GLPK Case Study 2 - 60016 Operations Research

A software development company wants to publish a mobile app to automatically generate grocery shopping lists. The software will use a web service to download the nutritional values of the foods available at the closest grocery shop, determined according to the location of the user, and then will produce a shopping list that maximizes the food calories that can be purchased for a given budget. The head of development has decided that the software will be interfaced to GLPK to generate the shopping recommendations. You are therefore given a sample GLPK data file (see Listing "food.dat") for testing purposes and you need to define the GMPL model that will be used to generate the shopping lists. In its basic version, the linear program has to express the following constraints:

- The shopping list specifies the amount in grams of each food to be purchased;
- The amounts of ingredients in the shopping list are at minimum the values specified in the nutrional requirements vector NR;
- The ingredients in 100 grams of food are specified by the FO matrix;
- The cost of each gram of food is specified by the CO vector;
- The maximum cost of the shopping list equals the Budget parameter;
- The objective function attempts to maximise the total number of calories in the shopping list;

(a) Write the GMPL linear program for the linear problem and find its optimal solution with glpsol;

(b) Using glpsol's output file, determine which variables are basic and which ones are nonbasic. Is the number of basic variables equal to the number of rows?

(c) In the optimal solution, verify that the reduced cost of Carrot in glpsol's output file corresponds to the value predicted by the theoretical formula.

Listing 1: food.dat

```
data;

param Budget := 10; /* pound sterlings */

set Foods := Apple Orange Oil Carrot Milk Chocolate Potato Spinach ;
set Ingredients := Calories Fats Carbs Proteins ;

param NR :=
Calories        2100    /* calories */
Fats            100     /* grams */
Carbs           225     /* grams */
Proteins        175 ;   /* grams */

/* ingredients per 100 grams of food */
param FO : Apple Orange Oil  Carrot Milk Chocolate Potato  Spinach :=
Calories   52    33     884  41     42     546       77      23
Fats       0.2   0.3    100  0.2     1      31       0.1     0.4
Carbs      14    8      0    10      5      61       17      3.6
Proteins   0.3   0.7    0    0.9    3.4    4.9       2      2.9 ;

param CO := /* cost per gram (pound sterlings) */
Apple           0.0065
Orange          0.0020
Oil             0.0330
Carrot          0.0070
Milk            0.0029
Chocolate       0.0140
Potato          0.0005
Spinach         0.0030 ;

end;
```