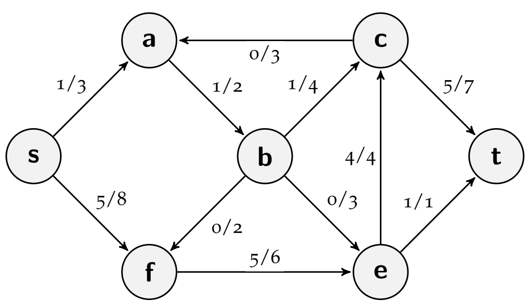
**Collaboration Policy:** You are encouraged to collaborate with up to 4 other students, but all work submitted must be your own *independently* written solution. List the computing ids of all of your collaborators in the `collabs` command at the top of the tex file. Do not share written notes, documents (including Google docs, Overleaf docs, discussion notes, PDFs), or code. Do not seek published or online solutions for any assignments. If you use any published or online resources (which may not include solutions) when completing this assignment, be sure to cite them. Do not submit a solution that you are unable to explain orally to a member of the course staff. Any solutions that share similar text/code will be considered in breach of this policy. Please refer to the syllabus for a complete description of the collaboration policy.

**Collaborators**: list your collaborators here

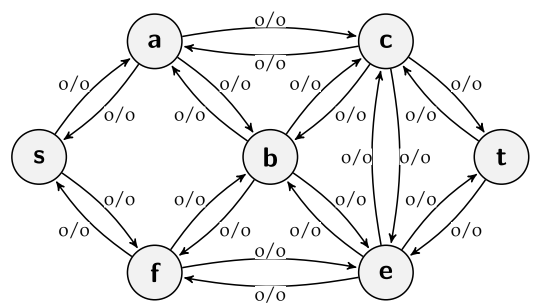
**Sources**: list your sources here

## problem 1 *Max Flow*

Given the following Flow Network $G$ and the beginning of the Residual Graph $G'$:




Flow Network $G$



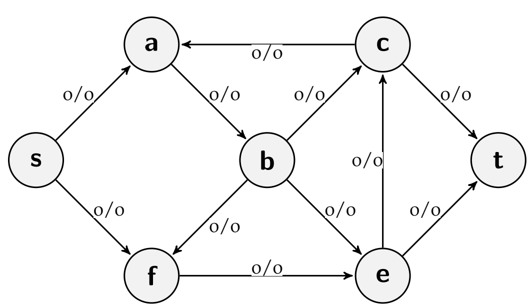

Residual Graph $G'$

1. Complete the Residual Graph $G'$ above. You **must** edit the graph in LaTeX above (do not upload a picture).

2. Find an augmenting path in the graph $G'$ using BFS. List the nodes in the path you found in order (e.g., $s \to a \to b \to c \to d \to t$).

   **Solution:**

3. Update the Flow Network $G$ above. You **must** edit the graph below (do not upload a picture).



4. Find the min cut of the graph. List the nodes on each side of the cut.

   **Solution:**

PROBLEM 2 *Closest Pair of Points Reduction*

Reduce Element Uniqueness to Closest Pair of Points in $O(n)$ time (the reduction needs to be done in $O(n)$, the CPP algorithm takes $O(n\log n)$ ). Element Uniqueness is defined as: given a list of numbers, return *True* if no number appears more than once (i.e., every number is distinct). For example, $\{1,3,7,2,3,4\}$ would return *False* and $\{4,3,12,8,9,14,1\}$ would return *True*. Remember that closest Pair of Points is defined as: given a list of points $(x,y)$, return the smallest distance between any two points.

**Solution:**

PROBLEM 3 *Reading and Evaluating Proofs*

Generative AI systems are exciting – *and scary*. They can answer many questions, but how much can we trust the results?

For this problem you will choose an generative AI system (e.g., ChatGPT) and ask it to do a proof for an algorithm we've studied. Specifically, ask for the proof that the reduction of Bi-Partite Matching to Max-Flow is correct. You'll then carefully read the proof it gives you and compare it to the version of that proof in our textbook, noting any issues or significant differences.

Here's a suggested prompt to give the system. You may use this unchanged, or alter it to try to get a better result.

*Answer this question as if you were a computer scientist. Formally prove that the Bi-Partite Matching algorithm using a max-flow algorithm is correct (i.e, it always find the optimal matching between nodes in the bi-partite graph).*

In your solution, provide the following;

1. Give the name and version number of the generative AI system you've used.

   **Solution:**

2. In a sentence, describe the proof strategy used by the AI.

   **Solution:**

3. Study the textbook's proof of this algorithm, Lemma 24.9 in Section 24.3 of the 4th edition of the textbook. In no more than 5 or 6 sentences, describe any issues or problems you see in the AI's result or how it differs from the textbook's proof. *Your answer might address the following questions: Do you think it successfully proves correctness? Are there gaps or odd logical jumps in the proof it provides? How different is it from the proof in the textbook? (If there are no issues to report, just say that.)*

   **Solution:**

4. Copy the prompt you gave the AI below.

   **Solution:**

5. Copy the AI's response (the proof) below.

   **Solution:**