

Lesson 4. Solving Optimization Models with a Computer

1 What are GMPL, GLPK, and GUSEK?

- **GMPL** is a programming language for optimization models
 - GMPL is also called **MathProg**
 - GMPL is very similar to **AMPL**, a popular commercial optimization modeling language
- **GLPK** is a software package that solves various types of optimization models, including linear programs
- **GUSEK** is an application that lets easily you write models in GMPL and solve them with GLPK

2 Some useful pointers

- On the course website:
 - A link to the GLPK Wikibook
 - The official GMPL language reference manual
 - GMPL exercise submission form
- Google can be your friend
 - Searching for “AMPL” can be useful as well

3 Installing GUSEK

- Download zip file from here:

<http://sourceforge.net/projects/gusek/files/latest/download>

- Unzip the file to any folder: Right-click the file, then select
- To run GUSEK, open the folder, double-click on `gusek.exe`

4 Modeling and solving Farmer Jones’s problem with GMPL

- Recall the linear program for Farmer Jones’s problem:

C = number of chocolate cakes to bake

V = number of vanilla cakes to bake

$$\begin{array}{ll} \text{maximize} & 3C + 4V \\ \text{subject to} & 4C + 2V \leq 32 \\ & 4C + 6V \leq 48 \\ & C \geq 0 \\ & V \geq 0 \end{array}$$

- Let's write GMP code for this linear program

- Start a new file (if one isn't open already)
- Type in the following GMP code

```
# Define decision variables and variable bounds
var C >= 0;
var V >= 0;



# Objective function
maximize total_profit: 3*C + 4*V;

# General constraints
subject to eggs: 4*C + 2*V <= 32;
subject to flour: 4*C + 6*V <= 48;

end;
```

- Save as farmer_jones.mod
 - ◊ .mod is the usual extension for GMP code

- Next, let's solve the linear program

- Make sure  Generate Output File on Go is checked
- Select  Go
- If all is well, a window with the output file (farmer_jones.out) will appear on the left, and a log will appear on the right
- If not, a log will appear on the right with error messages in purple
Click on the error messages to see the relevant part of your code

- In the output file:

- Status tells you if the model has an optimal solution, is unbounded, or is infeasible
- Objective tells you the optimal value, if it exists
- The table with Column name and Activity tells you the optimal solution

- Some GMP tips:

- You can write comments (code that will be ignored when run) like this:

```
# This is a comment.

/* This is also a comment. */
```

- Objective functions and constraints require unique names
 - ◊ Use something short and descriptive; no spaces allowed
- End every statement with a semi-colon!

- In Lesson 3, we showed that if the profit margin for vanilla cakes a satisfies $-2 \leq -\frac{3}{a} \leq -\frac{2}{3}$, then the current optimal solution remains optimal
- Try solving the model for Farmer Jones's problem with different profit margins for vanilla cakes
- Does our sensitivity analysis from Lesson 3 match up with what you see?