

**M1522.000900 Data Structure**  
**Spring 2025, Kang**  
**Homework 4 Answer Sheet [1/2]**

2023-12753 EunSu Yeo

- ※ Write your answers on the “your answer” columns.
- ※ Do **NOT** write anything on “score” columns.
- ※ Before submission, delete all the blue-colored texts, and convert the file into **PDF-format**.

| Question |                                     | Your Answer  | Points | Score |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|----------|-------------------------------------|--|--------|-------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|
| 1        | (1)                                 | $\frac{32}{11}$  | 5      |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          | (2)                                 | $\frac{63}{19}$  | 5      |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 2        |                                     | $P(3) = 0.34, P(4) = 0.27, P(5) = 0.18,$<br>$P(6) = 0.09, P(8) = 0.12$   | 15     |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 3        | (a)                                 | Not acceptable   | 15     |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          | (b)                                 | Acceptable, not good hash function   |        |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          | (c)                                 | Acceptable, good hash function   |        |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          | (d)                                 | Acceptable, not good hash function   |        |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 4        |                                     | (Answer in solution sheet)   | 10     |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 5        | (1)                                 | <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr><tr><td>A</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>B</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>C</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>D</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>E</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>F</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>G</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr></table> |        | A     | B | C | D | E | F | G | A | 0 | 1 | 1 | 0 | 0 | 0 | 0 | B | 1 | 0 | 1 | 1 | 0 | 0 | 0 | C | 1 | 1 | 0 | 1 | 0 | 1 | 0 | D | 0 | 1 | 1 | 0 | 1 | 1 | 1 | E | 0 | 0 | 0 | 1 | 0 | 0 | 1 | F | 0 | 0 | 1 | 1 | 0 | 0 | 1 | G | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 5 |  |
|          |                                     |  | A      | B     | C | D | E | F | G |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          |                                     | A  | 0      | 1     | 1 | 0 | 0 | 0 | 0 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          |                                     | B  | 1      | 0     | 1 | 1 | 0 | 0 | 0 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          |                                     | C  | 1      | 1     | 0 | 1 | 0 | 1 | 0 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          |                                     | D  | 0      | 1     | 1 | 0 | 1 | 1 | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          |                                     | E  | 0      | 0     | 0 | 1 | 0 | 0 | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          |                                     | F  | 0      | 0     | 1 | 1 | 0 | 0 | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|          | G                                   | 0  | 0      | 0     | 1 | 1 | 1 | 0 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| (2)      | 451 simple paths, 130 simple cycles | 5  |        |       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |

**M1522.000900 Data Structure**  
**Spring 2025, Kang**  
**Homework 4 Answer Sheet [2/2]**  
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| Question |     | Your Answer                 | Points | Score |
|----------|-----|-----------------------------|--------|-------|
| 6        |     | pnosmryvxwzuqt              | 10     |       |
| 7        |     | $\frac{n^3 + 3n^2 + 8n}{3}$ | 15     |       |
| 8        | (1) | a>c>f>e                     | 5      |       |
|          | (2) | 33                          | 5      |       |
|          | (3) | 22                          | 5      |       |

## Homework 4 Solution Sheet

2023-12753

EunSu Yeo

### 1. Question 1 [10 points]

#### 1.1. Q1(1) [5 points]

**Solution.**

[Write here](#)

For each selected i

i=0:  $1+1=2$

i=1:  $1+1=2$

i=2:  $1+2=3$

i=3: 1

i=4:  $2+1=3$

i=5:  $2+2=4$

i=6: 2

i=7:  $3+1=4$

i=8:  $3+2=5$

i=9: 3

i=10: 3

total sum: 32

probability to select each case:  $1/11$

$E(n)=32/11$

#### 1.2. Q1(2) [5 points]

**Solution.**

[Write here](#)

For each selected i

i=0:  $1+1=2$

i=1:  $1+1=2$

i=2:  $1+2=3$

i=3:  $1+2=3$

i=4:  $1+2=3$

i=5: 1

i=6:  $2+1=3$

i=7:  $2+1=3$

i=8:  $2+2=4$

i=9:  $2+2=4$

i=10:  $2+2=4$

i=11: 2

i=12:  $3+1=4$

i=13:  $3+1=4$

i=14:  $3+2=5$

i=15:  $3+2=5$

i=16:  $3+2=5$

i=17: 3

i=18: 3

total sum: 63

probability to select each case:  $1/19$

$E(n)=63/19$

### 2. Question 2 [15 points]

**Solution.**

[Write here](#)

With the given value the hash will be filled

$20 > \text{index } 9$

$24 > \text{index } 2$

$10 > \text{index } 10$

$9 > \text{index } 9(\text{collision occurs}) > \text{index } 1$

33>index 0

7>index 7

Now let's count the number that each index will be filled.

3:  $9+25=34$

4:  $9+18=27$

5:  $9+9=18$

6: 9

8:  $9+3=12$

Probability is 0.34, 0.17, 0.18, 0.09, 0.12 each

### 3. Question 3 [15 points]

**Solution.**

[Write here](#)

### 4. Question 4 [10 points]

**Solution.**

[Write here](#)

Count Heuristic

ABCDEFGH

D(1)ABCEFGH (4 comparison)

D(1)H(1)ABCEFG (8 comparison)

H(2)D(1)ABCEFG (2 comparison)

H(2)D(1)G(1)ABCEF (8 comparison)

H(3)D(1)G(1)ABCEF (1 comparison)

H(3)D(1)G(1)E(1)ABCF (7 comparison)

H(3)G(2)D(1)E(1)ABCF (3 comparison)

H(4)G(2)D(1)E(1)ABCF (1 comparison)

H(4)G(3)D(1)E(1)ABCF (2 comparison)

H(5)G(3)D(1)E(1)ABCF (1 comparison)

H(5)G(3)E(2)D(1)ABCF (4 comparison)

H(5)G(3)E(2)D(1)C(1)ABF

(7 comparison)

H(5)G(3)E(3)D(1)C(1)ABF

(3 comparison)

H(6)G(3)E(3)D(1)C(1)ABF

(1 comparison)

H(6)G(4)E(3)D(1)C(1)ABF

(2 comparison)

Total comparison: 54

Move-to-front Heuristic

DABCEFGH (4 comparison)

HDABCEFG (8 comparison)

HDABCEFG (1 comparison)

GHDABCEF (8 comparison)

HGDABCEF (2 comparison)

EHGDABCF (7 comparison)

GEHDABCF (3 comparison)

HGEDABCF (3 comparison)

GHEDABCF (2 comparison)

HGEDABCF (2 comparison)

EHGDABCF (3 comparison)

CEHGDABF (7 comparison)

ECHGDABF (2 comparison)

HCEGDABF (3 comparison)

GECHDABF (4 comparison)

Total comparison: 59

Transpose Heuristic

ABDCEFGH (4 comparison)

ABDCEFHG (8 comparison)

ABDCEHFG (7 comparison)

ABDCEHGF (8 comparison)

ABDCHEGF (6 comparison)

ABDCEHGF (6 comparison)

ABDCEGHF (7 comparison)

ABDCEHGF (7 comparison)

ABDCEGHF (7 comparison)

ABDCEHGF (7 comparison)

ABDECHGF (5 comparison)

ABDCEHGF (5 comparison)

ABDECHGF (5 comparison)

ABDEHCGF (6 comparison)

ABDEHGCF (7 comparison)

Total comparison: 95

## 5. Question 5 [10 points]

### 5.1. Q5(1) [5 points]

**Solution.**

[Write here](#)

### 5.2. Q5(2) [5 points]

**Solution.**

[Write here](#)

I've count the path that has length 0 which is path like A.

Though the given graph is undirected graph, the simple path and cycle has direction. So, I counted the path and cycle with the assumption that It's different cycle if the direction is different.

## 6. Question 6 [10 points]

**Solution.**

[Write here](#)

Let's assume that in DFS we visit the node in lexicographical order.

Starting with m

m>q>t(no deeper node)>r>u(no deeper node to go)>y>v>w>z(no deeper node)>x(no deeper node)

prints: tq/u/zw/x/vyr/m

n>o>s(no deeper node to go)

prints: son

p(no deeper node to go)

prints: p

Topological sort with DFS gives the reversed topological sequence. So the answer must be reversed to get the topological order

Answer: pnosmryvwxzuqt

## 7. Question 7 [15 points]

**Solution.**

[Write here](#)

1: n+n

(vertex for the outer line of the square)

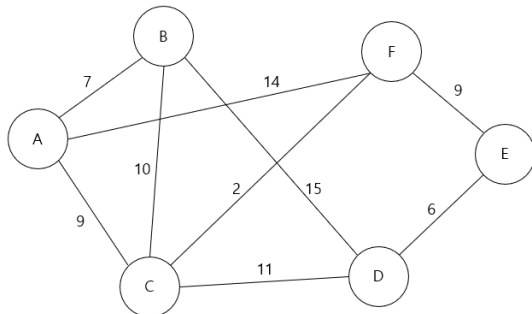
1: n+(n-1)=2n-1

2: n-1+(n-2)=2n-3

3: n-2+(n-3)=2n-5

n: n-(n-1)=1

$$\begin{aligned}
 & 2n + \sum_{k=1}^n (2n - (2k - 1))k \\
 &= 2n + \sum_{k=1}^n 2nk - \sum_{k=1}^n (2k^2 - k) \\
 &= 2n + n^2(n + 1) - 2\left(\frac{n(n+1)(2n+1)}{6}\right) + \frac{n(n+1)}{2} \\
 &= n^3 + \frac{3}{2}n^2 + \frac{5}{2}n - \frac{2n(n+1)(2n+1)}{6} \\
 &= \frac{2n^3 + 3n^2 + 13n}{6}
 \end{aligned}$$

**8. Question 8 [15 points]****8.1. Q8(1) [5 points]****Solution.**[Write here](#)

Let's think the situation using dijkstra's algorithm from the vertex a.

Step 1: check the smallest weight. We can find that edge(a,b) has the smallest weight. So connect the edge(a,b)

Step 2: check the smallest weight.

We can find the edge (a,c) is the smallest weight. So connect the edge(a,c)

Step 3: check the smallest weight.

It's edge(c,f). So connect the edge(c,f)

Step 4: check the smallest weight.

It's edge(f,e). So connect the edge (f,e)

Step 5: check the smallest weight.

It's edge (e,d). So connect the edge(e,d)

Then the algorithm stops.

We can find the shortest-path from a to e is  $a \rightarrow c \rightarrow f \rightarrow e$ .

**8.2. Q8(2) [5 points]****Solution.**[Write here](#)**8.3. Q8(3) [5 points]****Solution.**[Write here](#)

Maximum number of edge examined in before building MST by Kruskal's algorithm is 22