Homeowrk 3

Due On: November 6, 2020 2:59PM (CDT)

Problem 1(1 pts - Extra Credit) Is the following program linear? If so, convert it into the standard form.

$$\begin{aligned} \text{maximize } & \sum_{i=1}^{n-1} |x_i - x_{i+1}| \\ \text{subject to } & A\vec{x} \leq b \\ & \vec{x} \geq \vec{0} \end{aligned}$$

Problem 2. (3 pts) Write a linear programming formulation to solve the problem of sorting a set S of n distinct numbers.

Problem 3. (2 pts) You're sitting at your desk one day when a FedEx package arrives for - you. Inside is a cell phone that begins to ring, and you're not entirely surprised to discover that it's your friend Neo, whom you haven't heard from in quite a while. Conversations with Neo all seem to go the same way: He starts out with some big melodramatic justification for why he's calling, but in the end it always comes down to him trying to get you to volunteer your time to help with some problem he needs to solve. This time, for reasons he can't go into (something having to do with protecting an underground city from killer robot probes), he and a few associates need to monitor radio signals at various points on the electromagnetic spectrum. Specfficaly, there are n different frequencies that need monitoring, and to do this they have available a collection of sensors. There are two components to the monitoring problem. 1) A set L of m geographic locations at which sensors can be placed; and 2) set S of b interference sources, each of which blocks certain frequencies at certain locations. Specifically, each interference source i is specified by a pair (F_i, L_i), where F_i is a subset of the frequencies and L_i is a subset of the locations; it signifies that (due to radio interference) a sensor placed at any location in the set L_i will not be able to receive signals on any frequency in the set F_i. We say that a subset $L' \subseteq L$ of locations is sufficient if, for each of the n frequencies j, there is some location in L' where frequency j is not blocked by any interference source. Thus, by placing a sensor at each location in a sufficient set, you can successfully monitor each of the n frequencies. They have k sensors, and hence they want to know whether there is a sufficient set of locations of size at most k. We'll call this an instance of the Nearby Electromagnetic Observation Problem: Given frequencies, locations, interference sources,

and a parameter k, is there a sufficient set of size at most k? Prove that Nearby Electromagnetic Observation is NP-complete.

Problem 3. (3 pts) Prove that Euclidean-TSP is NP complete.

Problem 4. (2 pts) Show 3-dimensional matching is in APX.