CSCE 221 Cover Page
Homework Assignment #3
Due April 24 at 23:59 pm to eCampus

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Please list all sources in the table below including web pages which you used to solve or implement the current homework. If you fail to cite sources you can get a lower number of points or even zero, read more on Aggie Honor System Office website: `http://aggiehonor.tamu.edu/`

Type of sources				
People				
Web pages (provide URL)				
Printed material	Textbook			
Other Sources	Lecture Slides			

I certify that I have listed all the sources that I used to develop the solutions/codes to the submitted work.
On my honor as an Aggie, I have neither given nor received any unauthorized help on this academic work.

Your Name: Pratik Patel Date: 04/24/2019

Homework 3 (100 points)

due April 24 at 11:59 pm to eCampus.

Write clearly and give full explanations to solutions for all the problems. Show all steps of your work.

Reading assignment.

- Hash Tables Chap. 9
- Heap and Priority Queue, Chap. 8
- Graphs, Chap. 13

Problems.

1. (10 points) R-9.7 p. 417

   Draw the 11-entry hash table that results from using the has function, $h(k) = (3k + 5)$ mod 11, to hash the keys 12, 44, 13, 88, 23, 94, 11, 39, 20, 16, and 5, assuming collisions are handled by chaining.

1)

$h(12) = (3(12)+5)\ \%\ 11 = 41\ \%\ 11 = 8$

$h(44) = (3(44)+5)\ \%\ 11 = 137\ \%\ 11 = 5$

$h(13) = (3(13)+5)\ \%\ 11 = 44\ \%\ 11 = 0$

$h(88) = (3(88)+5)\ \%\ 11 = 269\ \%\ 11 = 5$

$h(23) = (3(23)+5)\ \%\ 11 = 74\ \%\ 11 = 8$

$h(94) = (3(94)+5)\ \%\ 11 = 287\ \%\ 11 = 1$

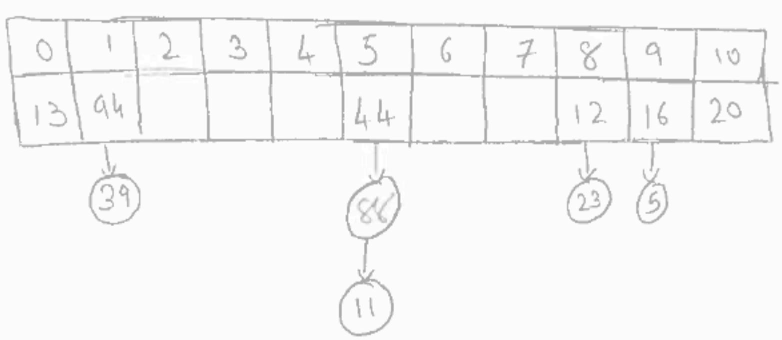
$h(11) = (3(11)+5)\ \%\ 11 = 38\ \%\ 11 = 5$

$h(39) = (3(39)+5)\ \%\ 11 = 122\ \%\ 11 = 1$

$h(20) = (3(20)+5)\ \%\ 11 = 65\ \%\ 11 = 10$

$h(16) = (3(16)+5)\ \%\ 11 = 53\ \%\ 11 = 9$

$h(5) = (3(5)+5)\ \%\ 11 = 20\ \%\ 11 = 9$



2. (10 points) R-9.8 p. 417

What is the result of the previous exercise, assuming collisions are handled by linear probing?

2)

0	1	2	3	4	5	6	7	8	9	10
13	94	39	16	5	44	88	11	12	23	20

h(12) = 8
h(44) = 5
h(13) = 0
h(88) = 5 ← Collision, so move to next available index (6)
h(23) = 8 ← Collision, so move to next available index (9)
h(94) = 1
h(11) = 5 ← Collision, so move to next available index (7)
h(39) = 1 ← collision, son move to next available index (2)
h(20) = 10
h(16) = 9 ← Collision, so move to next available index (3)
h(5) = 9 ← Collision, so move to next available index (4)

3. (10 points) R-9.10 p. 417

What is the result of Exercise R-9.7, when collisions are handled by double hashing using the secondary hash function $h_s(k) = 7 - (k \bmod 7)$?

3)

$h(12) = 8$

$h(44) = 5$

$h(13) = 0$

$h(88) = 5$ -> Collison, therefore,

$h(88) + h_s(88) = 5+3 = 8$

$\therefore h(8) = 7$

$\therefore h(88) = 7$

$h(23) = 8$ -> Collision, therefore,

$h(23) + h_s(23) = 8+5 = 13$

$h(13) = 0$

$\therefore h(23) = 0$

-> Again Collision,

$h(23) + 2h_s(23) = 8+10 = 18$

$h(18) = 4$

$\therefore h(23) = 4$

$h(94) = 1$

$h(11) = 5$ -> Collision, therefore,

$h(11) + h_s(11) = 5+3 = 8$

$h(8) = 7$

$\therefore h(11) = 7$

-> Again Collision,

$h(11) + 2h_s(11) = 5+6 = 11$

$h(11) = 5$

-> Again Collision,

$h(11) + 3h_s(11) = 5+9 = 14$

$h(14) = 4$

$\therefore h(11) = 4$

-> Again Collision.

$h(11) + 4h_s(11) = 5+12 = 17$

$h(17) = 1$

$\therefore h(11) = 1$

-> Again Collision,

$h(11) + 5h_s(11) = 5+15 = 20$

$h(20) = 10$

$\therefore h(11) = 10$

$h(39) = 1 \rightarrow$ Collision, therefore,

$$h(39) + h_s(39) = 1 + 3 = 4$$
$$h(4) = 6$$
$$\therefore h(39) = 6$$

$h(20) = 10 \rightarrow$ Collision, therefore,

$$h(20) + h_s(20) = 10 + 1 = 11$$
$$h(11) = 5$$
$$\therefore h(20) = 5$$

$\rightarrow$ Again Collision.

$$h(20) + 2h_s(20) = 10 + 2 = 12$$
$$h(12) = 8$$
$$\therefore h(20) = 8$$

$\rightarrow$ Again Collision,

$$h(20) + 3h_s(20) = 10 + 3 = 13$$
$$h(13) = 0$$
$$h(20) = 0$$

$\rightarrow$ Again Collision,

$$h(20) + 4h_s(20) = 10 + 4 = 14$$
$$h(14) = 4$$
$$\therefore h(20) = 4$$

$\rightarrow$ Again Collision.

$$h(20) + 5h_s(20) = 10 + 5 = 15$$
$$h(15) = 6$$
$$\therefore h(20) = 6$$

$\rightarrow$ Again Collision,

$$h(20) + 6h_s(20) = 10 + 6 = 16$$
$$h(16) = 9$$
$$\therefore h(20) = 9$$

$h(16) = 9 \rightarrow$ Collision, therefore

$$h(16) + h_s(16) = 9 + 5 = 14$$
$$h(14) = 4$$
$$\therefore h(16) = 4$$

$\rightarrow$ Again Collision

$h(16) + 2h_s(16) = 9 + 10 = 19$

$h(19) = 7$

$\therefore h(16) = 7$

$\rightarrow$ Again Collision,

$h(16) + 3h_s(16) = 9 + 15 = 24$

$h(24) = 0$

$\therefore h(16) = 0$

$\rightarrow$ Again Collision,

$h(16) + 4h_s(16) = 9 + 20 = 29$

$h(29) = 4$

$\therefore h(16) = 4$

$\rightarrow$ Again Collision

$\vdots$

$h(16) + 9h_s(16) = 9 + 45 = 54$

$h(54) = 2$

$\therefore h(16) = 2$

$h(5) = 9 \rightarrow$ Collision, therefore,

$h(5) + h_s(5) = 9 + 2 = 11$

$h(11) = 5$

$\therefore h(5) = 5$

$\rightarrow$ Again Collision,

$\vdots$

$\rightarrow$ Again Collision,

$h(5) + 8h_s(5) = 9 + 16 = 25$

$h(25) = 3$

$\therefore h(5) = 3$

0	1	2	3	4	5	6	7	8	9	10
13	94	16	5	23	44	39	88	12	20	11

4. (10 points) R-8.7 p. 361

An airport is developing a computer simulation of air-traffic control that handles events such as landings and takeoffs. Each event has a *time-stamp* that denotes the time when the event occurs. The simulation program needs to efficiently perform the following two fundamental operations:

- Insert an event with a given time-stamp (that is, add a future event)
- Extract the event with smallest time-stamp (that is, determine the next event to process)

Which data structure should be used for the above operations? Why? Provide big-oh asymptotic notation for each operation.

4) Binary Heap

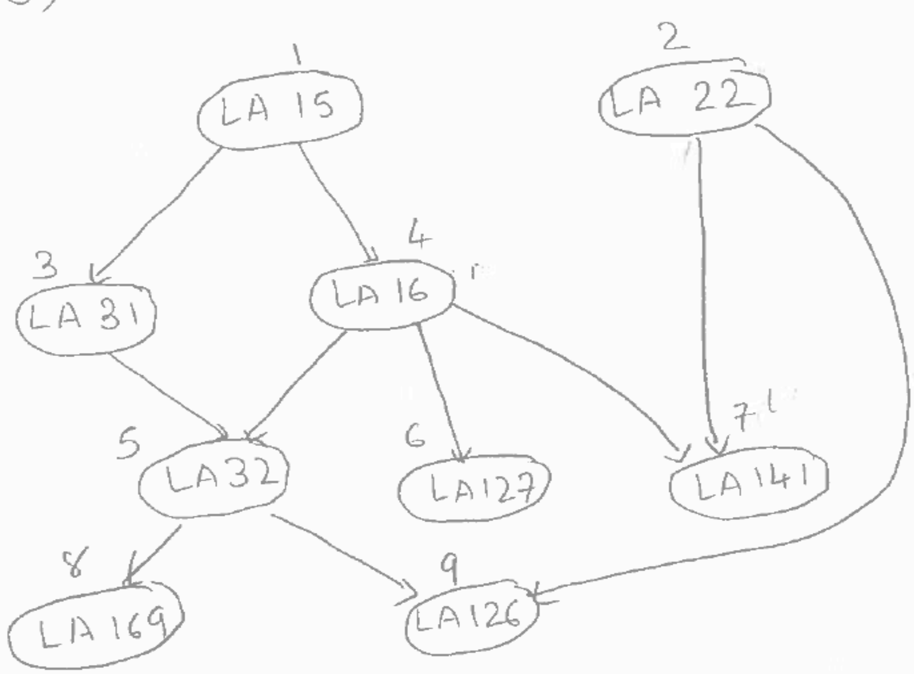
-> because we can remove the smallest element, which is the root and will take $\underline{O(1)}$ time.

-> Inserting elements will take $\underline{O(\log_2 n)}$ time

-> The keys will be the time stamp.

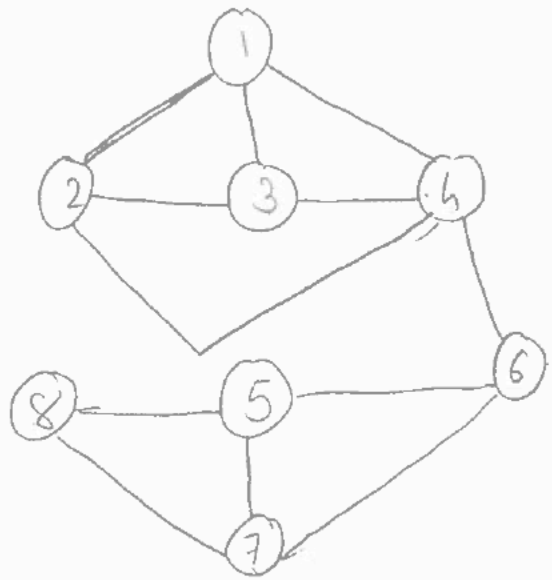
5. (10 points) R-13.5, p. 654

5)



6. (10 points) R-13.7, p. 655

6)



Starting Index-1

DFS : 1 2 3 4 6 5 8 7

BFS : 1 2 3 4 6 5 7 8

7. (10 points) R-13.16, p. 656

7)

```
Algorithm Dijkstra (G, v)

for all u ∈ G do    // Assume u is a vertex
    if (u = v)
        D[u] = 0
    else
        D[u] = ∞

Q ← Priority Queue
T ← tree
while (¬ Q.empty()) do
    u = Q.removeMin()
    if ( ¬ (u = v))
        T.addEdge(adj[u], u)
    for all z ∈ Q that z is adjacent to u do
        if (D[u] + w((u,z)) < D[z])
            D[z] = D[u] + w((u,z))
            change D[z] to key of vertex z in Q
            adj[z] = u

return T and the label D(u) of each vertex u.
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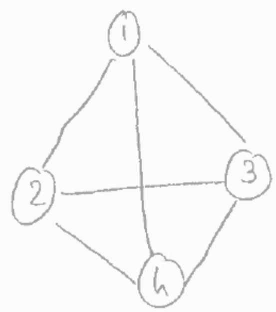
8. (10 points) R-13.31, p. 657

8)

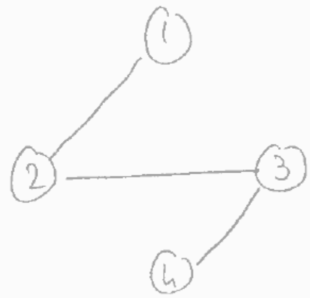
Graph



DFS starting from index 1,

1, 2, 3, 4

-> the tree will look like



∴ The search tree of a complete undirected graph looks like a path.

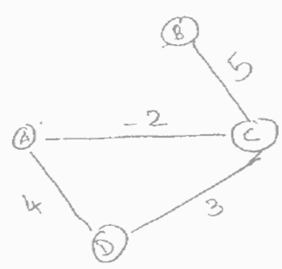
9. (10 points) C-13.10, p. 658

9)

We can use a similar algorithm to DFS. With necessory modifications we must not close circuits before all the edges are traversed. Whenever, there is a vertex with odd number of adjacent edges which aren't traversed yet, we can do a DFS and close the circuit. If we close a circuit and not all edges are traversed, we can then back track to the last vertex we saw with untraversed edges and make it a distinguished vertex. Then we try to find another edge that hasn't been traversed. In the end, we attach the old circuit to the new one. This algorithm takes $O(n+m)$ time because it is a modification of DFS. Attaching circuits would take $O(m)$ atmost.

10. (10 points) C-13.15, p. 659

10)



The shortest path from A to D = 4

→ The path $A \to C \to D$ gives us.

$$(-2) + 3 = 1$$

Hence it is incorrect, since $4 \neq 1$