CS635 – Problem Set #3

Due Date: February 13, 2014, **11AM**

Instructions for Handing In Homework

Formulate the following problems in GAMS and solve them. You should hand in one zip file containing exactly 4 files with the following names: `hw3-1.gms, hw3-2.gms, hw3-3.gms, hw3-3.txt`. Be sure to follow the instructions for displaying the appropriate solution values at the bottom of your GAMS files. The txt file should contain your comments answering problem 3.2.

1 Sugar Cane Production

The harvest of cane sugar in Australia is highly mechanized. The sugar cane is immediately transported to a sugar house in wagons that run on a network of small rail tracks. The sugar content of a wagon load depends on the field it has been harvested from and on the maturity of the sugar cane. Once harvested, the sugar content decreases rapidly through fermentation and the wagon load will entirely lose its value after a certain time. At this moment, eleven wagons all loaded with the same quantity have arrived at the sugar house. They have been examined to find out the hourly loss and the remaining life span (in hours) of every wagon; these data are summarized below:

Lot	1	2	3	4	5	6	7	8	9	10	11
Loss(kg/h)	43	26	37	38	13	54	62	49	19	28	30
Life span (h)	8	8	2	8	4	8	8	8	8	8	8

Every lot may be processed by any of the three, fully equivalent production lines of the sugar house. The processing of a lot takes two hours. It must be finished at the latest at the end of the life span of the wagon load.

1.1 Problem

The manager of the sugar house wishes to determine a production schedule for the currently available lots that minimizes the total loss of sugar. Write a GAMS model to do this. Ensure that you display only when each wagon is unloaded and the loss of product from each wagon in each unloading period.

2 House Captain

You have been selected to be the House captain for the Gryffindor Quidditch team. Congratulations! Your job is to select the players of the team to maximize the overall quality. You know the quality of each player for each position, and the team quality is merely the sum of the players' quality for their assigned positions. For those of you without 10-year old children, a Quidditch team consists of players of four different positions: seeker, chaser, keeper, and beater. On a team there are 2 beaters, 3 chasers, one keeper, and one seeker.

Here is the top data for your gams file.

```
set player /Harry_Potter, Ron_Weasley, Fred_Weasley, George_Weasley,
            Oliver_Wood, Angelina_Johnson, Ginny_Weasley, Hermione_Granger,
            Neville_Longbottom, Seamus_Finnegan, Dean_Thomas,
            Romilda_Vane, Colin_Creevy, Dennis_Creevy, Lavender_Brown,
            Alicia_Spinnet, Katie_Bell, Cormac_McLaggen,
            Demelza_Robinson /
    position  /seeker, chaser, beater, keeper/ ;

parameter quality(player, position) ;

option seed = 42;
quality(player,'seeker') = uniform(32,36);
quality(player,'chaser') = uniform(38,41);
quality(player,'beater') = uniform(30,35);
quality(player,'keeper') = uniform(28,38);

quality('Harry_Potter', 'seeker') = 42 ;
```

2.1 Problem

Write a linear programming model to maximize the quality of the Gryffindor house team. At the end of the program, display the numerical quality of the team (in a parameter named `houseScore`), and also display the set of students chosen to be a member of the team (in a dynamic set named `Gryffindor_team`). The code below can be used as a template.

```
parameters houseScore;
housescore = teamQuality.L ;

set Gryffindor_team(player,position) ;
Gryffindor_team(player,position) = yes$(x.L(player,position) > 0.001) ;
option Gryffindor_team:0:0:1;

display houseScore;
display Gryffindor_team ;
```

3 Milk production

Happy Milk Distributors (HMD) purchases raw milk from farmers in two regions: A and B. Prices, butterfat content and separation properties of the raw milk differ between the two regions. HMD processes the raw milk to produce cream and milk to desired specifications for distribution to the consumers.

Region A Raw Milk Milk from region A is 54 cents per gallon up to 500 gallons and 58 cents per gallon in excess of 500 gallons. There is no upper bound on the amount that can be purchased. Raw milk from Region A has 25% butterfat and when separated (at 5 cents per gallon) it yields two "milks", one with 41% butterfat and another with 12% butter fat.

The volume of milk is conserved in all separation processing.

Region B Raw Milk The purchase price for milk from region B is 38 cents per gallon up to 700 gallons and 42 cents per gallon thereafter. Raw milk from Region B has 15% butterfat

and when separated (at 7 cents per gallon) yields two "milks", one with 43% butterfat and another with 5% butterfat.

Production Process After the milk is purchased and collected at the plant, it is either mixed directly or separated and then mixed. The mixing is done at no cost, and its purpose is to produce cream and milk to specifications. For example, some of the raw milk from Region A may be separated and then mixed, and some of it may be mixed directly (i.e., without having been separated).

Demand and Selling Price The demand and selling price are described in the following table:

	Minimum req'd % of butterfat	Max vol dem (gallons)	Selling price (cents/gallon)
Cream	40	250	150
Milk	20	2000	70

For example, all the cream produced must have at least 40% butterfat, it sells at $1.50 per gallon, and as much as 250 gallons of the cream produced can be sold.

3.1 Problem

Assuming free disposal, formulate a linear program in GAMS which when solved enables HMD to maximize its profit.

3.2 Problem

Suppose that the purchase price for milk from region B were 50 cents per gallon up to 700 gallons and 30 cents per gallon thereafter. Can you still formulate the profit maximization problem as a linear program? If not, why not?