GAMSCHK & GAMS Documentation

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Based on materials written by Gillig & McCarl and improved upon by many previous lab instructors

Special thanks to Mario Andres Fernandez
Outline

1. Review
2. PRE and POST Solution
3. Steps to Run GAMSCHK
4. GAMSCHK Options
   - DISPLAYCR
   - BLOCKPIC
   - PICTURE
   - ANALYSIS
Review

- **LIMROW**: controls the number of rows (equations) in the equation listing
- **LIMCOL**: controls the number of columns (variables) in the variable listing

Unfortunately, for large models the LIMROW and LIMCOL option can generate very substantial output files. An alternative way of displaying models is GAMSCHK.
Review

- LIMROW: controls the number of rows (equations) in the equation listing
- LIMCOL: controls the number of columns (variables) in the variable listing
- Unfortunately, for large models the LIMROW and LIMCOL option can generate very substantial output files.
Review

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- **LIMCOL**: controls the number of columns (variables) in the variable listing
- Unfortunately, for large models the LIMROW and LIMCOL option can generate very substantial output files.
- An alternative way of displaying models is **GAMSCHK**.
GAMSCHK

- GAMSCHK is a system for verifying model structure and solutions to see if all is correct.
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- **PRE solution**: To verify the model structure before worrying too much about the answer.
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- **PRE solution**: To verify the model structure before worrying too much about the answer.

- **POST solution**: To enlist the solvers help in an exercise to find the causes of unrealistic solutions, unbounded or infeasible problems.
PRE Solution

- List selected equations and/or variables (DISPLAYCR)
PRE Solution

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- Generate schematics on equations/variables blocks (BLOCKPIC)
PRE Solution

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- List characteristics of equations/variables blocks (BLOCKLIST)
PRE Solution

- List selected equations and/or variables (**DISPLAYCR**)
- Generate schematics on equations/variables blocks (**BLOCKPIC**)
- List characteristics of equations/variables blocks (**BLOCKLIST**)
- Find obvious specification errors (**ANALYSIS**)

Relevant options:
- PRE & POST
- Steps
- Options
PRE Solution

- List selected equations and/or variables (DISPLAYCR)
- Generate schematics on equations/variables blocks (BLOCKPIC)
- List characteristics of equations/variables blocks (BLOCKLIST)
- Find obvious specification errors (ANALYSIS)
- Generate schematics on location of coefficients by sign and magnitude on individual equation/variable basis (PICTURE)
PRE Solution

- List selected equations and/or variables (DISPLAYCR)
- Generate schematics on equations/variables blocks (BLOCKPIC)
- List characteristics of equations/variables blocks (BLOCKLIST)
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- List characteristics of equations/variables (MATCHIT)
Post Solution

- Reconstructing reduced cost and equation activity (POSTOPT)
Post Solution

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- Helping resolve problems with unbounded or infeasible models (NONOPT)
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- On a post solution basis, POSTOPT is used to check for Non-Sensical solutions by observing a faulty attribute of the solution in terms of
  - Allocation (variable and equation levels, e.g. Variable.L, Equation.L)
Post Solution

- Reconstructing reduced cost and equation activity (POSTOPT)
- Helping resolve problems with unbounded or infeasible models (NONOPT)
- On a post solution basis, POSTOPT is used to check for Non-Sensical solutions by observing a faulty attribute of the solution in terms of
  - Allocation (variable and equation levels, e.g. Variable.L, Equation.L)
  - Valuation (variable and equation marginals e.g. Variable.M, Equation.M)
Steps to Run GAMSCHK

- **STEP 1**: insert a command line right before the `SOLVE` statement:
  
  ```
  OPTION LP = GAMSCHK;
  OPTION NLP = GAMSCHK;
  OPTION MIP = GAMSCHK;
  ```

  ```
  Model Transport /ALL/ ;
  OPTION LP = GAMSCHK;
  Solve  Transport USING LP MINIMIZING TotalCost ;
  ```
Steps to Run GAMSCHK

**STEP 1**: insert a command line right before the **SOLVE** statement:

- **OPTION LP** = GAMSCHK;
- **OPTION NLP** = GAMSCHK;
- **OPTION MIP** = GAMSCHK;

```plaintext
Model Transport /ALL/;
OPTION LP = GAMSCHK;
Solve Transport using LP minimizing TotalCost;
```
Steps to Run GAMSCHK

- **STEP 2**: create a new file with extension *.gck that has the same corresponding name as the program file.
Steps to Run GAMSCHK

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Example

exgamschk.gms → exgamschk.gck
Steps to Run GAMSCHK

- To create a new file, go to the File menu and use the New option. You will then get a file called untitled with an empty screen then save as exgamschk.gck.
- Make sure *gms and *gck files are saved within the same folder.
Steps to Run GAMSCHK

- **STEP 3**: select procedures and provide inputs in the *gck* file.
- If the *gck* file cannot be found, then it is assumed that the BLOCKPIC procedure is selected.

```
exgamschk.gck

DISPLAYCR
  Variables
    Transport
  Equations
    Costsum

POSTOPT
  VARIABLES
    Transport
  EQUATIONS
    SupplyBal
```
Steps to Run GAMSCHK

- **STEP 3:** select procedures and provide inputs in the *.gck file.
- If the *.gck file cannot be found, then it is assumed that the BLOCKPIC procedure is selected.

**Procedure names:** pre or post solutions
Steps to Run GAMSCHK

- **STEP 3**: select procedures and provide inputs in the *.gck file.
- If the *.gck file cannot be found, then it is assumed that the BLOCKPIC procedure is selected.

**Procedure names:** pre or post solutions

**Item selection input:** specify variables and equations you want to display

```
exgamschk.gck

DISPLAYCR

Variables
  Transport
Equations
Costsum

POSTOPT

VARIABLES
  Transport
EQUATIONS
  SupplyBal
```
Input Rules in *.gck File

```
DISPLAYCR
VARIABLES
  Transport
EQUATIONS
  Costsum

DISPLAYCR
VARIABLES
  Transport(Seattle,*)

DISPLAYCR
VARIABLES
  Tr*
```
Input Rules in *.gck File

- If a variable or equation name is entered without any following parentheses, then all cases for that variable or equation are selected.
Input Rules in *.gck File

- If a variable or equation name is entered without any following parentheses, then all cases for that variable or equation are selected.

- If all elements from sets are selected, wild cards can be used. Select cases where the first set element equals SEATTLE and any element from the second set.
Input Rules in *.gck File

- If a variable or equation name is entered without any following parentheses, then all cases for that variable or equation are selected.

- If all elements from sets are selected, wild cards can be used. Select cases where the first set element equals SEATTLE and any element from the second set.

- If a wild card is used to select items (e.g. Tr*), GAMS will select anything starting Tr.
DISPLAYCR

-----### Executing DISPLAYCR

-----### DISPLAYING VARIABLES
-----### VAR Transport

## Transport(Seattle,"New York")
CostSum -250.00
SupplyBal(Seattle) 1.0000
DemandBal("New York") 1.0000

-----### DISPLAYING EQUATIONS
-----### EQU SupplyBal

## SupplyBal(Seattle)
Transport(Seattle,"New York") 1.0000
Transport(Seattle,Chicago) 1.0000
Transport(Seattle,Topeka) 1.0000

=L= 35.000
DISPLAYCR

---### Executing DISPLAYCR

---### DISPLAYING VARIABLES

---### VAR Transport

## Transport(Seattle,"New York")

CostSum = -250.00
SupplyBal(Seattle) = 1.0000
DemandBal("New York") = 1.0000

---### DISPLAYING EQUATIONS

---### EQU SupplyBal

## SupplyBal(Seattle)

Transport(Seattle,"New York") = 1.0000
Transport(Seattle,Chicago) = 1.0000
Transport(Seattle,Topeka) = 1.0000

=35.000

- DISPLAYCR produces output much like LIMROW and LIMCOL, but DISPLAYCR allows one to select specific items.
DISPLAYCR produces output much like LIMROW and LIMCOL, but DISPLAYCR allows one to select specific items.

Display variable names and associated coefficients in equations
DISPLAYCR produces output much like LIMROW and LIMCOL, but DISPLAYCR allows one to select specific items.

- Display variable names and associated coefficients in equations
- Display equations and associated coefficients with variables
**BLOCKPIC**

- **BLOCKPIC** is used to find GAMS coding errors in a model structure by looking at a whole summary of the model. Scaling can also be investigated.

```
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>r</td>
<td>o</td>
</tr>
<tr>
<td>t</td>
<td>a</td>
</tr>
<tr>
<td>n</td>
<td>s</td>
</tr>
<tr>
<td>l</td>
<td>p</td>
</tr>
<tr>
<td>O</td>
<td>C</td>
</tr>
<tr>
<td>R</td>
<td>H</td>
</tr>
<tr>
<td>t</td>
<td>t</td>
</tr>
</tbody>
</table>

CostSum | - | + | E  | O  |
SupplyBal | + |  | L  | +  |
DemandBal | + |  | G  | +  |
Variable Typ | + | u
```
### BLOCKPIC

- **Number of coefficients by block**

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>T T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>r o</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a t</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s l</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p c</td>
<td>c</td>
<td>E</td>
</tr>
<tr>
<td>o o o</td>
<td>R</td>
<td>n</td>
</tr>
<tr>
<td>r s</td>
<td>H</td>
<td>t</td>
</tr>
<tr>
<td>t t</td>
<td>S</td>
<td>s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1+</th>
<th>E</th>
<th>1+</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CostSum</td>
<td>6-</td>
<td></td>
<td>6-</td>
<td></td>
</tr>
<tr>
<td>SupplyBal</td>
<td>6+</td>
<td>L</td>
<td>2+</td>
<td>6+</td>
</tr>
<tr>
<td>DemandBal</td>
<td>6+</td>
<td>G</td>
<td>3+</td>
<td>6+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>12+</th>
<th>1+</th>
<th>5+</th>
<th>13+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coeff Cnts</td>
<td>6-</td>
<td></td>
<td></td>
<td>6-</td>
</tr>
<tr>
<td># of Vars</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Type</td>
<td>&gt;=0</td>
<td>&lt;0&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### C. Average Number of Coefficients by Column Block -- Strip 1

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>f</td>
</tr>
<tr>
<td>r</td>
<td>o</td>
<td>s</td>
</tr>
<tr>
<td>a</td>
<td>t</td>
<td>f</td>
</tr>
<tr>
<td>n</td>
<td>a</td>
<td>p</td>
</tr>
<tr>
<td>s</td>
<td>l</td>
<td>e</td>
</tr>
<tr>
<td>p</td>
<td>C</td>
<td>r</td>
</tr>
<tr>
<td>o</td>
<td>o</td>
<td>E</td>
</tr>
<tr>
<td>r</td>
<td>s</td>
<td>H</td>
</tr>
<tr>
<td>t</td>
<td>t</td>
<td>S</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CostSum</td>
<td>1+</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>1-</td>
<td>6-</td>
</tr>
<tr>
<td>SupplyBal</td>
<td>1+</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>2+</td>
<td>3+</td>
</tr>
<tr>
<td>DemandBal</td>
<td>1+</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>3+</td>
<td>2+</td>
</tr>
<tr>
<td>Cfs PerVar</td>
<td>2+</td>
<td>1+</td>
</tr>
<tr>
<td></td>
<td>1-</td>
<td></td>
</tr>
<tr>
<td># of Vars</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Var Type</td>
<td>&gt;=0</td>
<td>&lt;0&gt;</td>
</tr>
</tbody>
</table>

- **Average number of coefficients by column block**
- **Maximum and minimum coefficients by block**

---

```
### D. Scaling - Maximum & Minimum Coefficients by Block -- Strip 1

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>H</td>
</tr>
<tr>
<td>r</td>
<td>o</td>
<td>S</td>
</tr>
<tr>
<td>a</td>
<td>t</td>
<td>u</td>
</tr>
<tr>
<td>n</td>
<td>a</td>
<td>M</td>
</tr>
<tr>
<td>s</td>
<td>l</td>
<td>a</td>
</tr>
<tr>
<td>p</td>
<td>C</td>
<td>x</td>
</tr>
<tr>
<td>o</td>
<td>o</td>
<td>M</td>
</tr>
<tr>
<td>r</td>
<td>s</td>
<td>i</td>
</tr>
<tr>
<td>t</td>
<td>t</td>
<td>n</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CostSum</td>
<td>250</td>
<td>1</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>151</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SupplyBal</td>
<td>1</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>350</td>
<td>1</td>
</tr>
<tr>
<td>DemandBal</td>
<td>1</td>
<td>325</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>275</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td></td>
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</tr>
<tr>
<td>Total Var</td>
<td>250</td>
<td>1</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>275</td>
</tr>
</tbody>
</table>
```
- **PICTURE** permits investigation and verification of the structure of equations and variables.
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Look at interrelationships between items

- how coefficients for a variable appear across equations?
- What variables appear in an equation?
- How some variables balance against other variables in equations?
- How signs are distributed?
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- Look at interrelationships between items
  - how coefficients for a variable appear across equations?
  - What variables appear in an equation?
  - How some variables balance against other variables in equations?
  - How signs are distributed?

- Look at magnitude, sign and location of coefficients
- **PICTURE** permits investigation and verification of the structure of equations and variables.

- Look at interrelationships between items
  - How coefficients for a variable appear across equations?
  - What variables appear in an equation?
  - How some variables balance against other variables in equations?
  - How signs are distributed?

- Look at magnitude, sign and location of coefficients

- Avoid immense output from using LIMROW/LIMCOL or DISPLAYCR
- Coefficient code

<table>
<thead>
<tr>
<th>LOWER BOUND (INCLUSIVE)</th>
<th>CODE</th>
<th>UPPER BOUND (LESS THAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000.00000</td>
<td>G</td>
<td>+INFINITY</td>
</tr>
<tr>
<td>100.00000</td>
<td>F</td>
<td>1000.00000</td>
</tr>
<tr>
<td>10.00000</td>
<td>E</td>
<td>100.00000</td>
</tr>
<tr>
<td>1.00000</td>
<td>D</td>
<td>10.00000</td>
</tr>
<tr>
<td>1.00000</td>
<td>C</td>
<td>1.00000</td>
</tr>
<tr>
<td>0.50000</td>
<td>B</td>
<td>1.00000</td>
</tr>
<tr>
<td>0.00000</td>
<td>A</td>
<td>0.50000</td>
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<tr>
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</tr>
<tr>
<td>-INFINITY</td>
<td>7</td>
<td>-1000.00000</td>
</tr>
</tbody>
</table>
- Model structure
- Look at magnitude, sign and location of coefficients
Dictionary of variables and equations

---### Dictionary of Variables

| Transport | 1: Transport("Seattle","New York") |
| Transport | 2: Transport("Seattle",Chicago) |
| Transport | 3: Transport("Seattle",Topeka) |
| Transport | 4: Transport("San Diego","New York") |
| Transport | 5: Transport("San Diego",Chicago) |
| Transport | 6: Transport("San Diego",Topeka) |
| TotalCost | 1: TotalCost |

---### Dictionary of Equations

| CostSum | 1: CostSum |
| SupplyBal | 1: SupplyBal("Seattle") |
| SupplyBal | 2: SupplyBal("San Diego") |
| DemandBal | 1: DemandBal("New York") |
| DemandBal | 2: DemandBal(Chicago) |
| DemandBal | 3: DemandBal(Topeka) |
ANALYSIS

- ANALYSIS is used to analyze the structure of all variables and equations. Information from ANALYSIS is used to define if individual variables or equations in the model have specification errors which lead to redundancy, zero variable values, infeasibility, unboundedness, or obvious constraint redundancy in linear programs.

Example

\[ \begin{align*}
\text{max } & 3X + 2Y + 4Z \\
\text{subject to } & 2X + 3Y \leq -5 - 2X - Y + Z \\
& X, Y \geq 0
\end{align*} \]

Z is unbounded.
X and Y are infeasible.
ANALYSIS

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**Example**

\[
\begin{align*}
\text{max} & \quad 3X + 2Y + 4Z \\
\text{s.t.} & \quad 2X + 3Y \leq -5 \\
& \quad -2X - Y + Z \geq 4 \\
& \quad X, Y \geq 0
\end{align*}
\]
ANALYSIS

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**Example**

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\begin{align*}
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\]

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**Example**

\[
\begin{align*}
\text{max} & \quad 3X + 2Y + 4Z \\
\text{s.t.} & \quad 2X + 3Y \leq -5 \\
& \quad -2X - Y + Z \geq 4 \\
& \quad X, Y \geq 0
\end{align*}
\]

- Z is unbounded.
- X and Y are infeasible.
**ANALYSIS**

---

**Warning** These variables will equal zero because they have a zero lower bound. An undesirable object function coefficient. 

All 0 or - coefficients in the \( =G= \) rows

All 0 or + coefficients in the \( =L= \) rows

And no coefficients in the \( =E= \) rows

```plaintext
## move crops
```

---

**ERROR** This \( =L= \) constr. causes an infeasible model. 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 negative

```plaintext
## rentalLand
```
**ANALYSIS**

**** Warning These variables will equal zero because they have a zero lower bound an undesirable objective function coefficient all 0 or - coefficients in the =G= rows all 0 or + coefficients in the =L= rows and no coefficients in the =E= rows

## movecrops

**** ERROR This =L= constr. causes an infeasible model 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 negative

## rentalLand
### ANALYSIS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
<th>Expression</th>
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<td>f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>emgs</td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>dvola</td>
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<td>profitacct</td>
<td>+ + + + m + E 0</td>
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<tr>
<td>croponhand</td>
<td>+ + m + L 0</td>
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<tr>
<td>Land</td>
<td>+ + - + L +</td>
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<tr>
<td>mincattle</td>
<td>+</td>
<td>G +</td>
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<tr>
<td>rentalLand</td>
<td>+</td>
<td>L -</td>
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<td>Variable Typ</td>
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</tbody>
</table>

**Warning** These variables will equal zero because they have a zero lower bound, an undesirable objective function coefficient, all 0 or - coefficients in the =G= rows, all 0 or + coefficients in the =L= rows, and no coefficients in the =E= rows.

```
## movecrops
```

**ERROR** This =L= constr. causes an infeasible model 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 negative.

```
## rentalLand
```
Heads On 5

- I will email you the question and requirement.
- You send an **electronic** copy of your *.gms file via email. Put your name in first line as comment.
- Hand in a **hard** copy of *.lst file (from “Solution Report” to the end).