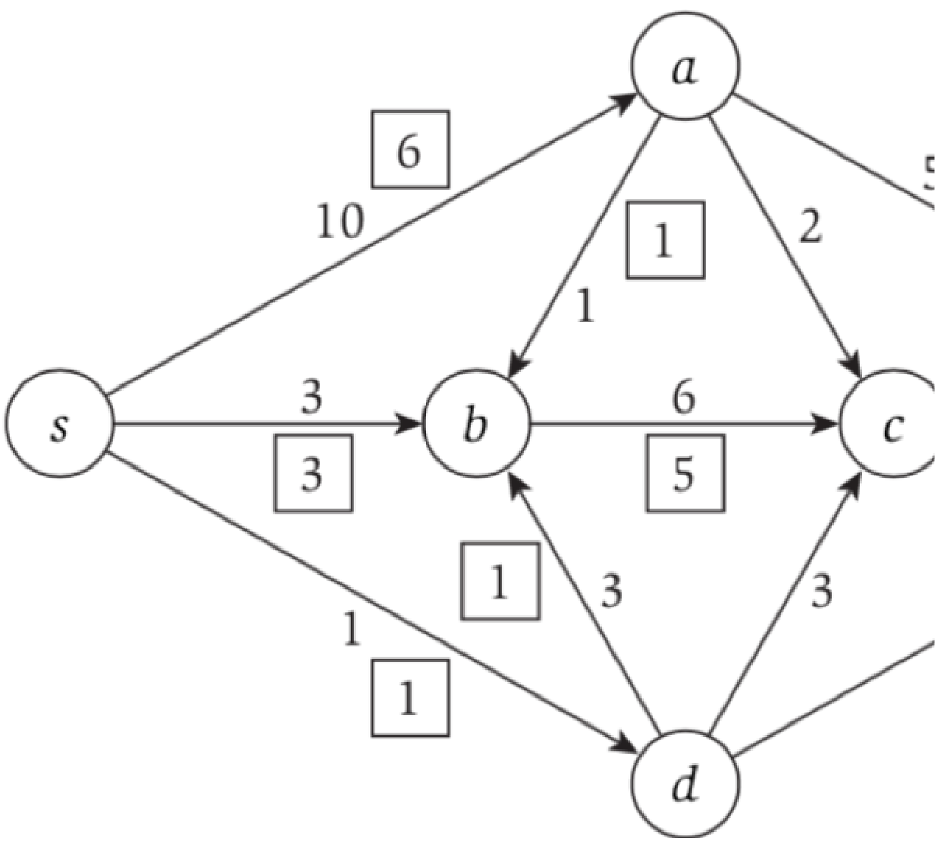
Module 6 Graded Assignment and Quiz

Due Nov 5, 2021 at 11:59pm **Points** 5 **Questions** 5
Available Oct 23, 2021 at 12am - Jan 8 at 11:59pm 3 months
Time Limit None

Instructions

Question 1

The following figure shows a flow network on which an s-t flow has been computed. The capacity of each edge appears as a label next to the edge, and the numbers in boxes give the amount of flow sent on each edge. (Edges without boxed numbers have no flow being sent on them.)



a) What is the value of this flow? Is this a maximum (s,t) flow in this graph?

b) Find a minimum s-t cut in the flow network and state what its capacity is.

Question 2

Decide whether you think the following statement is true or false. If it is true, give a short explanation. If it is false, give a counter-example:

Let G be an arbitrary flow network, with a source s, a sink t, and a positive integer capacity c(e) on every edge e; and let (A,B) be a minimum s-t cut with respect to these capacities {c(e): e ∈ E}. Now suppose we add 1 to every capacity; then (A,B) is still a minimum s-t cut with respect to these new capacities {1+c(e): e ∈ E}.

Question 3

Consider a set of mobile computing clients in a certain town who each need to be connected to one of several possible base stations. We'll suppose there are n clients, with the position of each client specified by its (x, y) coordinates in the plane. There are also k base stations; the position of each of these is specified by (x, y) coordinates as well

For each client, we wish to connect it to exactly one of the base stations. Our choice of connections is constrained in the following ways

There is a range parameter r—a client can only be connected to a base station that is within distance r. There is also a load parameter L—no more than L clients can be connected to any single base station

Your goal is to design a polynomial-time algorithm for the following problem. Given the positions of a set of clients and a set of base stations, as well as the range and load parameters, decide whether every client can be connected simultaneously to a base station, subject to the range and load conditions in the previous paragraph.

Question 4

In a standard s-t Maximum-Flow Problem, we assume edges have capacities, and there is no limit on how much flow is allowed to pass through a node. In this problem, we consider the variant of the Maximum-Flow and Minimum-Cut problems with node capacities.

Let G = (V, E) be a directed graph, with source s ∈ V, sink t ∈ V, and nonnegative node capacities {c(v) ≥ 0} for each v ∈ V. Given a flow f in this graph, the flow though a node v is defined as f-in(v). We say that a flow is feasible if it satisfies the usual flow-conservation constraints and the node-capacity constraints: f-in(v) ≤ c(v) for all nodes.

Give a polynomial-time algorithm to find an s-t maximum flow in such a node-capacitated network. Define an s-t cut for node-capacitated networks, and show that the analogue of the Max-Flow Min-Cut Theorem holds true.

This quiz was locked Jan 8 at 11:59pm.

Attempt History

	Attempt	Time	Score
LATEST	Attempt 1	14 minutes	5 out of 5

Score for this quiz: **5** out of 5

Submitted Nov 5, 2021 at 7:55pm

This attempt took 14 minutes.

Question 1

1 / 1 pts

Regarding question one from this week's graded assignment prompt, give the value of the flow as seen in the figure.

- 14
- Correct! 10
- 20
- 6

Question 2

1 / 1 pts

Regarding question one from this week's graded assignment prompt, state the value of the capacity of the minimum s-t cut found in the network displayed in the figure.

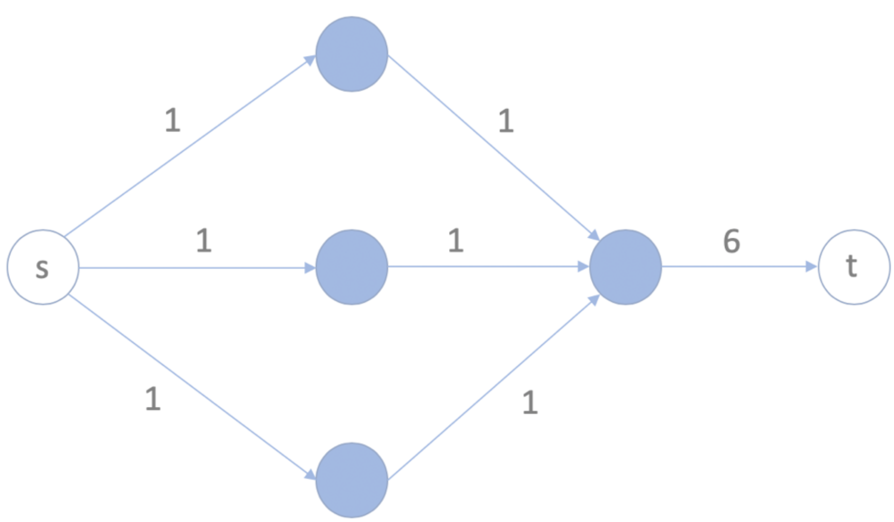
- 10
- 12
- 14
- Correct! 11

Question 3

1 / 1 pts

Regarding question two from this week's graded assignment prompt, is the statement true or false, and why?

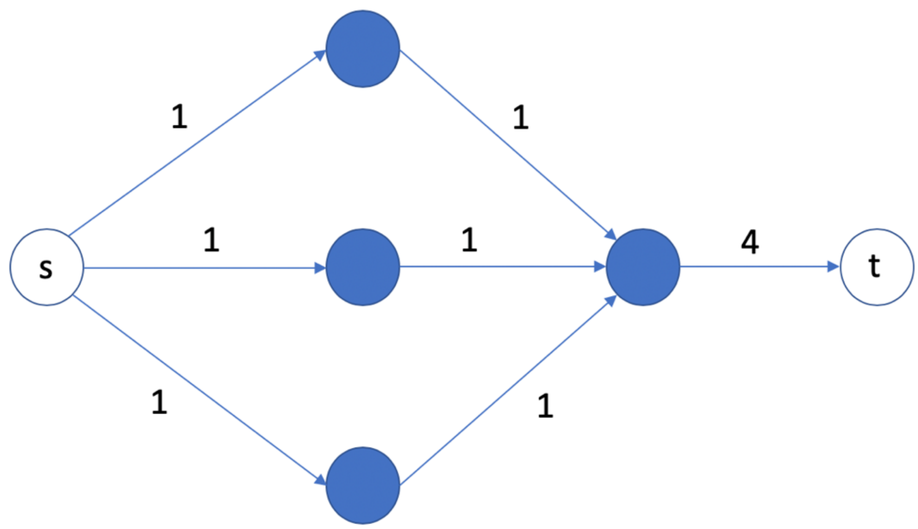
- False - The following network is a counterexample (note that the edge weights denote capacities):



True - The set of edges that form the minimum cut will each have their capacities incremented by one, as well as the capacities of all other edges in the network, thus the relative capacity of every cut will remain the same.

Correct!

False - The following network is a counterexample (note that the edge weights denote capacities):



Question 4

1 / 1 pts

Regarding question 3 from this week's graded assignment prompt, suppose we invent the following correct solution:

We build the following flow network. There is a node vi for each client i, a node w_j for each base station j, and an edge (v_i,w_j) of capacity 1 if client i is within range of base station j. We then connect a super-source s to each of the client nodes by an edge of capacity 1, and we connect each of the base station nodes to a super-sink t by an edge of capacity L.

Which of the following applications of the Ford-Fulkerson algorithm does this variant most closely resemble?

Correct!

- The bipartite matching problem
- The network connectivity problem
- The edge disjoint paths problem
- None of these options

Question 5

1 / 1 pts

Regarding question 4 from the homework prompt, which of the following algorithms will correctly solve an instance of the problem presented in polynomial time?

- Create a new graph G' that is a copy of G, but for any node v with capacity c(v) in G, set the edge capacities of all edges incident to v in G' to c(v) and let no vertices in G' have corresponding capacities. Finally, run the Ford-Fulkerson algorithm on G'.

Correct!

- Create a new graph G' from G where for all nodes that are not the source or sink, create a pair of nodes in G' connected by an edge whose capacity corresponds to the capacity of the corresponding node in graph G. Connect these node pairs via infinite capacity edges in correspondence with the edges of G. Finally, run the Ford-Fulkerson algorithm on G'.
- Any algorithm that solves this problem provably requires exponential time in the size of G.
- Running the Ford-Fulkerson algorithm on G will deliver the desired result.

Quiz Score: **5** out of 5