CSCI 3104 PS6a

Jonathan Phouminh

TOTAL POINTS

7 / 10

QUESTION 1

1 1 / 1

✓ **+ 1 pts** **Correct**

+ 0.5 pts Partially correct

+ 0 pts Incorrect or not attempted

+ 0 pts Plagiarism

QUESTION 2

2 0 / 2

+ 1 pts Got the capacity constraint right

+ 1 pts Got Flow conservation right

+ 0 pts Incorrect/ Not attempt.

✓ **+ 0 pts** **I think you kind of misunderstood the question**

+ 0 pts Plagiarism

QUESTION 3

3 1 / 2

+ 1 pts Correctly answers what forward weights represent

✓ **+ 1 pts** **Correctly answers what backward weights represent**

+ 0.5 pts Partially answers what forward weights represent

+ 0.5 pts Partially answers what backward weights represent

+ 0 pts Incorrect

+ 0 pts Plagiarism

The forward edge weights represent the capacity minus the current flow, while the backward edges represent the current flow.

QUESTION 4

5 pts

4.1 1 / 1

✓ **+ 0.5 pts** **Correct conclusion.**

✓ **+ 0.5 pts** **Reasonable justification.**

+ 0 pts Incorrect/Not attempted.

+ 0 pts Plagiarism

4.2 2 / 2

✓ **+ 0.5 pts** **Identified correct s-t path**

✓ **+ 1 pts** **Identified correct bottleneck edge or its value**

✓ **+ 0.5 pts** **Written correct max flow value**

+ 1 pts Partially correct answer

+ 0 pts Incorrect answer

+ 0 pts Not attempted

+ 0 pts Plagiarism

4.3 2 / 2

✓ **+ 1 pts** **Residual capacities correct on all forward edges of the selected path.**

✓ **+ 1 pts** **Residual capacities correct on all backward edges of the selected path**

+ 0.5 pts Minor mistakes in residual capacities on a few of the forward edges of selected path. Please refer to the solution for an example path and capacities.

+ 0.5 pts Minor mistakes in residual capacities on a few of the backward edges of selected path. Please refer to the solution for an example path and capacities.

+ 0 pts Empty or incomplete solution submitted or incorrect approach followed. Please refer to the solution file for an example path.

+ 0.5 pts Didn't mention backward edge weights explicitly but bottleneck edge and maximum flow values are correct for the selected path in the previous part.

+ 0 pts Plagiarism

Name: Jonathan Phouminh

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CSCI 3104, Algorithms **Profs. Hoenigman & Agrawal**
Problem Set 6a (10 points) **Fall 2019, CU-Boulder**

Instructions for submitting your solution:

- The solutions **should be typed** and we cannot accept hand-written solutions. Here's a short intro to Latex.
- You should submit your work through **Gradescope** only.
- If you don't have an account on it, sign up for one using your CU email. You should have gotten an email to sign up. If your name based CU email doesn't work, try the identikey@colorado.edu version.
- Gradescope will only accept **.pdf** files (except for code files that should be submitted separately on Gradescope if a problem set has them) and **try to fit your work in the box provided**.
- You cannot submit a pdf which has less pages than what we provided you as Gradescope won't allow it.
- Verbal reasoning is typically insufficient for full credit. Instead, write a logical argument, in the style of a mathematical proof.
- For every problem in this class, you must justify your answer: show how you arrived at it and why it is correct. If there are assumptions you need to make along the way, state those clearly.
- You may work with other students. However, **all solutions must be written independently and in your own words.** Referencing solutions of any sort is strictly prohibited. You must explicitly cite any sources, as well as any collaborators.

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1. (1 pt) What do the edge weights of a graph G in a maximum-flow network represent?

   Solution. The edge weights of a graph G in a maximum flow network represent the capacity for that edge.

2. (2 pts) What are the two conditions that must be met for network flow?

   Solution.

   1) Digraph (V,E) with source $\in$ V and sink t $\in$ V, in short, all nodes are reachable from source.
   2) Capacity c(e)$>$ 0 for each e $\in$ E.

3. (2 pts) What do the edge weights in the residual graph G_f represent? Include both forward and backward edges.

   Solution.

   The edge going from source to t (destination node), represents the current amount of flow through that edges capacity. And the edge weight of the edge going from destination to source represents capacity$-$flow of the edge going from source to the destination node. In other words, the edge weight of the edge from destination node to source represents the amount of flow that can be returned

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4. (5 pts) Based on the following network and the given edge capacities answer the following.

PS6/Flow_6a.jpeg

(a) (1 pts) Can the max flow be 5 (capacity(e_{sa}) + capacity(e_{sc}))? Justify your answer in one sentence.

Solution.
Considering just the edge from s to a and s to c we can have a max flow of 5 because the capacity of those edges add up to 5, however if we examine the next path that edge c will take, the max flow cannot be 5.

(b) (2 pts) For the graph, identify one simple $s-t$ path and the bottleneck edge value on that path. Also report the maximum allowed flow on this $s-t$ path.

Solution.

If we choose the path s,a,b,t, we will be bottle necked by the edge from s to a because it has the smallest capacity for flow. The maximum allowed flow is limited by it's bottle neck edge, thus the max flow is also its bottle neck, 1.

(c) (2 pts) Assuming all $f(e)$ are initially 0 where f represents flow, what are the residual capacities on the forward and backward edges of G_f after one iteration of the Ford-Fulkerson algorithm. Use the simple path you identified in Part b.

Solution.

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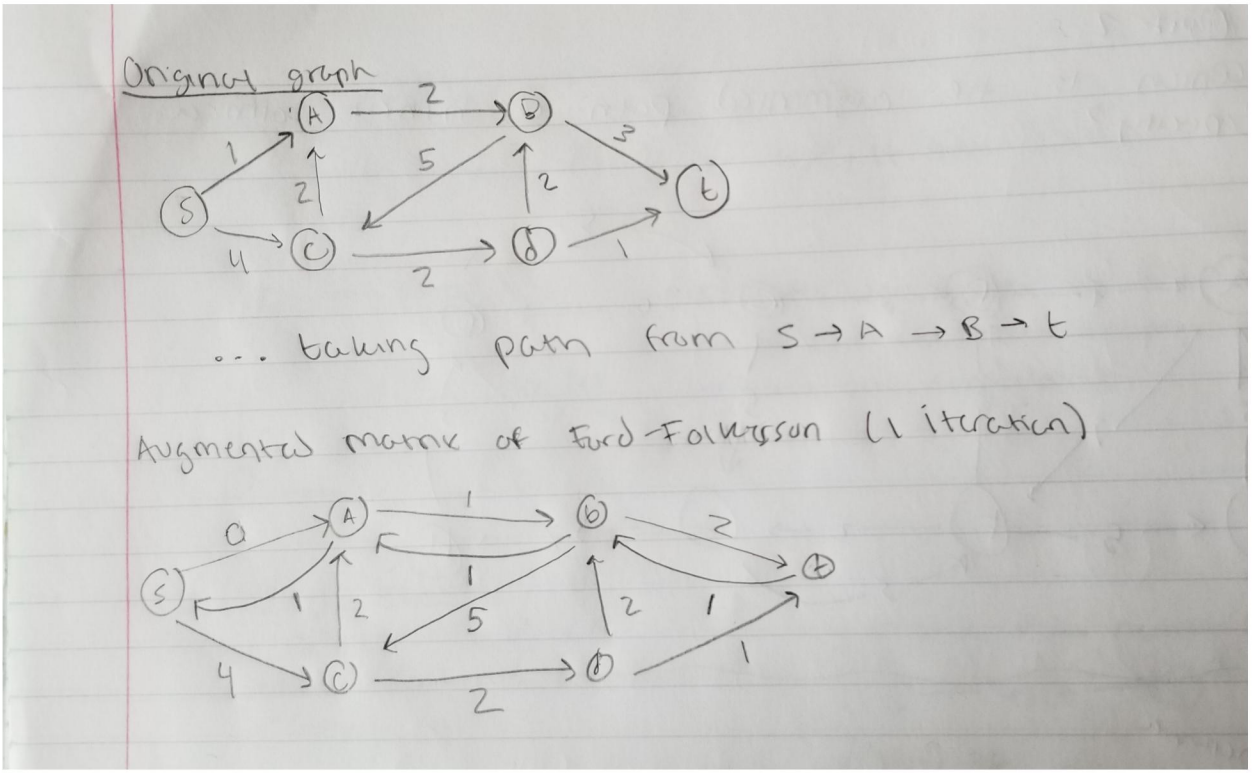

Collaborated with: Zachary Chommala, Bao Nguyen