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I am involved with two main forms of GAMS usage

1. Instructor/Advisor to many students
2. Large scale model building in applied research and consulting settings



Today's Messages

1. GAMS allows you to add features to facilitate your usage -- I will present an example
2. Your potential use of a GAMS based modeling support package I have developed



Background

Given my diverse usages I needed a

1. Package which would help portray student models to them or me to aid in instruction and research
2. Package which could help me debug big models



Solution

Developed new GAMS “solvers”

| | |
|---------|---------------------------------------|
| GAMCHK | Pre and post solution portrayal tools |
| GAMSBAS | Basis saver |
| GAMSMAP | Model component file mapper |

Discussion Points

Solver capabilities -- will discuss GAMCHK
How solvers were developed



GAMSCHK Capabilities

Pre optimization - Formulation Checking

Show selected variables and equations

Picture elements or blocks

Examine for obvious misspecifications

Summarize scaling and structure

Post optimization - Solution Checking

Reconstruct reduced cost or equation activity

Help in finding unbounded or infeasible cause



Example of GAMSCHK Preopt Picture

| | D | O | S | W | M | I | O | R | A | O | R | O | V | E | A | A | E | I | L | D | L | D | T | T | T | R | A | R | A | A | A | A | R | H | S | | |
|--------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OBJ | + | - | - | - | - | - | - | - | - | - | - | - | + | - | + | + | - | - | + | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | E | 0 | |
| RAWGRADEA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | + |
| RAWMANU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | + |
| RAWUNREG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | + |
| MINMVRDEA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| MAXMVRDEA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| MINGRDACL1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| UNREGFLUID | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| RAWMILKIN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | 0 |
| MILKPRODIN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | 0 |
| MINRESERVE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | - |
| TRNRESERVE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | 0 |
| CAPACITLIM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| MIXLIMIT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | 0 |
| WHEYLIM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | 0 |
| MILKPRDOUT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| MINCLLOWN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| IMPORTMIN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| IMPORTMAX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| EXPORTMIN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| EXPORTMAX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| RAWIMPMIN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| RAWIMPMAX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| RAWEXPMIN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| RAWEXPMAX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| BALPRIORITY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | + |
| MINPRIORITY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| MAXPRIORITY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| BALGOVTSTK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | + |
| MINGOVTSTK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | - |
| MAXGOVTSTK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | L | + |
| Variable Typ | u | + | + | + | + | + | + | + | + | + | + | u | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | |

EQUATIONS-3408

VARIABLES-29931

NONZEROS-96700



Example of GAMSCHK Preopt Analysis & Display

Analysis of Equations

(nonlinear terms at current point)

```
**** Warning  This =L= constraint causes all
              variables in it to have a zero solution v.
              since the nonnegative variables present
                  have only 0 or + coefficients
              the nonpositive variables present
                  have only 0 or - coefficients
              the unrestricted variables
                  have only zero coefficients
              and the rhs is zero.
```

```
##          MILKPRODIN( GRLOUIS , Q1 , DRYCHDWHEY )
            MILKPRODIN( GRLOUIS , Q1 , DRYMOTWHEY )
            MILKPRODIN( NORLEANS , Q1 , DRYCHDWHEY )
            MILKPRODIN( NORLEANS , Q1 , DRYMOTWHEY )
```

Display

```
## MILKPRODIN( GRLOUIS , Q1 , DRYCHDWHEY )

MAKEMIX( GRLOUIS , Q1 , ICECRMMIX , DRYCHDWHEY )      1.0000
=L= 0.00000E+00
```



Example of GAMSCHK Postopt

----## VAR TRANSPORT - Reduced Cost

```
## TRANSPORT(PLANT3, TABLES, FUNCTIONAL)
  SOLUTION VALUE .000000E+00

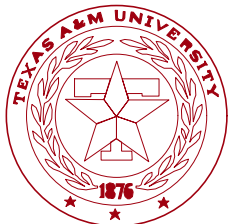
  EQN           Aij           Ui           Aij*Ui
  OBJT           20.000         1.0000         20.000
  LINKTABLE(FUNCTIONAL) -1.0000         212.00        -212.00
  TRNTABLEEQ(PLANT3, FUNCTIONAL) 1.0000         200.00         200.00
  TRUE REDUCED COST 8.0000
```

----## EQU LINKTABLE - Activity in Equation

```
## LINKTABLE(FANCY)

  VAR           Aij           Xj           Aij*Xj
  MAKETABLE(PLANT1, FANCY) -1.0000         20.360         -20.360
  TRANSPORT(PLANT3, TABLES, FANCY) -1.0000         8.6487         -8.6487
  SELL(PLANT1, TABLES, FANCY) 1.0000         .00000E+00     .00000E+00
  SELL(PLANT1, DINSETS, FANCY) 1.0000         29.009         29.009
  =L=
  RHS COEFF .00000E+00

  SLACK EQUALS .00000E+00
```



How Solvers Were Developed

My approach required the usage of the model matrix file

Thus when GAMS set up problem to solve I wanted a copy

I might then want to solve and do postoptimality calculations or do preoptimality processing

I worked with GAMS Development Corporation to achieve goals



Steps to Implementation

1. Use GAMS Iolibrary (available in Fortran or C) procedures to access problem input and pass back output
2. Write Fortran code for my processes
3. Compile modules for multiple machines
4. Create batch files for multiple machines
5. Include in GAMS installation as allowed solver



Comments

Solver was unique in needing things beyond needs of conventional solvers.

- Unscaled or scaled data
- Multiple passes on one matrix
- Solved or unsolved model

GAMS was most supportive and accomodating

- Special code written to supply needed data
- Bugs fixed in my and their code

Procedures now generally available

- PC, SUN, HP7000, DEC Alpha, IBM RS6000
- Free through WWW
agrinet.tamu.edu/mccarl



Implications for Potential GAMS Users

1. Those wishing to solve particular problems

- a. Many different solvers can and have been interfaced
LP, NLP , MIP, MINLP, CGE, Equation solver
- b. GAMS has tools to facilitate your interface

2. Modelers

- a. GAMS supports analysis of large models
- b. GAMSCHK/GAMSBAS/GAMSMAP supports
debugging, use and computer efficiency

