

## Bruce McCarl's GAMS Newsletter Number 36

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### 1 Updates to Expanded GAMS User Guide by McCarl et al.

I updated the Expanded User’s Guide to reflect the items discussed here with a few other changes. The latest can be found at <http://www.gams.com/dd/docs/bigdocs/gams2002/mccarlgamsuserguide.pdf> and will be in upcoming GAMS releases.

### 2 Updates to GAMS

#### 2.1 Singleton sets

As of release 24.3.1 GAMS introduced a new type of set which is called a Singleton Set. This is a special case of a GAMS Set which has at most a single element (it may also be empty with zero elements). Singleton Sets can be used in assignment statements without being controlled by a controlling index operator.

The syntax is

```

Singleton set      s /oneelement/
Set                a /a1*a3/
Set                b /b1*b3/
Singleton set      subsetofa(a) /a1/
Singleton set      subsetofb(b) /b3/
Singleton set      multidim(a,b) /a2.b3/ ;

```

where s, subsetofa and multidim are singleton sets in simple set, subset and tuple forms

In addition when assigning to the set it is automatically cleared out first thus

```

Subsetofa ("a1")=yes;
Subsetofa ("a2")=yes;

```

would result in Subsetofa containing only a2.

In turn one can say

```

parameter xx(a) /a1 10, a2 4, a3 6/;
parameter xy(b) /b1 10, b2 4, b3 6/;
scalar zz;
zz=xx(subsetofa);
zz=xx(subsetofa)+100*xy(subsetofb);

```

without uncontrolled index errors as the singleton sets with single elements are automatically evaluated.

More on this is found in the GAMS USER Guide and the McCarl Guide.

## 2.2 Updates to Extrinsic Functions

There have been some developments on extrinsic functions with new programming capabilities, normal related distributions, derivatives and hessian computations. Specifically

- GAMS now allows up to 20 arguments in the specification of a function (used to be 10).
- GAMS now allows extrinsic function libraries that do not have features to return first derivatives and/or Hessian values. GAMS approximates these using finite differences. An example can be found in library file `trilib` which implements a **Sine** function without derivatives leaving their calculation to GAMS.
- New GAMS options have been introduced to allow users to influence the numerical derivative calculations mainly in the context of extrinsic functions, but also in some cases with the calculations using intrinsic functions. This uses option `FDDelta` to control step size and `FDOpt` to control derivative and hessian calculation method and scaling. More is in the McCarl Guide and the release notes.
- A new extrinsic function library `parcclib` was added that accesses the GAMS parameter file. Vary limited information can be found in the GAMS User's Guide, Appendix J.

### 2.3 More Normal PDFs and CDFs

The extrinsic function library **cpp** or **cppclib** has been expanded to include functions for the PDF and CDF of the trivariate normal distribution along with the univariate and bivariate. Documentation for **cpp** appears in Appendix J of the GAMS User's Guide and in the next version of the McCarl guide.

### 2.4 A New Solver - LocalSolver

GAMS added the solver [LocalSolver](#) 5.0 from Innovation 24 into the group of available solvers. LocalSolver can solve large-scale, mixed-variable, non-convex optimization problems (GAMS model types MIP, (MI)QCP, (MI/D)NLP). It combines local search techniques, constraint propagation and inference techniques, linear and mixed-integer programming techniques, and nonlinear programming techniques in a unique hybrid neighborhood search approach to find high-quality feasible solutions. Hence, LocalSolver offers an alternative for problems where conventional branch-and-bound and/or outer-approximation based solution methods do not provide satisfactory results.

### 2.5 More secure "obfuscated" save files

Users can find it desirable to solve models on computational grids or clouds that are outside a secure computing environment. GAMS contains facilities that allows one to prepare a restart files that within it alters all the names and other documentation related to the model so it is virtually impossible to figure out the context. In turn, then this can be more securely used in the less secure environment.

GAMS also contains ways to take a subsequent save file containing results from the less secure environment and back translate it inside the original secure environment.

This is done using an "obfuscated" save files, which is a save file where symbol and UEL names have been obfuscated. Generally this means all the text strings have been changed to computer generated labels that do not convey problem information.

To do this one employs the command line options [saveobfuscate](#) (abbreviated as [so](#)) and [xsaveobfuscate](#) (abbreviated as [xso](#)) that respectively generate uncompressed and compressed obfuscated save files. Also the command line option [restartNamed](#) ([rn](#)) can be used to bring back the original names when restarting from both an [obfuscated save file](#) and a [regular save file](#).

The syntax for use is as follows.

- To save a GAMS model for future execution into an [obfuscated save file](#) one does

```
gams trnsport a=c s=0named saveobfuscate=0anon
```

where one also must create and retain a [regular save file](#) so back translation can be done

- To start from the **obfuscated save file** and do a continued **job with reporting and whatever else** one would use

```
gams more r=0anon rn=0named
```

The **obfuscated work file** is basically the original save file but with all strings for symbols, set elements and explanatory text replaced with obfuscated names.

GAMS **obfuscates** by keeping the original length of the symbol/label and creating a sequence of strings e.g. for symbols of length 3 we create A00, A01, A02, ..., Z. Similarly for explanatory text, GAMS always uses the single quote character and creates many weird looking labels. For the other strings (symbol text and label text) we just change all characters in these strings. The only other strings obfuscated are the titles and subtitles. File names are not obfuscated.

The basic way this works is on the original machine you run

```
gams mymodel a=c s=0named so=0obfuscated
```

which yields an **obfuscated restart file** plus a **local restart file** that gives instructions for back translating the information. Note these files have not been executed since a compile only command line parameter (**a=c**) was used

Now we move the **obfuscated work file** to a non-secure machine and start up execution of an **empty file** there restarting from the obfuscated save file and the in turn save the results.

The empty file can be created using

```
execute "echo * Empty > jobforremote.gms"
```

the run can then be done as

```
gams jobforremote r=0obfuscated s=1obfuscated
```

which will execute the original job on the remote machine but in an obfuscated manner and create a **saved file with the results**.

In turn one can bring that file back to the original machine and **run an additional job** translating the results back using the **local save file**

```
gams continue r=1obfuscated rn=0named
```

## 2.6 Running jobs from within GAMS

GAMS users can start up jobs from within GAMS. These can be started immediately with asynchronous calls. An option also allows these to be started on different processors than the

one being used by the parent process. This involves using call, execute, and put utility with ASYNC and AsyncNC appended.

## 2.7 Leads and lags over non ordered sets

Lag and lead set operations require the set to be ordered and constant. In some special cases one would want to use lags and leads on dynamic and/or unordered sets. The dollar control option `$on/$offOrder` relaxes the ordering requirement.

## 3 Updates to GDX utilities

- GDX2SQLITE has been released and is a tool that can move data from GAMS to a SQLITE database.
- GDXDUMP has a new option `SymbolsAsSet` to write the symbol table for a set as data.
- GDXMRW has new utilities `irgdx` and `iwgdx` that facilitate exchanging indexed GDX data with Matlab.
- GDXRENAME is a new utility to rename set elements in a GDX file using a mapping given by a second GDX file called `map.gdx`. Searching for GDXRENAME on the GAMS web site reveals an example as will the next McCarl guide update

## 4 Updates to the GAMS IDE

- The help menu now has a link to the search page on the GAMS website

## 5 Updates to APIs

There are new API features

- Regarding the API that deals with GDX files also known as the "Indexed GDX" (IDX) library that allow reading and writing of indexed GDX files plus an example `xp_CalcInverseIDX`.
- Making more GAMS options available regarding appending, dumping, error messages, tracing, and other items as discussed in the release notes
- The latest releases include tutorials on API usage in the GAMS system directory on your computer under the subdirectory `<gams system directory>/docs/API`. This document can also be accessed through the GAMSIDE Help menu under the subdirectory Docs in the subdirectory API..

## 6 A new way to get help

There is a new online experimental GAMS help system, which includes the McCarl guide. This is available at <http://www.gams.com/help/infocenter/index.jsp>

## 7 Courses offered

I will be teaching

- Basic to Advanced GAMS class Aug 10, 2015- Aug 14, 2015 (5 days) in the Colorado mountains at Frisco (near Breckenridge). The course spans from Basic topics to an Advanced GAMS class. Details are found at [http://www.gams.com/courses/basic\\_and\\_advanced.pdf](http://www.gams.com/courses/basic_and_advanced.pdf) .
- Basic GAMS class Aug 10, 2015- Aug 12, 2015 (3 days) in the Colorado mountains at Frisco (near Breckenridge). The course starts assuming no GAMS background. Details are given at <http://www.gams.com/courses/basic.pdf> .
- Advanced GAMS class Aug 12, 2015- Aug 14, 2015 (3 days) in the Colorado mountains at Frisco (near Breckenridge). The course is for users who have a GAMS background. Details are found at <http://www.gams.com/courses/advanced.pdf> .

Further information and other courses are listed on <http://www.gams.com/courses.htm> . Note I also give custom courses for individual groups a couple of times a year.

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