Computer Science Department,
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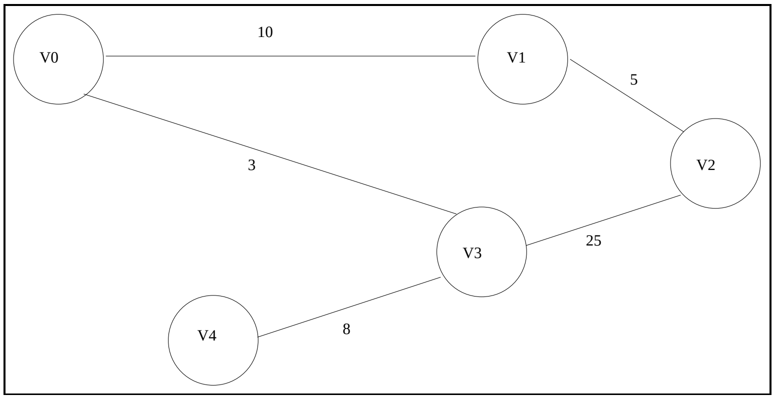
CSC 311
The Second Semester, 2020/2021
Homework #4
Due on April 18, 2021.

Q1:
We define the *capacity* of a path in a weighted graph $G(V, E)$ to be the minimum weight of an edge along that path. For example, the capacity of the path $[V0, V1, V2]$ in the graph below is 5 and the capacity of the path $V1, V0, V3, V2$ is 3. A maximum-capacity path between u and v is a simple path between u and v whose capacity is larger than or equal to those of all paths from u to v. In the graph below, the maximum capacity path from $V0$ to $V3$ is $[V0, V1, V2, V3]$.

(a) Show that if $[a, b, \ldots, u, v]$ is a maximum-capacity path from a to v, then a maximum-capacity path from a to u followed by the edge (u, v) is a maximum-capacity path from a to v.

(b) Is it true that if $[a, b, c, u, v]$ is a maximum-capacity path from a to v, then $[a, b, c, u]$ is a maximum-capacity path from a to u? Why?

(c) Can you think of an algorithm you have seen before that can be modified to find the maximum-capacity paths from a particular vertex s to all other vertices in the graph? How?



Q2:

Assume that we want to provide cellular phone stations (towers) along a highway between two cities. Each station can cover a circle whose radius is n km. We want to place the minimum number of these stations so that the whole highway is covered. Another constraint we have is the power supply points which are at specific points along the the highway; a station can be placed only at a power supply point. Assume that we already have a cellular phone station at the beginning of the highway (we call this location point 0) and that we have an array $A[\,]$ that gives the location of each power supply point. In other words, $A[i]$ is the distance between the ith power supply point and point 0.

Give the pseudocode of an algorithm that takes as input the coverage radius n, the number of power supply points m, and the array $A[\,]$. Your algorithm is supposed to return a Boolean array B, such that $B[i]$ is set to 1 if you decide to place a station at the ith power supply point, and is set to 0 otherwise. You should have the minimum number of 1's, so that the whole segment between point 0 and the last power supply point is covered by the cellular phone service.

Hint: Be Greedy!!

Stations algorithm$(n, m, A[\,])$

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return $(B[\,])$;

What is the complexity of your algorithm?