Exercise 8 (for grade) ~ Monday, November 28, 2022 ~ CPSC 535.01 Fall 2022

Write one submission for your entire group, and write all group members' names on that submission. Turn in your submission before the end of class. The X symbol marks where you should write answers.

Recall that our recommended problem-solving process is:

1. **Understand** the problem definition. What is the input? What is the output?
2. **Baseline** algorithm for comparison
3. **Goal** setting: improve on the baseline how?
4. **Design** a more sophisticated algorithm
5. **Inspiration** (if necessary) from patterns, bottleneck in the baseline algorithm, other algorithms
6. **Analyze** your solution; goal met? Trade-offs?

Follow this process for each of the following computational problems. For each problem, your submission should include:

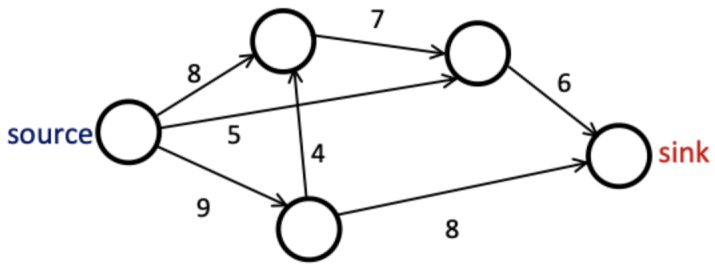
a. State are the input variables and what are the output variables
b. Pseudocode for your baseline algorithm, that needs to include the data type and an explanation for any variable other than input and output variables
a. The Θ-notation time complexity of your baseline algorithm, with justification.

and if you manage to create an improved algorithm:

c. Answer the question: how is your improved algorithm different from your baseline; what did you change to make it faster?
d. Pseudocode for your improved algorithm, that needs to include the data type and an explanation for any variable other than input and output variables
a. The Θ-notation time complexity of your improved algorithm, with justification.

Today's problems are:

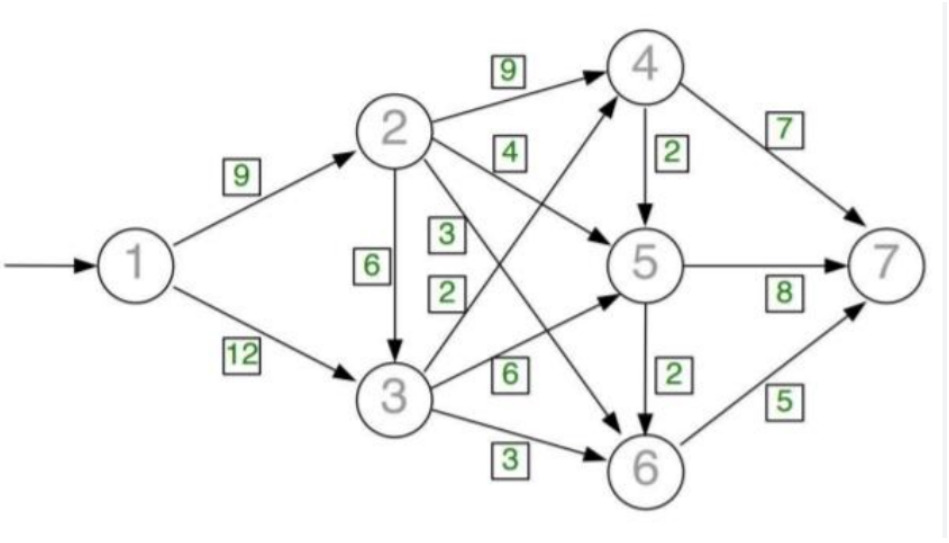
1. *(Max-flow, Ford-Fulkerson method*
   Show the execution of the Ford-Fulkerson on the flow network below:



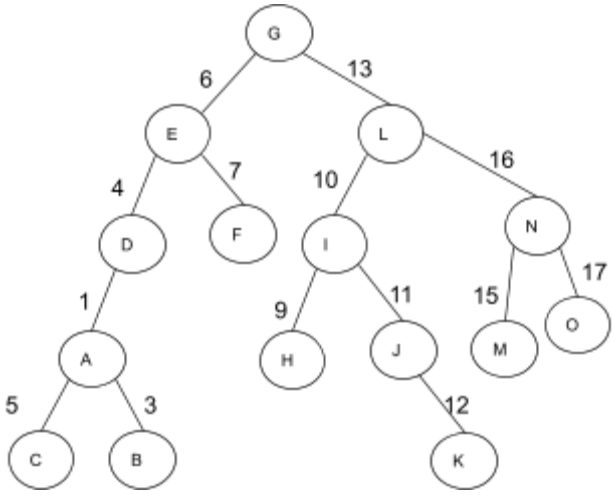
Flow Network(Graph)

   Show each augmenting path and the residual graph after each augmenting path.

2. *(Max-flow, Edmond-Karp algorithm*
   Show the execution of the Edmonds-Karp algorithm on the flow network below, with the source s=1 and the sink t=7:



3. *(Maximum matching in a tree)*
   Compute the maximum matching in the tree below:



Names

Write the names of all group members below.

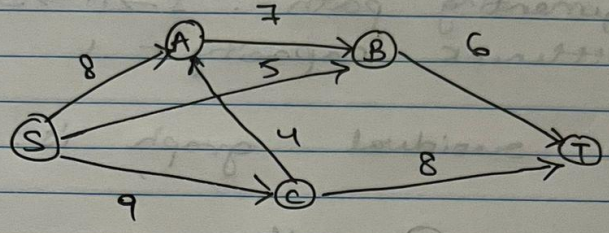
X

Rosa Cho
Vyshnavi Reddy
Jaspreet Mehra

Exercise 1: Solve and provide answer

X

(1)

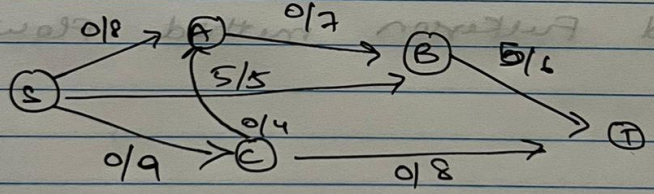


Step1:

Select one arbitary path from S to T

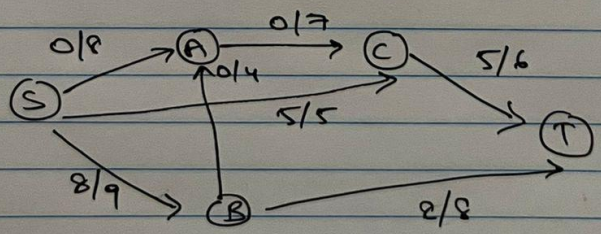
S-B-T

Minimum capacity is S-B(5)



Step2:

Consider S-C-T path

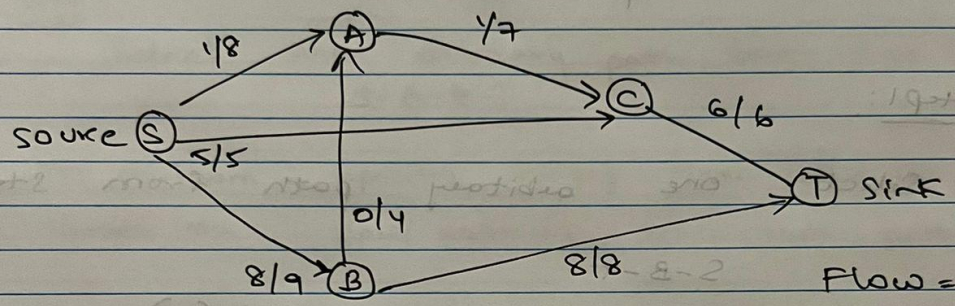


Flow = 5+8
= 13

Step3: Letus consider path $S \rightarrow A \rightarrow C \rightarrow T$

Augmenting path : $S \rightarrow A \rightarrow C \rightarrow T$
Bottleneck capacity = 1

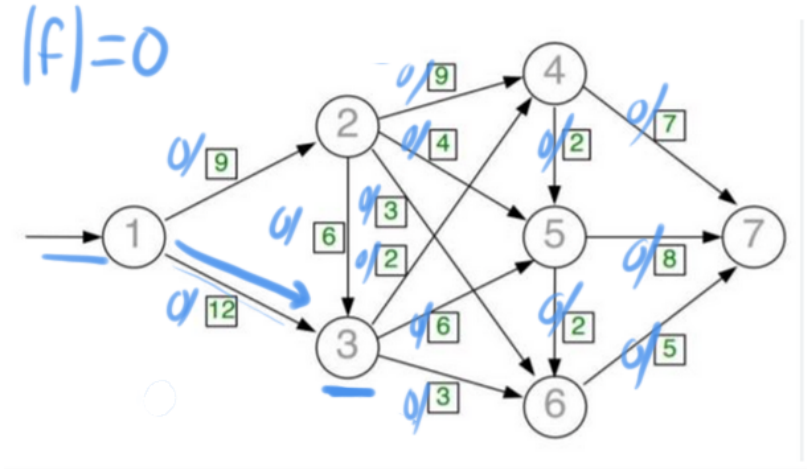
Therefore residual graph is:

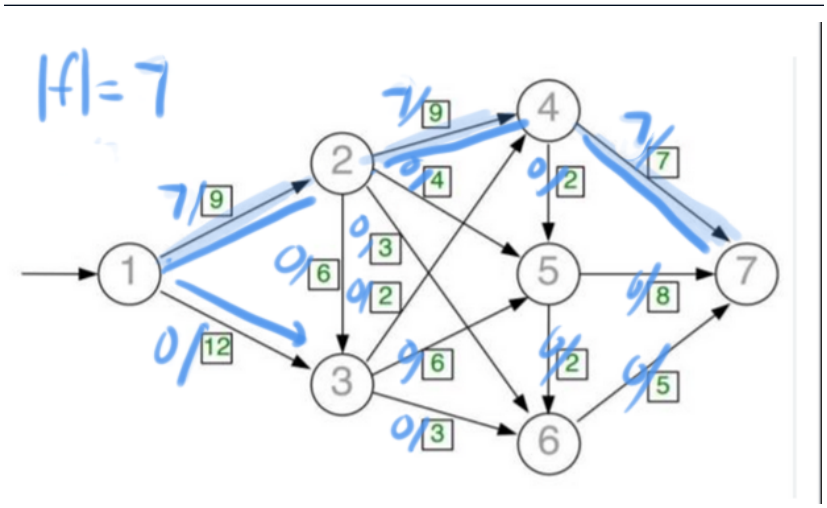


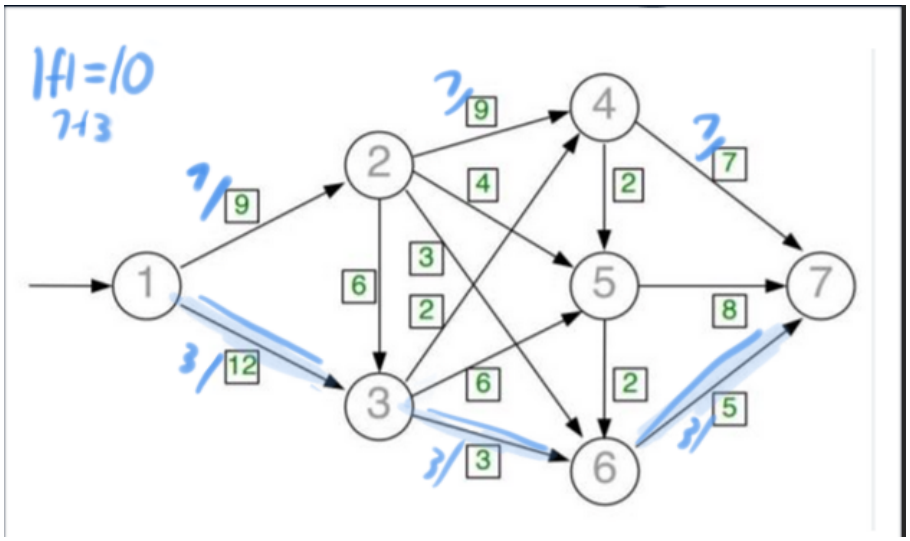
Flow = 5+8+1
= 14

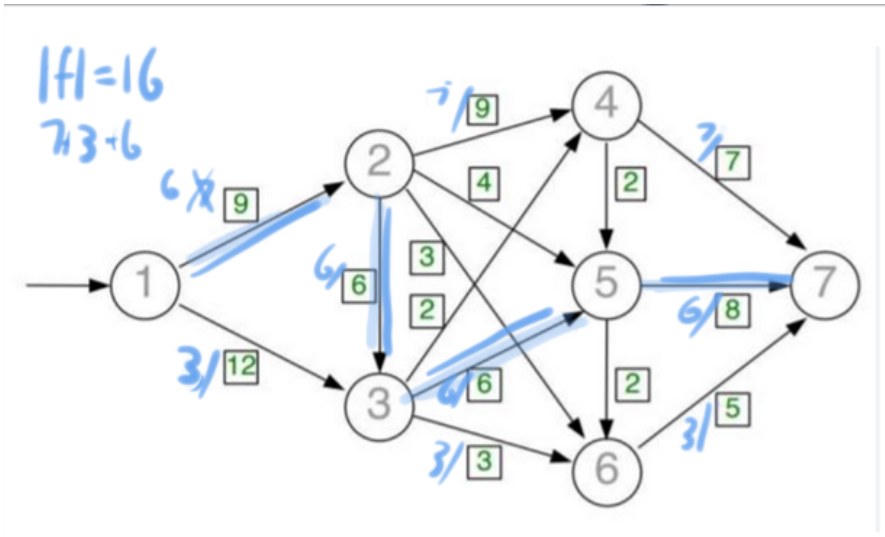
Ford Fulkerson method Flow = 5+8+1
= 14 //

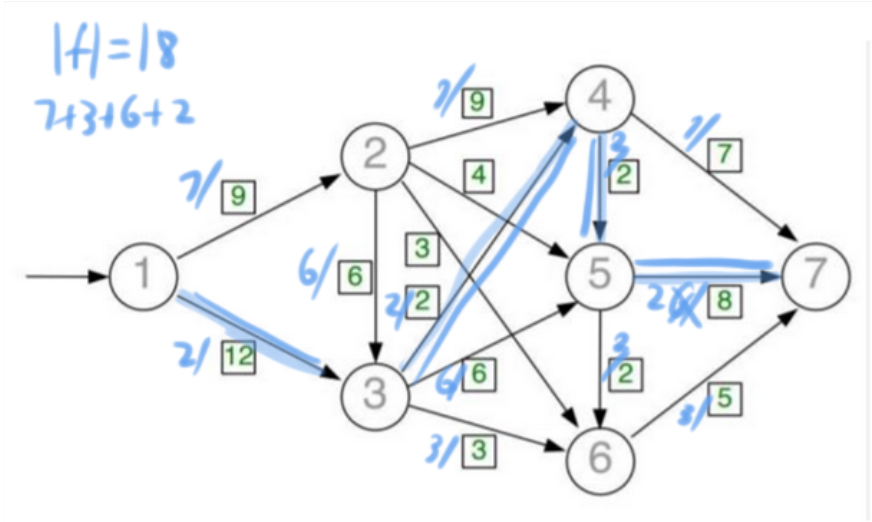
Exercise 2: Solve and provide answer

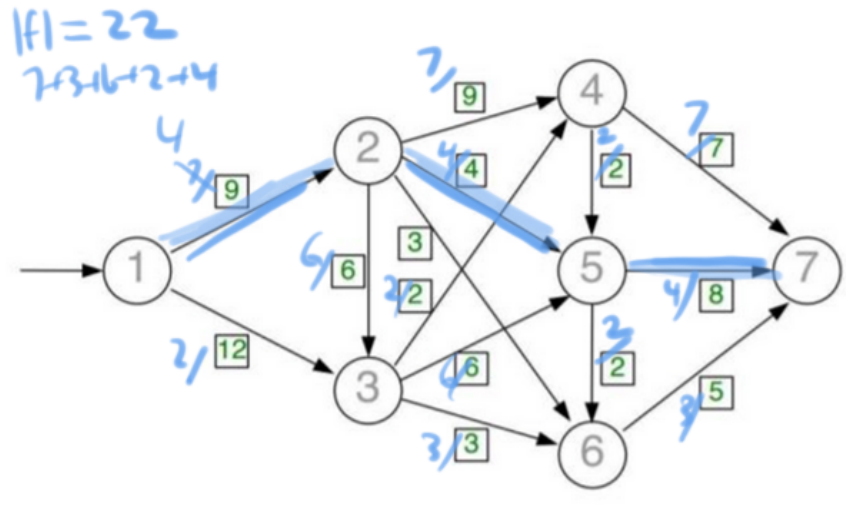


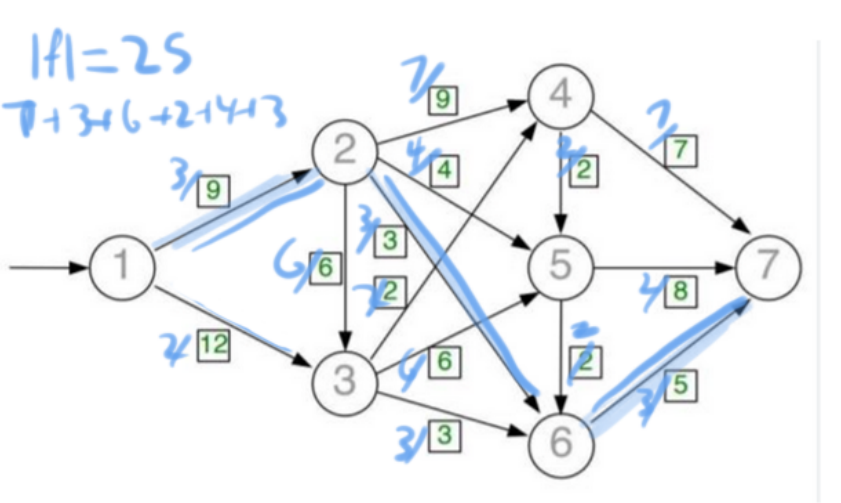





|f|=16
7+3+6
1
2
3
4
5
6
7
9
12
6
3
2
4
2
7
8
5


|f|=18
7+3+6+2
1
2
3
4
5
6
7
9
12
6
3
2
4
2
7
8
5


|f|=22
7+3+6+2+4
1
2
3
4
5
6
7
9
12
6
3
2
4
2
7
8
5


|f|=25
7+3+6+2+1+4+3
1
2
3
4
5
6
7
9
9
12
6
3
2
4
6
3
2
2
7
8
5

Exercise 3: Solve and provide answer

X

Solution 1:

Step 1:

Input: Here we have, Undirected bipartite graph as the input

Output: Output is number of maximum matched vertices in the given graph i.e., the edges are weighted

Step2:

Maximum matched edges are as follows :

i) G - 6 or 13 pick = 13

ii) E - 4 or 7 pick = 7

iii) D - 1 pick = 1

iv) A - 5 or 3 pick = 3 (we know 3 is less but, 3 increase the maximum matching)

v) L - (Has each vertices edge is only one associated edge, so we cannot pick the maximum matching edge)

vi) I - 9 or 11 pick = 9 (we know 9 is less but, 9 increase the maximum matching)

vii) J - 12 pick = 12

viii) N - 15 or 17 pick = 17

Step3:

Set of vertices in maximum matching -

{

(G, L) = 13

(E, F) = 7

(D, A) = 1

(A, B) = 3

(I, H) = 9

(J, K) = 12

(N, O) = 17

}

Set of edges are = {13, 7, 1, 3, 9, 12, 17}

Summation = 62

Solution 2:

Step 1:

Input: Here we have, Undirected bipartite graph as the input

Output: Output is number of maximum matched vertices in the given graph i.e., the edges are weighted

Step2:

Maximum matched edges are as follows :

i) G - 6 or 13 pick = 13
ii) E - 4 or 7 pick = 7
iii) D - (Has each vertices edge is only one associated edge, so we cannot pick the maximum matching edge)
iv) A - 5 or 3 pick = 5 (we know 3 is less but, 3 increase the maximum matching)
v) L - (Has each vertices edge is only one associated edge, so we cannot pick the maximum matching edge)
vi) I - 9 or 11 pick = 9 (we know 9 is less but, 9 increase the maximum matching)
vii) J - 12 pick = 12
viii) N - 15 or 17 pick = 17

Step3:
Set of vertices in maximum matching -
{
(G, L) = 13
(E, F) = 7
(A, C) = 3
(I, H) = 9
(J, K) = 12
(N, O) = 17
}

Set of edges are = {13, 7, 5, 9, 12, 17}
Summation = 63