IEOR 240 - Fall 2022
Homework 2
Due Date: 09/26/2022 (Monday) at 11:59PM.

Submission requirement
For problems that require a mathematical formulation, please clearly state the definition of decision variables and the indexes of them. Write a sentence to explain each constraint and objective function. Also include an explanation of the optimal solution when you are required to solve the problem in AMPL.

Submit your homework (typed, scanned or photographed) and AMPL code in a single pdf file. You can choose to merge the pdf files together or include screenshots of your AMPL code and solutions in your homework pdf.

1. Giapetto's Woodcarving, Inc., manufactures two types of wooden toys: soldiers and trains. A soldier sells for \$27 and uses \$10 worth of raw materials. Each soldier that is manufactured increases Giapetto's variable labor and overhead costs by \$14. A train sells for \$21 and uses \$9 worth of raw materials. Each train built increases Giapetto's variable labor and overhead costs by \$10. The manufacture of wooden soldiers and trains requires two types of skilled labor: carpentry and finishing. A soldier requires 2 hours of finishing labor and 1 hour of carpentry labor. A train requires 1 hour of finishing and 1 hour of carpentry labor. Each week, Giapetto can obtain all the needed raw material but only 100 finishing hours and 80 carpentry hours. Demand for trains is unlimited, but at most 40 soldiers are sold each week.

   Formulate a linear programming model of Giapetto's situation that can maximize Giapetto's weekly profit (i.e. revenue − cost), and solve it using AMPL.

2. **(Work scheduling problem)** A hospital requires different number of nurses on different days of the week. The number of nurses required on each day is given below:

   - Monday: 17
   - Tuesday: 13
   - Wednesday: 15
   - Thursday: 19
   - Friday: 14
   - Saturday: 16
   - Sunday: 11

Union rules state that each nurse must work five consecutive days and then receive two days off. For example, a nurse who works from Thursday to Monday must be off on Tuesday and Wednesday. The hospital wants to meet its daily requirements while minimizing the number of nurses must be hired. (You may ignore the fact that numbers of nurses must be integer).

Formulate this problem as a linear programming model, and solve it using AMPL.

3. **(Blending problem)** You have decided to enter the candy business. You are considering producing two types of candies: Slugger Candy and Easy out Candy, both of which consist solely of sugar, nuts, and chocolate. At present, you have in stock 100 oz of sugar, 20 oz of nuts, and 30 oz of chocolate. The mixture used to make Slugger Candy must contain at least 10% nuts and 10% chocolate. The mixture used to make Easy Out Candy must contain at least 20% nuts. Each ounce of Slugger Candy can be sold for 20 cents, and each ounce of Easy Out Candy for 25 cents.

   Formulate a linear programming model that will enable you to maximize your revenue from candy sales. **You don't need to solve this problem. You don't need to write AMPL code for this problem.**

4. Consider a school district with I neighborhoods, J schools, and G grades at each school. Each school j has a capacity of C_{jg} for grade g. In each neighborhood i, the student population of grade g is S_{ig}. Finally, the distance of school j from neighborhood i is d_{ij}. Formulate a linear programming problem whose objective is to assign all students to schools, while minimizing the total distance traveled by all students. (You may ignore the fact that numbers of students must be integer).

   Formulate a linear programming model that will enable you to minimize the total distance traveled by all students. **You don't need to solve this problem. You don't need to write AMPL code for this problem.**