BLG 372E

ANALYSIS OF ALGORITHMS II

CRN: 22853

REPORT OF HOMEWORK #3

Real Estate Matching

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STUDENT NAME: TUĞRUL YATAĞAN

STUDENT NUMBER: 040100117

INSTRUCTOR: ZEHRA ÇATALTEPE

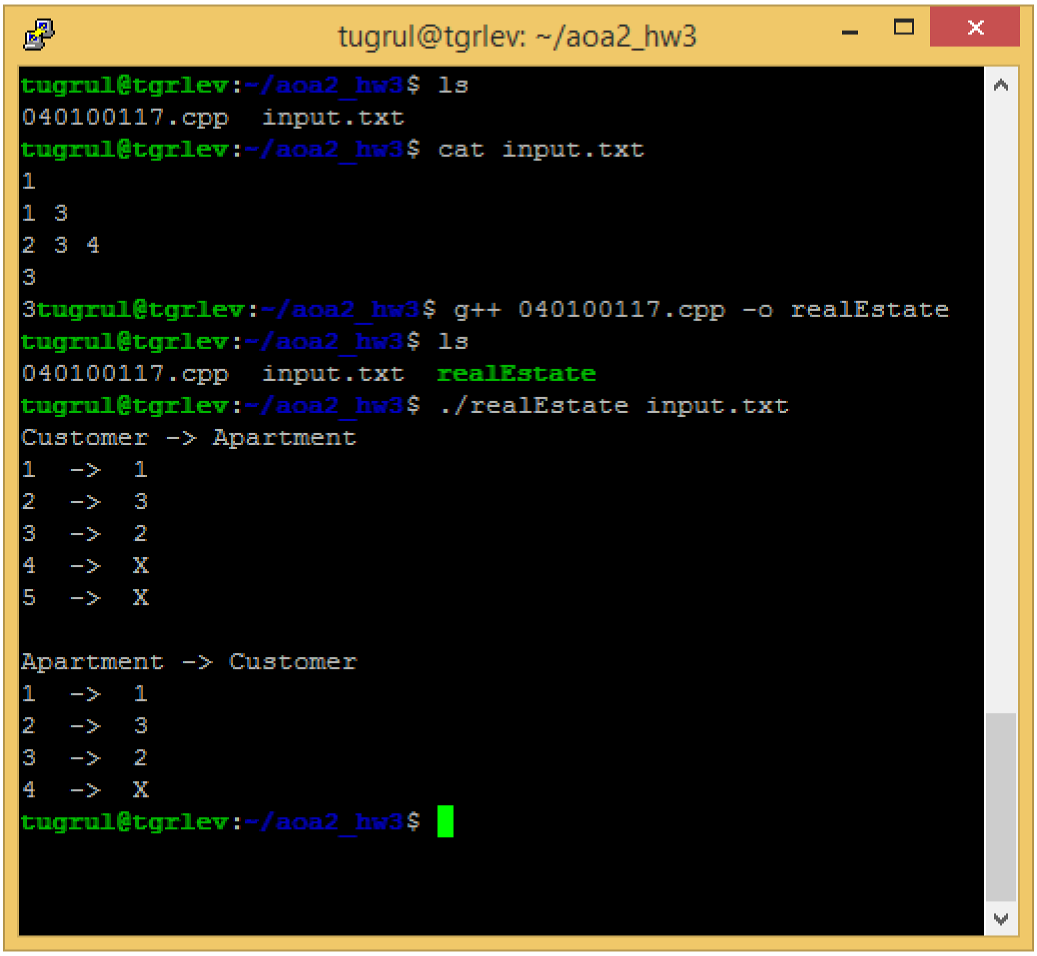
1. Building and Running

The program built and compiled without any warning or error under g++ and the program executed with commands:

```
g++ 040100117.cpp -o realEstate

./realEstate input.txt
```

Sample output is below:



```
tugrul@tgrlev: ~/aoa2_hw3
tugrul@tgrlev:~/aoa2_hw3$ ls
040100117.cpp  input.txt
tugrul@tgrlev:~/aoa2_hw3$ cat input.txt
1
1 3
2 3 4
3
3tugrul@tgrlev:~/aoa2_hw3$ g++ 040100117.cpp -o realEstate
tugrul@tgrlev:~/aoa2_hw3$ ls
040100117.cpp  input.txt  realEstate
tugrul@tgrlev:~/aoa2_hw3$ ./realEstate input.txt
Customer -> Apartment
1   ->  1
2   ->  3
3   ->  2
4   ->  X
5   ->  X

Apartment -> Customer
1   ->  1
2   ->  3
3   ->  2
4   ->  X
tugrul@tgrlev:~/aoa2_hw3$
```

2. Data Structures and Variables

Purpose of the all classes and methods explained in the source code as comment lines. In a nutshell;

- **`BipartiteGraph`** is the main class for algorithm. It can be used for all unary bipartite graph problems.
- Constructor of the **`BipartiteGraph`** class is allocates and initializes necessary data structures.
- **`match`** method of the **`BipartiteGraph`** class calls **`augment`** function for algorithm. **`augment`** is the main function of the algorithm.
- **`match`** method also prints the results as human readable format.

- **`adjacencyMatrix`** of the **`BipartiteGraph`** class is the matrix for keeping graph as two dimensional boolean array.

3. Analysis

The Ford-Fulkerson's Algorithm is used in this maximum bipartite matching problem. Ford-Fulkerson's Algorithm is;

Main function:

```
FORDFULKERSON(G,E,s,t)
FOREACH e ∈ E
   f(e) ← 0
Gf ← residual graph
WHILE (there exists augmenting path P)
   f ← augment(f, P)
   update Gf
ENDWHILE
RETURN f
```

Auxiliary function:

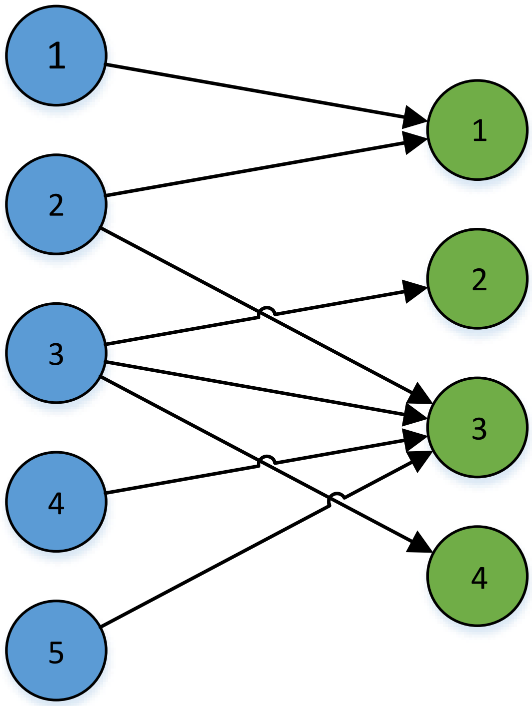
```
AUGMENT(f,P)
b ← bottleneck(P)
FOREACH e ∈ P
   IF (e ∈ E)
      f(e) ← f(e) + b
   ELSE
      f(eR) ← f(e) - b
RETURN f
```

(http://www.cse.iitd.ernet.in/~Naveen/courses/CSL758/Ford%20Fulkerson%20Algorithm.ppt)

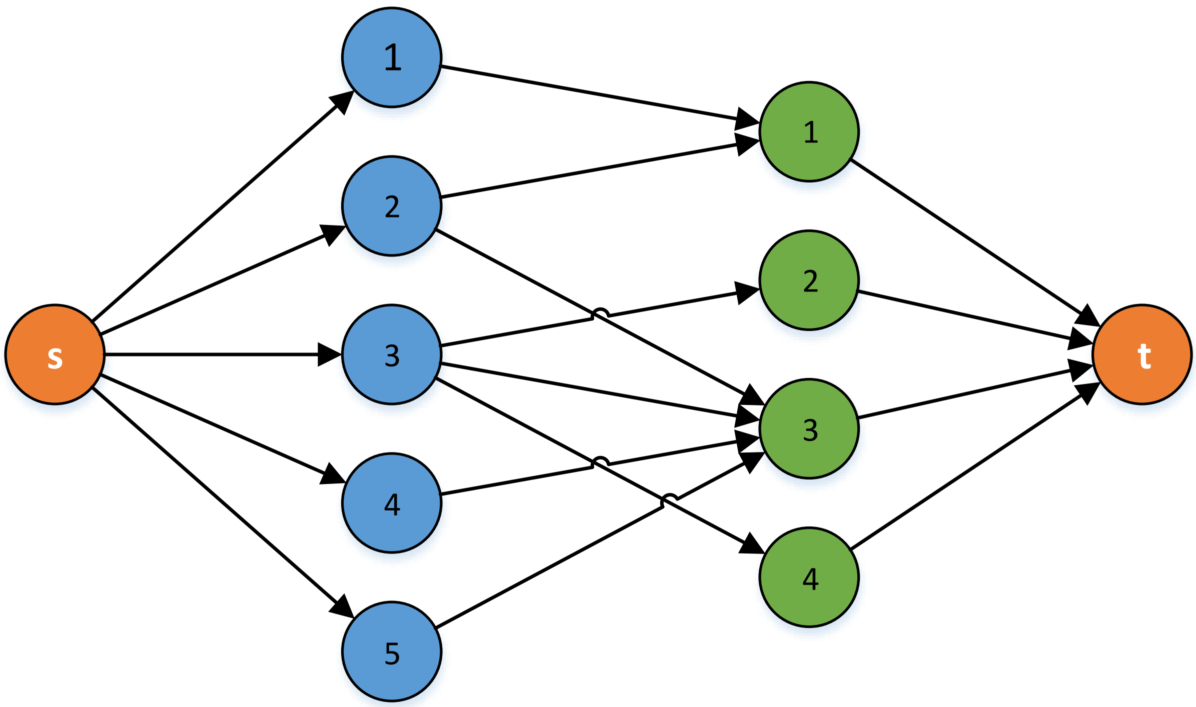
When the capacities are integers, the runtime of Ford-Fulkerson is bounded by O(E * f), where E is the number of edges in the graph and f is the maximum flow in the graph. This is because each augmenting path can be found in O(E) time and increases the flow by an integer amount which is at least 1. Therefore the time complexity becomes O(max_flow * E).

4. Graphs

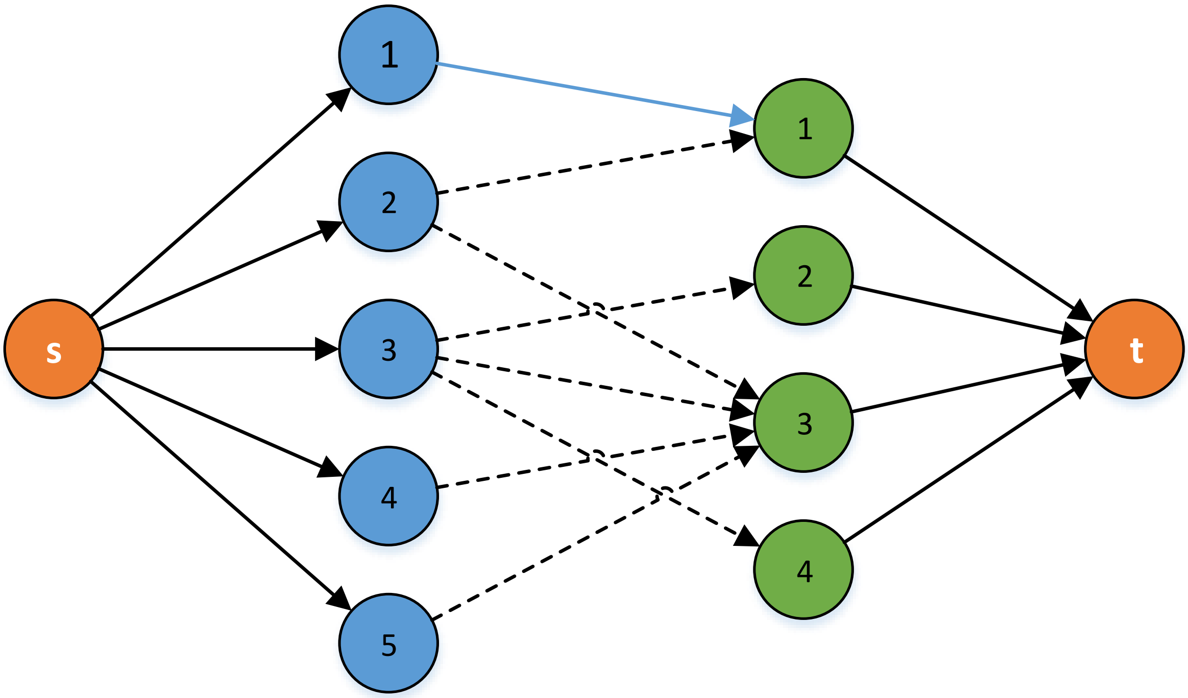
1. Initial graph

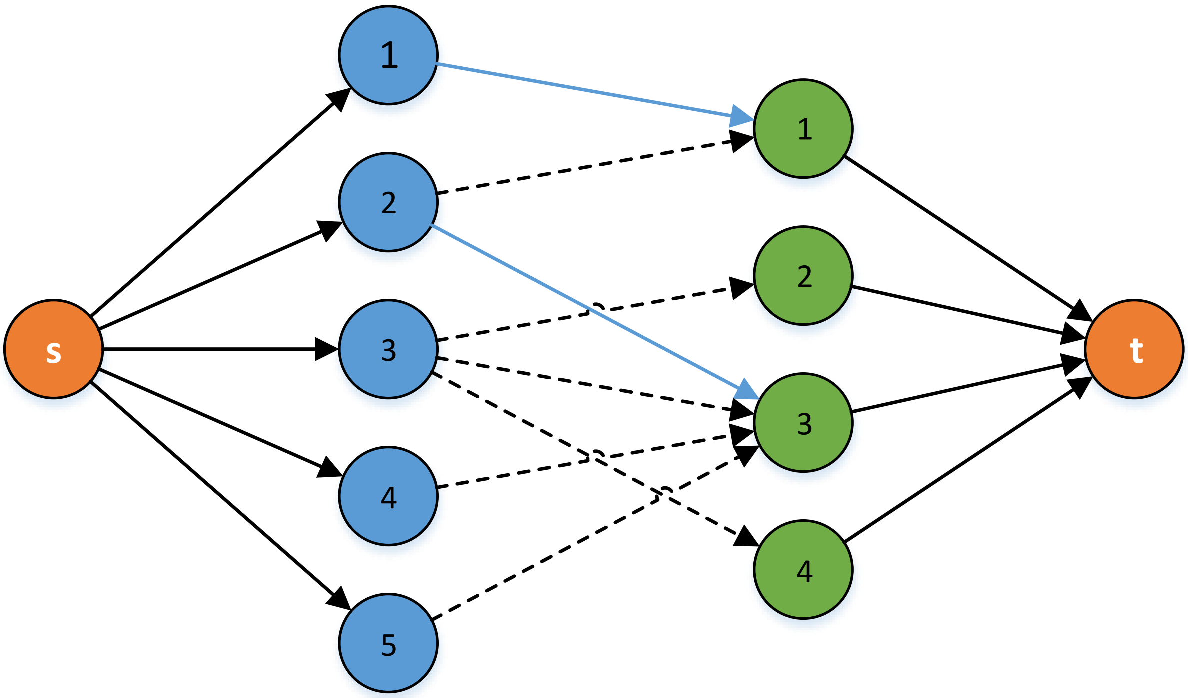


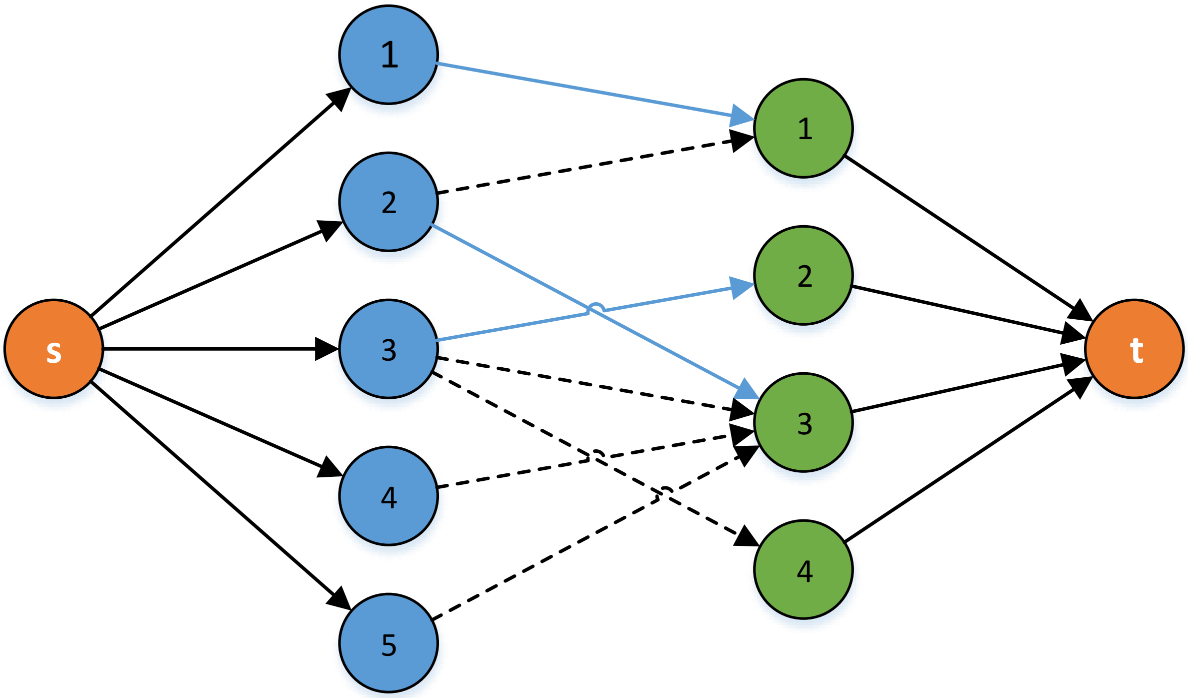
2. Source and sink are added



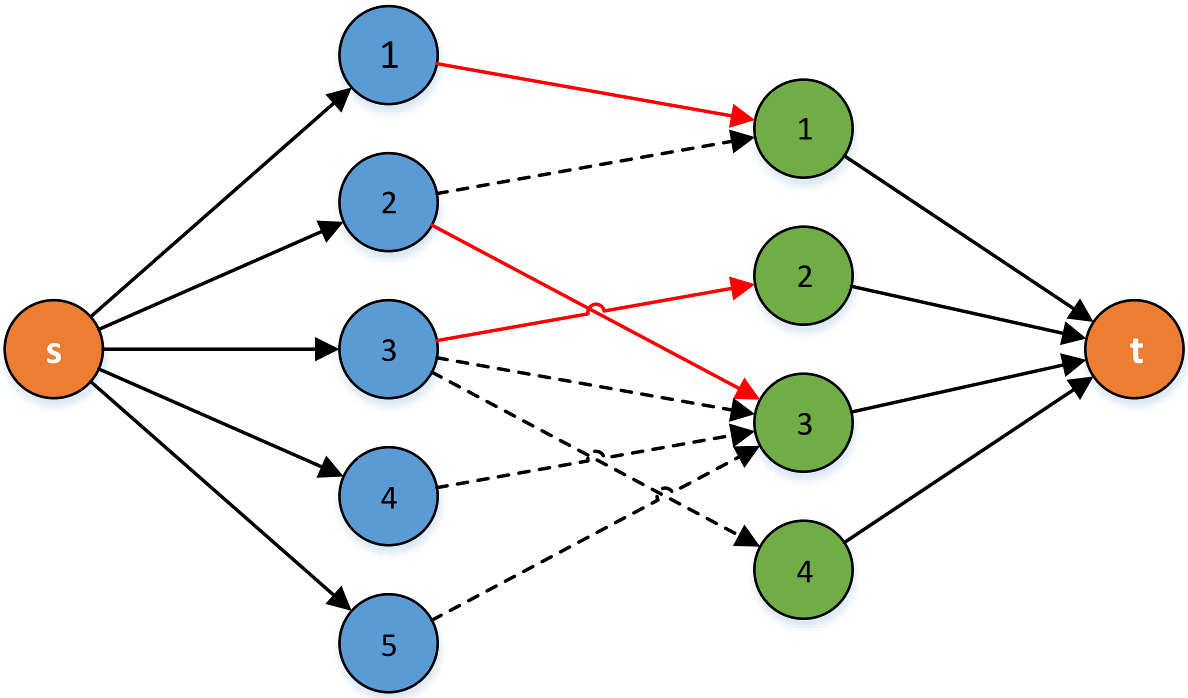
3. Algorithm starts







4. Algorithm finishes



5. Final graph, source and sink are removed