CSE 521: Design and Analysis of Algorithms **Winter 2017**

Problem Set 5

Deadline: March 9th (at 12:00PM) in canvas

1) You are given data containing grades in different courses for 5 students; say $G_{i,j}$ is the grade of student i in course j. (Of course, $G_{i,j}$ is not defined for all i, j since each student has only taken a few courses.) We are trying to "explain" the grades as a linear function of the student's innate aptitude, the easiness of the course and some error term.

$$G_{i,j} = \text{aptitude}_i + \text{easiness}_j + \epsilon_{i,j},$$

where $\epsilon_{i,j}$ is an error term of the linear model. We want to find the best model that minimizes the sum of the $|\epsilon_{i,j}|$'s.

a) Write a linear program to find aptitude_i and easiness_j for all i, j minimizing $\sum_{i,j} |\epsilon_{i,j}|$.

b) Use any standard package for linear programming (Matlab/CVX, Freemat, Sci-Python, Excel etc.; we recommend CVX on matlab) to fit the best model to this data. Include a printout of your code, the objective value of the optimum, $\sum_{i,j} |\epsilon_{i,j}|$, and the calculated easiness values of all the courses and the aptitudes of all the students.

	MAT	CHE	ANT	REL	POL	ECO	COS
Alex		C+	A	B+	A-	C	
Billy	B+	A-			A-	B+	B
Chris	B	B+			A	A-	B+
David	A+		B-	A		A-	
Elise		B-	D	B+	B	B	C

Assume $A = 4, B = 3$ and so on. Also, let $B+ = 3.33$ and $A- = 3.66$.

2) Consider the following problem that arises in telecommunications networks. The network consists of a cycle on n nodes, numbered 0 through $n-1$ clockwise around the cycle. Some set C of calls is given; each call is a pair (i, j) originating at node i and destined for node j. The call can be routed either clockwise or counterclockwise around the ring. The objective is to route the calls so as to minimize the total load on the network. The load L_i on link $(i, i+1 \bmod n)$ is the number of calls routed through link $(i, i+1 \bmod n)$, and the total load is the $\max_{1 \le i \le n} L_i$. Give a linear programming based 2-approximation algorithm for this problem.

3) **Extra Credit:** Write the dual of the linear program that you designed for problem 2.