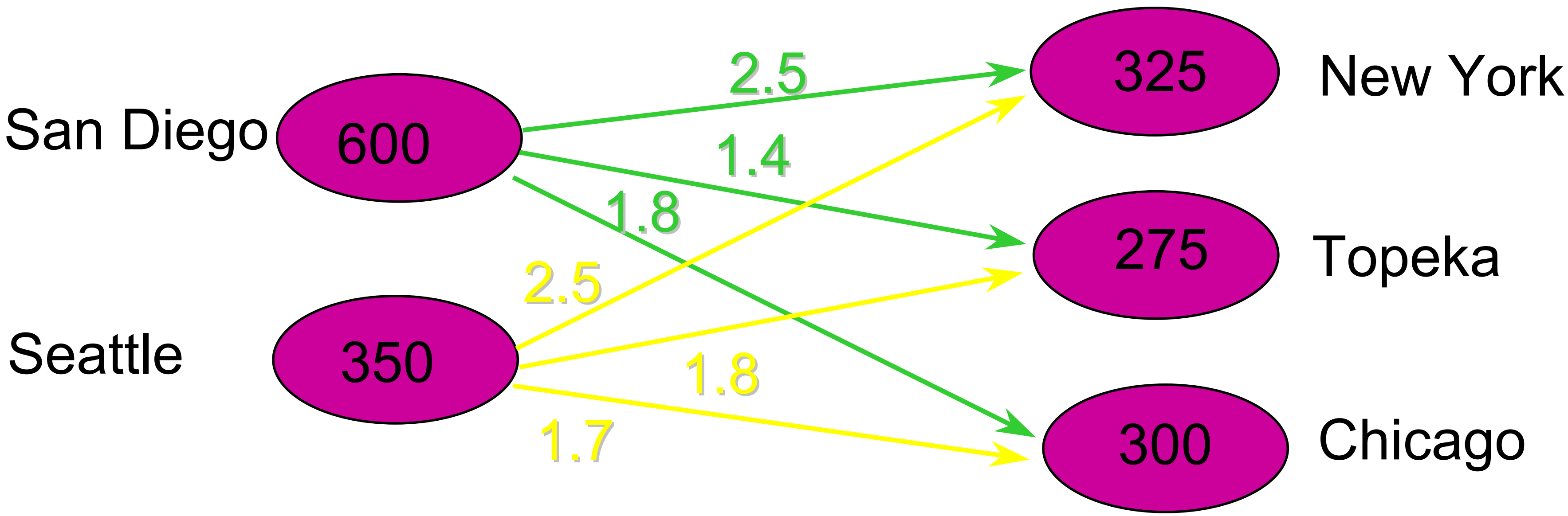
Contributed Plug&Play Solvers

AMPLwrap	Framework for using AMPL solver for GAMS models
DEA	Large scale Data Envelop Analysis Solver from University of Wisconsin at Madison
Kestrel	Framework for using remote NEOS solvers with a local GAMS system
QPwrap	Quadratic programming in GAMS

Supported Platforms

Solver/Platform availability - 20.7 June 14, 2002							
	Intel		Sun Sparc	HP 9000	DEC Alpha	IBM RS-6000	SGI
	Windows 95/98/Me/NT/2000/XP	Linux	Solaris	HP-UX 10	Digital Unix 4.0	AIX 4.3	IRIX
BDMLP	✔	✔	✔	✔	✔	✔	✔
CONOPT	✔	✔	✔	✔	✔	✔	✔
CPLEX 7.5	✔	✔	✔	✔	✔	✔	✔
DECIS	✔	✔	✔		✔		✔
DICOPT	✔	✔	✔	✔	✔	✔	✔
MILES	✔	✔	✔	✔	✔	✔	✔
MINOS	✔	✔	✔	✔	✔	✔	✔
MPSGE	✔	✔	✔	✔	✔	✔	✔
OSL V3	✔	✔	✔	✔		✔	✔
PATH	✔	✔	✔	✔	✔	✔	✔
SBB	✔	✔	✔	✔	✔	✔	✔
SNOPT	✔	✔	✔	✔	✔	✔	✔
XA	✔	✔	✔	✔	✔	✔	
XPRESS 13.02	✔	✔	✔	13.01			

Transport Example

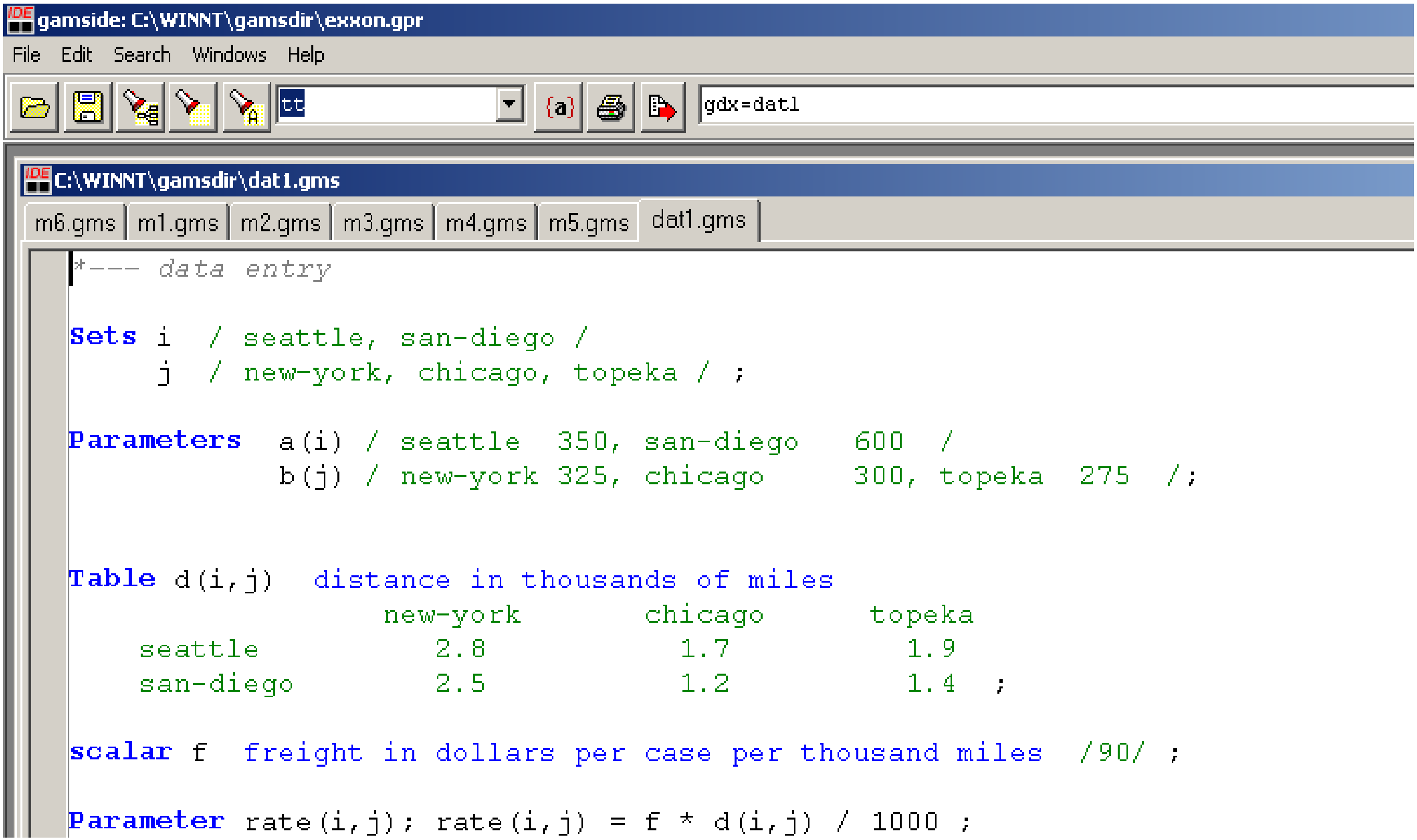


Minimize	Transportation cost
subject to	Demand satisfaction at markets
	Supply constraints

GAMS Implementation

- Using the GAMS IDE to build a model
- Data Entry
- Max/Min Shipments
- Nonlinear Cost
- MCP Formulation
- Flexible Demand
- call GAMS IDE

GAMS IDE


gamside: C:\WINNT\gamsdir\exxon.gpr
File Edit Search Windows Help
tt
gdx=dat1
C:\WINNT\gamsdir\dat1.gms
m6.gms m1.gms m2.gms m3.gms m4.gms m5.gms dat1.gms
*--- data entry
Sets i / seattle, san-diego /
j / new-york, chicago, topeka / ;
Parameters a(i) / seattle 350, san-diego 600 /
b(j) / new-york 325, chicago 300, topeka 275 /;
Table d(i,j) distance in thousands of miles
new-york chicago topeka
seattle 2.8 1.7 1.9
san-diego 2.5 1.2 1.4 ;
scalar f freight in dollars per case per thousand miles /90/ ;
Parameter rate(i,j); rate(i,j) = f * d(i,j) / 1000 ;

Model m1.gms

C:\WINNT\gamsdir\m1.gms

m6.gms | m1.gms | m2.gms | m3.gms | m4.gms | m5.gms | dat1.gms

```
sets i    canning plants
     j    markets

parameters a(i)     capacity of plant i in cases
           c(i,j)   transport cost in thousands of dollars per case
           b(j)     demand at market j in cases

Variables  x(i,j)   shipment quantities in cases
           z        total transportation costs in thousands of dollars
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) ..    a(i) =g= sum(j, x(i,j)) ;

demand(j) ..    sum(i, x(i,j))  =g=  b(j);

Model m1 /all/ ;
```

Model m1.gms (cont.)

```
Model m1 /all/ ;

$call gams dat1 gdx=dat1
$gdxin dat1
$load i j a b c=rate

*--- solve LP and store results

Solve m1 us lp min z ;

parameter rep(i,j,*) Summary Report;

rep(i,j,'lp') = x.l(i,j);
```

Min/Max Shipments

```
*  min and max shipmenst
option limcol=0,limrow=0;
scalars xmin / 100 /
        xmax / 275 /;
binary variables ship(i,j)    decision variable to ship
equations        minship(i,j) minimum shipments
                 maxship(i,j) maximum shipments ;

minship(i,j).. x(i,j) =g=   xmin*ship(i,j);
maxship(i,j).. x(i,j) =l=   xmax*ship(i,j);

model m2 min shipmenst / cost,supply,demand,minship,maxship /;
solve m2 using mip minimizing z;

rep(i,j,'mip') = x.l(i,j); display rep;
```

Nonlinear Cost

```
* nonlinear cost
equation nlcost nonlinear cost function; scalar beta;

nlcost.. z =e= sum((i,j), c(i,j)*x(i,j)**beta);
model m3 / nlcost,supply,demand /;

beta = 1.5; solve m3 using nlp minimizing z;
rep(i,j,'nlp-convex') = x.l(i,j);

beta = 0.6; solve m3 using nlp minimizing z;
rep(i,j,'nlp-non') = x.l(i,j);

option nlp=baron; solve m3 using nlp minimizing z;
rep(i,j,'nlp-baron') = x.l(i,j); display rep;
```

Min/Max and NL objective

```
* min/max and nl obj

model m4 / nlcost,supply,demand, minship,maxship /;

option minlp=baron; solve m4 using minlp minimizing z;
option nlp  =snopt;         option optcr=0;
option minlp=sbb; solve m4 using minlp minimizing z;

rep(i,j,'minlp') = x.l(i,j); display rep;
```

MCP Formulation

```
* lp as mcp
positive variables w(i) shadow price at supply node
                   p(j) shadow price at demand node;

equations profit(i,j) zero profit condition;

profit(i,j).. w(i) + c(i,j) =g= p(j);

model m5 / profit.x, supply.w, demand.p /;

solve m5 using mcp;

rep(i,j,'mcp') = x.l(i,j); display rep;
```

Flexible Demand

```
* flexible demand
parameter pbar(j) reference price
                  esub(j) price elasticity
                / new-york 1.5, chicago 1.2, topeka 2.0 /;
equation flexdemand(j) price responsive demand;
flexdemand(j).. sum(i, x(i,j)) =g= b(j)*(pbar(j)/p(j))**esub(j);
model m6 / profit.x, supply.w, flexdemand.p /;

pbar(j) = p.l(j); solve m6 using mcp; rep(i,j,'mcp-flex') = x.l(i,j);
```

Counter Factual

```
* counter factual
c('seattle',j) = 2.0*c('seattle',j);

solve m5 using mcp; rep(i,j,'cf-fix‘ ) = x.l(i,j);
solve m6 using mcp; rep(i,j,'cf-flex') = x.l(i,j);
display rep;

$libinclude xldump rep rep
```

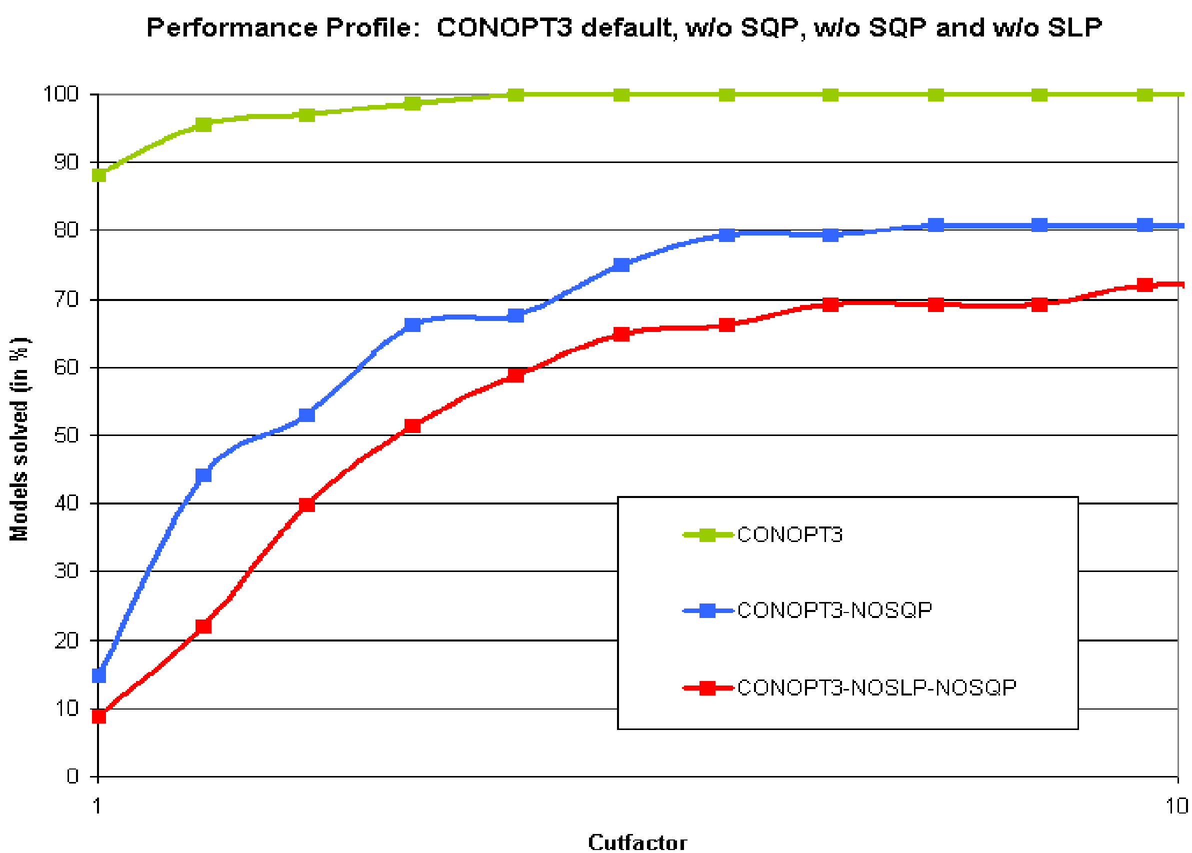
Summary Result

		lp	mip	nlp-convex	nlp-non	nlp-baron	minlp	mcp	mcp-flex	cf-fix	cf-flex
seattle	new-york	300	200	144.1625		325	225	300	300		
seattle	chicago		100	99.76905	25		100			300	
seattle	topeka			96.7684	275						
san-diego	new-york	25	125	180.8375	325		100	25	25	325	244.8687
san-diego	chicago	300	200	200.2309	275	300	200	300	300		202.4646
san-diego	topeka	275	275	178.2316		275	275	275	275	275	152.6666

New Technologies

- Second order derivatives:
  - CONOPT3 multi-method NLP solver
  - PATHNLP solves NLP as an MCP
- GAMS Data Exchange (GDX) provides platform independent data transfer and mapping facilities.
- MCP and MPEC model types

CONOPT3 Performance



Definition of MCP

$$\text{Find } y \text{ such that}$$
$$h(y) \perp y \in \boldsymbol{B} = \{y \mid a \leq y \leq b\}$$

The variable y "complements" the function h

$$\text{Exactly one of}$$
$$\begin{array}{ll} (a)\ a_i < y_i < b_i & \text{and } h_i(y) = 0 \\ (b)\ y_i = a_i & \text{and } h_i(y) \geq 0 \\ (c)\ y_i = b_i & \text{and } h_i(y) \leq 0 \end{array}$$

Special Cases

Nonlinear equations:

$$a_i = -\infty, b_i = +\infty \;\Rightarrow\; h_i(y) = 0$$

Nonlinear complementarity:

$$a_i = 0, b_i = +\infty \;\Rightarrow\; 0 \leq y_i,\; h_i(y) \geq 0$$
$$y_i h_i(y) = 0$$

$$\text{Key: either } y_i = 0 \text{ or } h_i(y) = 0$$

GAMS Model

```
* data specified i,j,A,b,c,g
positive variables p(i), z(j);
equations S(i), L(j);
S(i).. b(i) + sum(j, A(i,j)*z(j))
          - c(i)*sum(k, g(k)*p(k)) / p(i) =g= 0;
L(j).. - sum(i, p(i)*A(i,j)) =g= 0;
model walras /S.p, L.z/;
solve walras using mcp;
```

Definition of MPEC

$$\text{minimize } f(x,y)$$
$$\text{such that } g(x,y) \leq 0$$

Add complementarity to definition of h; parameter x

$$h(x,y) \perp y \in \boldsymbol{B}$$

Theory hard; no constraint qualification

NCP Functions

$$\text{Definition} \ : \ \phi(r,t) = 0 \Leftrightarrow 0 \le r \perp t \ge 0$$

$$\text{Example} \ : \ \phi_{min}(r,t) = \min\{r,t\}$$

$$\text{Example} \ : \ \phi_F(r,t) = \sqrt{r^2 + t^2} - r - t$$

$$\text{Componentwise definition} \ : \Phi_i(x,y) = \phi(h_i(x,y), y_i) = 0$$

$$\Phi(x,y) = 0 \Leftrightarrow 0 \le h(x,y) \perp y \ge 0$$

MPEC Approaches

- Implicit: $\min f(x,y(x))$
- Auxiliary variables: $s = h(x,y)$
- NCP functions: $\Phi(s,y) = 0$
- Smoothing: $\Phi_\mu(s,y) = 0$
- Penalization: $\min f(x,y) + \mu \{s'y\}$
- Relaxation: $s'y <= \mu$
- Different problem classes require different solution techniques

Parametric algorithm NLPEC

- **Equreform = 1**
- **Initmu = 0.01**
- **Numsolves = 5**
- **Updatefac = 0.1**
- **Finalmu = 0**
- **Initslo = 0**

$$
\begin{gathered}
\text{NLP}\,(\mu) : \min f(x,y) \\
g(x,y) \leq 0 \\
s = h(x,y) \\
0 \leq s, \; y \geq 0 \\
s_i y_i = \mu
\end{gathered}
$$

Reformulate problem and set up sequence of solves

Running NLPEC

- Create the GAMS model as an MPEC
- Setup nlpec.opt
  - `Gams modelfile mpec=nlpec optfile=1`
- Reformulated automatically
- Results returned directly to GAMS

Benefits/Drawbacks

- Easy to adapt existing models
- Large-scale potential
- Customizable solution to problem
- Available within GAMS right now
- Models hard to solve
- Local solutions found
- Scarcity of MPEC models

Frontiers

- Find all or multiple equilibria
  - Use nlp=baron parametrically
- Structural identification
  - Inverse problems
- Optimal tariff calculations
  - Large-scale datasets
- Stackelberg (leader/follower) games

Thin or Zero client modeling

- Model and modeling system reside on application server

- Prototype user and data interfaces with Excel style data exchange

- Model submission via e-mail or web

- Model results delivered via the web and e-mail with Excel style attachements

Excel Data

tnetsdb.xls [Read-Only]

	H	I	J	K	L	M	N	O	P	Q	R
1	tnetid	Site	*Requestor	*Category	*Procedure	Test Object Avail	*Twin/Single/Envir	Req Ref No	*Req Comp. Date	*Sample Count	Runs Per Sample
2	WD3PVQ	APTL	pkuchta	EMISSIONS	NS06	72556	single	none	3-Nov-01	2	1
3	WD3QE9	APTL	pkuchta	EMISSIONS	COMBO	72556	single	none	8-Nov-01	2	1
4	WD3QM5	APTL	pkuchta	DIESEL	EPA75_D	72556	single	none	9-Nov-01	2	1
5	WD3P09	APTL	pkuchta	EMISSIONS	NS67	84369	single	none	19-Oct-01	4	1
6	WD3PVR	APTL	pkuchta	EMISSIONS	NS06	86997	single	none	3-Nov-01	2	1
7	WD3QED	APTL	pkuchta	EMISSIONS	COMBO	86997	single	none	14-Nov-01	2	1
8	WD3QM6	APTL	pkuchta	DIESEL	HWFET_D	86997	single	none	9-Nov-01	2	1
9	WD3N64	APTL	ehunsang	EMISSIONS	NS103	90786	single	none	5-Oct-01	3	1
10	WD3N65	APTL	ehunsang	EMISSIONS	NS06	90786	single	none	5-Oct-01	3	1
11	WD3N66	APTL	ehunsang	EMISSIONS	NS06	90786	single	none	6-Oct-01	3	1
12	WD3NKB	APTL	ehunsang	EMISSIONS	NS61	90786	single	none	12-Oct-01	3	1
13	WD3NLG	APTL	ehunsang	EMISSIONS	COMBO	90786	single	none	12-Oct-01	3	1
14	WD3RAY	APTL	ehunsang	EMISSIONS	NS06	90786	single	none	9-Dec-01	1	1
15	WD3HT5	APTL	ehunsang	EMISSIONS	NS77	91306	single	none	20-Oct-01	2	1
16	WD3HU5	APTL	ehunsang	EMISS							
17	WD3N68	APTL	ehunsang	EMISS							
18	[illegible]	APTL	ehunsang	[illegible]							

tnet / cap / schedule / except / stats

tnetsdb.xls [Read-Only]

	A	B	C	D
28	**Objective Weights**			
29	Early start	0.10		Range 0-1
30	Completion Date	0.10		Range 0-1
31	Department Profile	1.00		Range 0-1
32	Enforce prototype tracking	1.00		Range 0-1
33				
34	**Fixed Week-1 Tests**			
35	WD3NN2			

Data Interface inside GAMS

E:\gams\projects\tnet\cd\gms\dr.gms

m6.gms | m1.gms | m2.gms | m3.gms | m4.gms | m5.gms | dat1.gms | m1.lst | dr.gms

```
* Data reading module

$onecho > xlsin.txt
par=tnet  dim=9 rng=tnet!h1:r65536
par=capf  dim=2 rng=cap!a2:e8
par=dp   rdim=1 rng=cap!b13:c26
par=objw rdim=1 rng=cap!a29:b32
par=sd   cdim=0 rng=cap!b10:b10
sset=fix rdim=1 rng=cap!a35:a65536
$offecho

$if not set xlsname $set xlsname tnetnew.xls

$call =gdxxrw %xlsname%    @xlsin.txt log=con
$if errorlevel 1 $abort 'Reading TNet input sheet'
```

Excel Data

ictdw.xls [Read-Only]

	A	B	C	
66	Flavors:	Lvolmet	Low vol m	
67		Mvolmet	Medium vo	
68		Hvolmet	High vol m	
69		Semiscc	Semi-soft	
70		Ls-lbtu	Low sulfur	
71		Ls-hbtu	Low sulfur	
72		Ms-hbtu	Medium su	
73		Ms-lbtu	Medium su	
74		Hssteam	High sulfu	
75		Vlowbtu	Very low b	
76				
77	Flavor/Sector Map		Met	Th
78		Lvolmet	y	
79		Mvolmet	y	
80		Hvolmet	y	
81		Semiscc	y	
82		Ls-lbtu	n	
83		Ls-hbtu	n	
84		Ms-hbtu	n	
85		Ms-lbtu	n	
86		Hssteam	n	
87		Vlowbtu	n	

ictdw.xls [Read-Only]

	A	B	C	D	E	F	G	H
46	Table MDATA starts below:							
47				PRICE	RESERVES	CAPACITY	PSCALE	QSCALE
48	Alas	Vlowbtu	1	12.3	30.00		0.5	0.4
49	Alas	Vlowbtu	2	19.5	3.00			0.4
50	Alas	Vlowbtu	3	20.4	45.00	0.5	0.5	0.4
51	Alas	Vlowbtu	4	999	999.00	99		
52	Canw	Lvolmet	1	23.77	101.00	4.3	0.5	0.4
53	Canw	Lvolmet	2	23.98	173.00	5.6	0.5	0.4
54	Canw	Lvolmet	3	24.01	25.00	0.0	0.5	0.4
55	Canw	Lvolmet	4	28.68	3.55	2.2	0.5	0.4
56	Canw	Lvolmet	5	28.80	35.50	2.6	0.5	0.4
57	Canw	Lvolmet	6	999	999.00	99		
58	Canw	Mvolmet	1	24.77	109.00	4.6	0.5	0.4
59	Canw	Mvolmet	2	26.25	109.00	4.2	0.5	0.4
60	Canw	Mvolmet	3	999	999.00	99		
61	Canw	Semiscc	1	21.04	35.00	1.7	0.5	0.4
62	Canw	Semiscc	2	25.77	7.00	0.3	0.5	0.4
63	Canw	Semiscc	3	27.25	5.00	0.2	0.5	0.4
64	Canw	Semiscc	4	999	999.00	99		
65	Canw	Ls-lbtu	1	13.08	3.00	0.3	0.5	0.4
66	Canw	Ls-lbtu	2	16.18	4.30	1.0	0.5	0.4
67	Canw	Ls-lbtu	3	17.50	33.60	1.6	0.5	0.4
68	Canw	Ls-lbtu	4	20.04	23.00	0.7		
69	Canw	Ls-lbtu	5	999	999.00	99		
70	Canw	Ls-hbtu	1	24.48	15.00	0.0	0.5	0.4
71	Canw	Ls-hbtu	2	29.30	7.70	0.6	0.5	0.4
72	Canw	Ls-hbtu	3	999	999.00	99		

Ready

Data Interface inside Excel

ictdw.xls [Read-Only]

	A	B	C	D	E	F
1	**ICT Setup**					
2						
3	**Type**	**GAMS Name**	**Rng**			
4	PAR	Cdata	CDATA!A13			
5	PAR	CPar	CPAR!A17			
6	PAR	Ddata	DDATA!A22			
7	PAR	Globrate	GLOBRATE!A			
8	PAR	Hr	HR!A12			
9	PAR	Mdata	MDATA_DEL			
10	PAR	Mprice	MPRICE!A4			
11	PAR	Newportc	NEWPORTC!			
12	PAR	Odata	ODATA!A19			
13	PAR	Pdata	PDATA!A13			
14	PAR	Pdatmin	PDATMIN!A1			
15	PAR	Prodmin	PRODMIN!A1			
16	PAR	Qfmaxdat	QFMAXDAT!A			
17	PAR	Qfmindat	QFMINDAT!A			
18	PAR	Qmaxdat	QMAXDAT!A9			
19	PAR	Qmindat	QMINDAT!A1			
20	PAR	Rate	RATE!A32			
21	PAR	Tdata	TDATA!A13	2		
22	SSET	I	Exporters		1	
23	SSET	J	Importers		1	
24	SSET	K	Flavors		1	
25	SSET	BR	BRegions		1	
26	SET	KL	FSMap	2		
27	SET	BRI	RegExpMap	2		
28	SET	BRJ	RegImpMap	2		

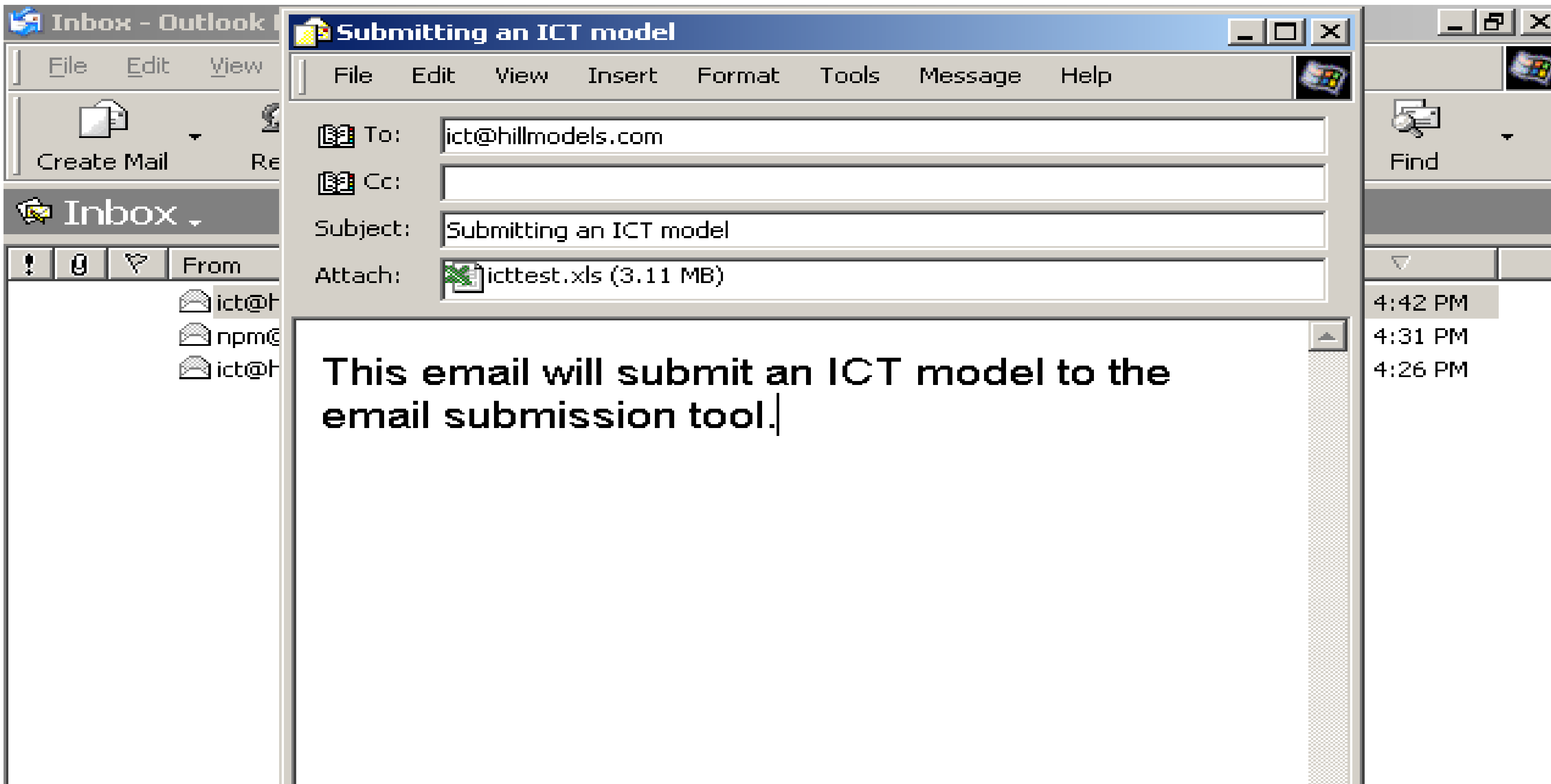
E:\gams\projects\ICT\060602\ict_011.gms

m6.gms | m1.gms | m2.gms | m3.gms | m4.gms | m5.gms | dat1.gms | m1.lst | dr.gms | ict_011.gms

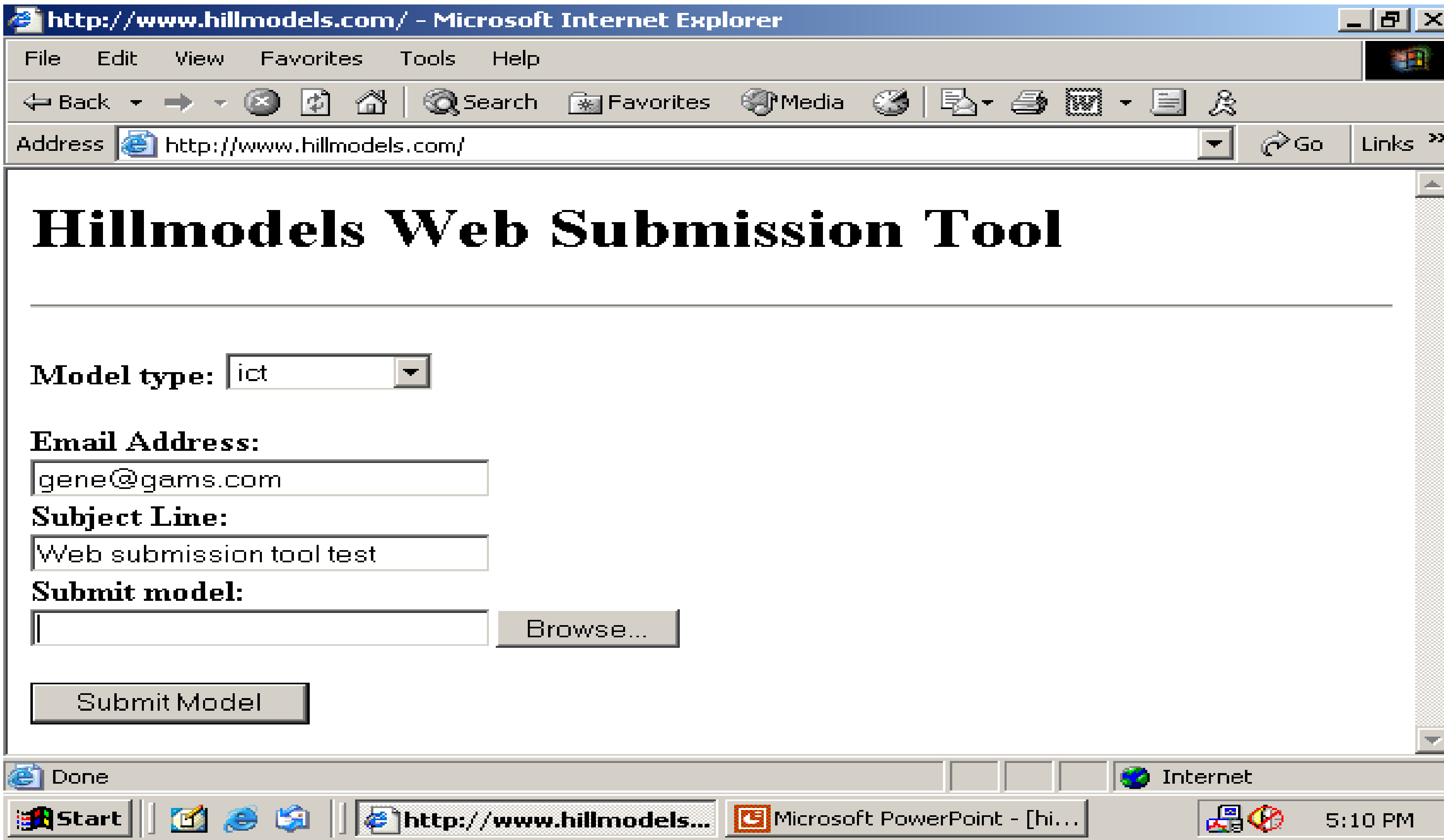
```
* Get data from the Excel file
$call gdxxrw %xlsfile% o=ictin.gdx index=ictparms
$gdxin ictin.gdx


$load I J K KL BR BRI BRJ
$load Cdata CPar Ddata Globrate Hr Mdata Mprice
$load Newportc Odata Pdata Pdatmin Prodmin Qfmaxdat
$load Qfmindat Qmaxdat Qmindat Rate Tdata
```

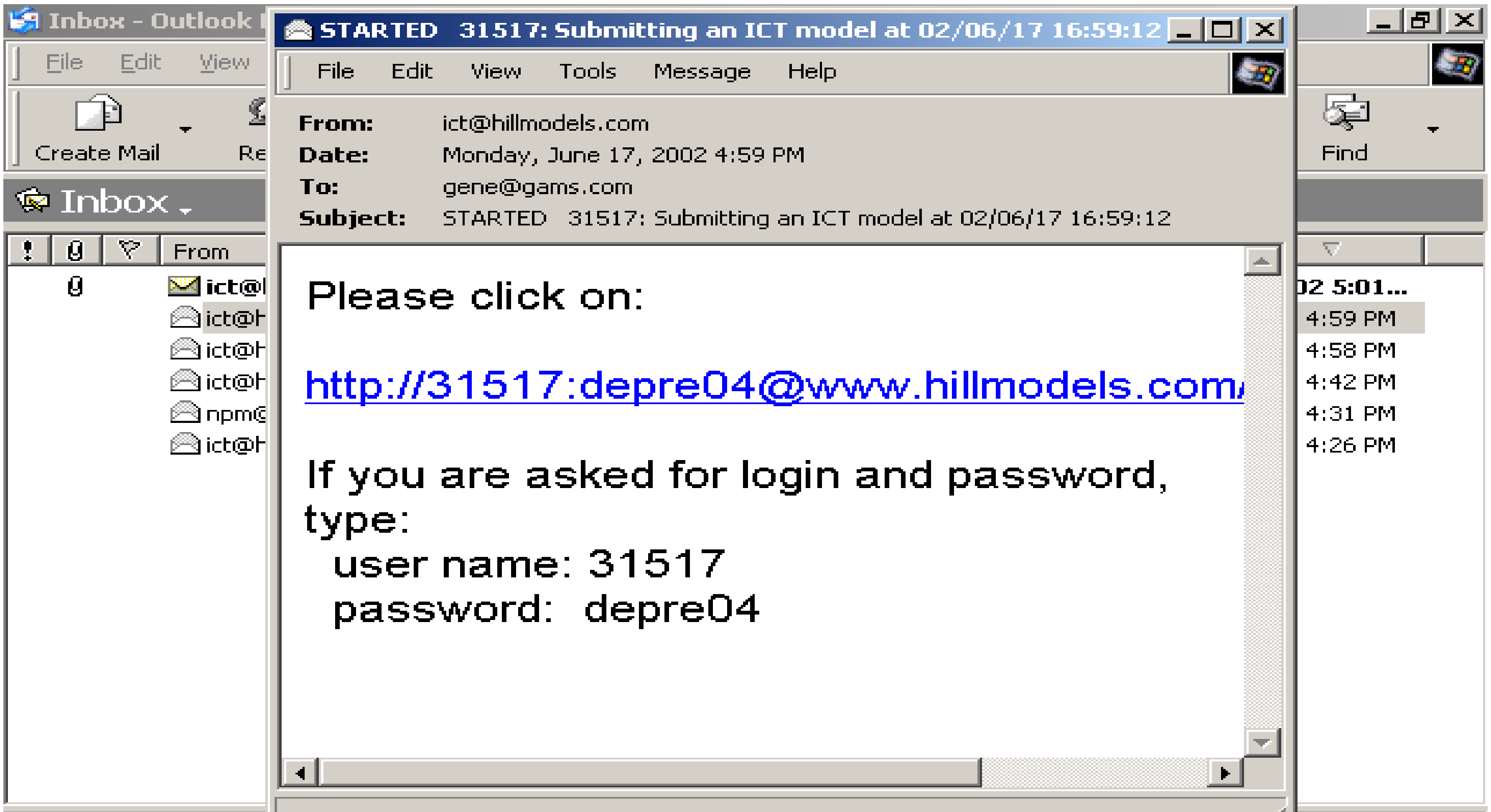
E-mail Submission



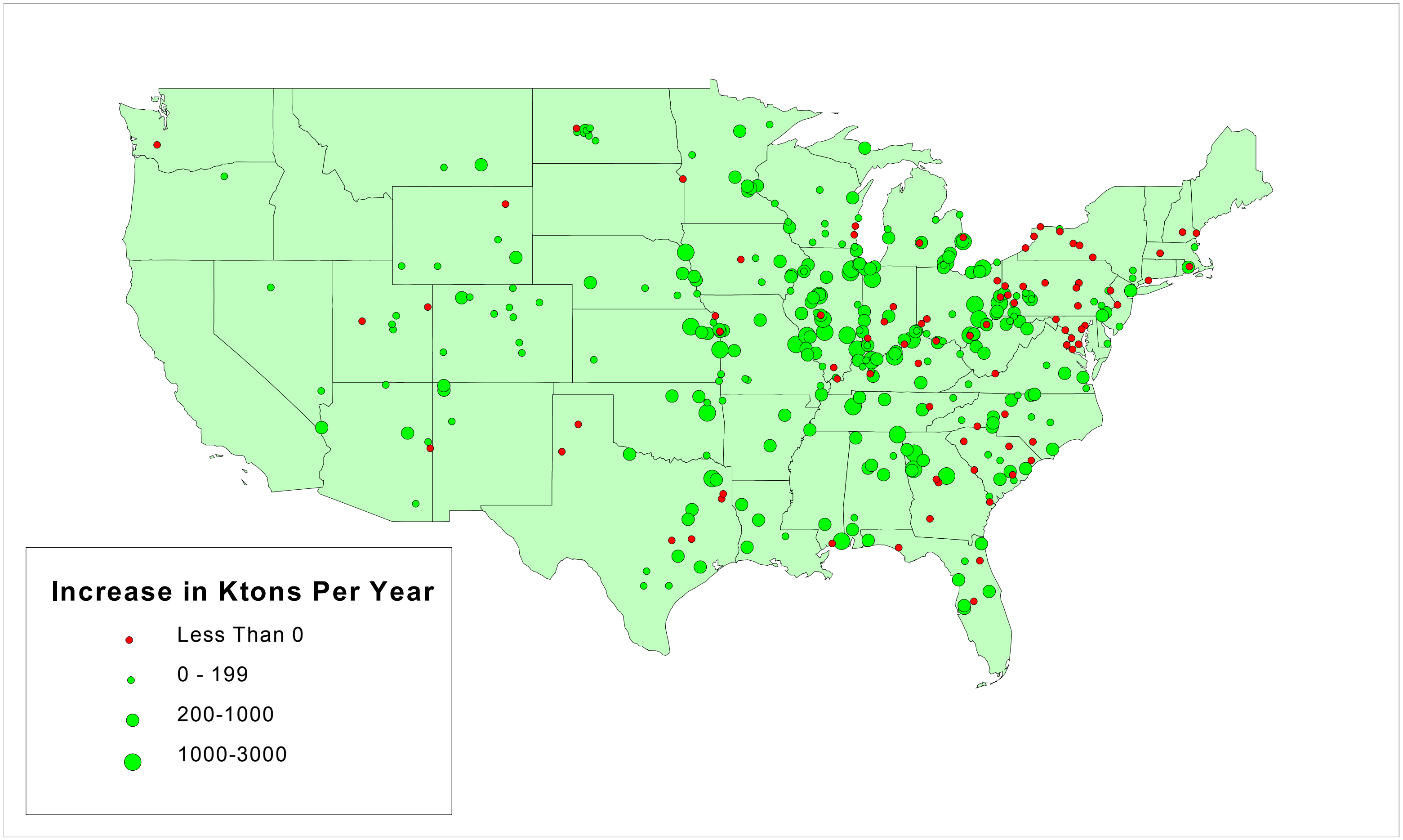
Web Submission



Job Info Via e-mail



Result Presentation



GAMS World Home Page

GAMS World

The Worlds
- GLOBAL
- MINLP
- MPEC
- MPSGE
- Performance
- Translation

Search

Contact

Welcome to the GAMS World

This is the home page of the GAMS World, a web site aiming to bridge the gap between academia and industry by providing highly focused forums and dissemination services in specialized areas of mathematical programming.

Substantial progress was made in the 1980s and 1990s with the development of algebra based modeling systems, algorithms, and computer codes to solve large and complex mathematical programs. The application of these tools, however, was less than expected. The abstraction, expression, and translation of real world problems into reliable and effective operational systems requires highly specialized and domains specific knowledge. The process of acquisition and dissemination of this knowledge is complex and poorly understood and the number of "good modelers" is much less than we all hoped for. Similarly, the process of transforming a new algorithm into a reliable and effective solution system is a slow and expensive process and there are few "good implementers". This web site hopes to address some of these problems by helping with the collection and dissemination of domain specific information and knowledge that is outside the established channels because of its content or form.

For example, model structures and results get published in commercial and academic papers but it is virtually impossible to reproduce any of those results or lift model components and data from one study to be used in some other study. Algorithm implementers face a similar dilemma when trying to get their hands on real world data models and data to test and refine their systems. This web site offers a few, well focused and maintained services to help with the dissemination of problems and solutions.

GAMS World is featured by GAMS Development Corp. and GAMS Software GmbH

Purpose of GAMS World

…a web site aiming to bridge the gap between academia and industry by providing highly focused forums and dissemination services in specialized areas of mathematical programming.

Substantial progress in the 1980s and 1990s …. application of these tools less than expected …. abstraction, expression, and translation of real world requires highly specialized and domains specific knowledge … process of acquisition and dissemination of this knowledge is complex and poorly understood…process of transforming a new algorithm into a reliable and effective solution system is a slow and expensive…helping with the collection and dissemination of domain specific information and knowledge that is outside the established channels because of its content or form.

MINLP World Home Page

MINLP World

- Editorial Board
- MINLPLib
- MINLP Solvers
- MINLP List
- Related Links
- Search
- Contact

Welcome to the MINLP World!

MINLP World is a forum for discussion and dissemination of information about all aspects of Mixed Integer Nonlinear Programming (MINLP).

MINLP models are models that combine combinatorial aspects with nonlinearities. MINLP models are much more difficult than both Mixed Integer Linear Programming (MIP) and Nonlinear Programming (NLP) models.

MINLP is still a new field, and we cannot yet solve all the problems that naturally fall within this area. It is the purpose of this site to bring people that work with MINLP together. We are interested in practical software (MINLP Solvers), testing, comparison, and quality of solvers (MINLPLib), research in both solution methods and in good model formulations, and in improving the communication between people interested in these topics (Related Links and MINLP list).

MINLP World is featured by GAMS World

MPEC World Home Page

MPEC World

- Editorial Board
- MPECLib
- MPEC Solvers
- MPEC List
- Related Links
- Search
- Contact

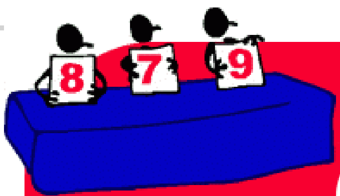
Welcome to the MPEC World!

MPEC World is a forum for discussion and dissemination of information about all aspects of Mathematical Programs with Equilibrium Constraints (MPEC).

MPEC is a relatively new field (not nearly so mature as LP or NLP), and we cannot yet solve many of the problems that naturally fall within this area. It is the purpose of this site to bring people that work with MPEC together. We are interested in practical software (MPEC Solvers), testing, comparison, and quality of solvers (MPECLib), research in both solution methods and in good model formulations, and in improving the communication between people interested in these topics (Related Links and MPEC list).

MINLP World is featured by GAMS World

Performance Home Page



Performance World

- Editorial Board
- PerformanceLib
- Performance Tools
- Performance List
- Related Links
- Search
- Contact

Welcome to the Performance World!

Performance World is a forum for discussion and dissemination of information and tools about all aspects of performance testing of mathematical programming problems. This world has been established in response to user demands for independent and reproducible performance results.

Overall performance highly depends on problem formulation, solver, and tuning parameters. Our performance tools are designed to serve the different needs of our user community. One user may be interested in finding the most reliable way to solve a proprietary or classified model. On the other hand, an academic researcher may be interested in testing a new algorithm against a set of existing test problems and competing approaches. The main features are:

- Uniform access to a comprehensive set of established and new test problems
- Automation tools for collecting performance measurements
- Tools for analyzing and visualizing test results

What's New:

- Try our online PAVER Server for automated performance analysis and batch file creation
- New tools for analyzing non-convex or discrete models
- MINLP type models from the MINLP World have been added to the PerformanceLib A tutorial (August, 2002)

Translation Services

[GAMS World Home | GMS2XX Translator | Search | Contact]

Instructions

In order to use the GMS2XX translation service which is based on the "solver" GAMS/CONVERT you have to attach your model to an email and send it to our translation server at gms2xx@gamsworld.org. You specify the language in the subject line, for example

```
Subject: GAMS
```

At the moment we support the following *languages*:

- AMPL
- BARON
- CplexLP
- CplexMPS
- GAMS
- LGO
- LINGO
- MINOPT
- ALL (this creates scalar versions of all supported languages, listed above)

Global World Home Page

GLOBAL World

- Editorial Board
- GLOBALLib
- GLOBAL Solvers
- GLOBAL List
- Related Links
- Search
- Contact

Welcome to GLOBAL World!

The Global World is a forum for discussion and dissemination of all aspects of computational methods to find global optimal solutions to nonconvex nonlinear optimization problems.

Recently, general purpose global solution algorithms have been implemented and have matured into reliable solution systems that can be connected to modeling systems. These new developments make the application of nonlinear global optimization methods available to users outside the narrow global research community.

General purpose global nonlinear optimization is a new field and much work needs to be done to test the capabilities and robustness on real world models. We are interested in practical software (see GLOBAL Solvers) and an ever growing, well maintained library of academic and practical client test problems in the GLOBAL Library. Communication is supported by maintaining the GLOBAL list server and related links.

For other specialized topics in the are of mathematical programming consult the GAMS World.

GLOBAL World is featured by GAMS World

GAMS/GLOBAL Solvers

The solvers differ in the methods they use, in whether they find globally optimal solution with proven optimality, and in the size of models they can handle, and in the format of models they accept.

BARON. Branch-and-Reduce algorithm from N. Sahinidis, University of Illinois Urbana-Champaign

LGO. Lipschitz Global Optimization from Pinter Consulting Services, Canada

OQMS. OptQuest/NLP algorithms by OptTek Systems and Optimal Methods

BARON

BARON is a computational system for solving non convex optimization problems to global optimality. Purely continuous, purely integer, and mixed-integer nonlinear problems can be solved with the software. The Branch And Reduce Optimization Navigator derives its name from its combining interval analysis and duality in its reduce arsenal with enhanced branch and bound concepts as it winds its way through the hills and valleys of complex optimization problems in search of global solutions.

LGO

LGO combines rigorous statistical methods with traditional mathematical programming methods to find solutions within well defined bounds. Tailored versions of LGO have been applied successfully in number of large scale special purpose applications.

GAMS

OQMS

OQMS. This system combines existing the robust nonlinear optimization technologies with OptTek's state-of-the-art metaheuristic search procedures, including Tabu Search, Neural Networks, and Scatter Search, into a single composite method.

Future Directions

- Value Added Applications
- Solution Service Providers
- Distributed System Architectures
- New Solution Approaches
- Continued Changes in the Modeling 'Industry'

Contacting GAMS Development

GAMS can be contacted at this address:

GAMS Development Corporation
1217 Potomac Street, NW
Washington, DC 20007
USA
Phone: (202) 342-0180
Fax: (202) 342-0181

If you prefer e-mail, here are some important addresses:

General Information and Sales: sales@gams.com
Customer Support: support@gams.com
Webmaster: webmaster@gams.com

In Europe you can contact us at this address:

GAMS Software GmbH
Eupener Str. 135-137
50933 Cologne
Germany
Phone: (+49) 221 949-9170
Fax: (+49) 221 949-9171

The central e-mail address for our European office is: info@gams.de