CS395
Assignment 2
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1)
a)
graph a)

DFS =>

f 5,1
g 4,2
e 3,3
b 2,4   c 7,6
a 1,5   d 6,7

graph b)
Not a directed acyclic graph, so cannot be topologically sorted.

b)
graph a)
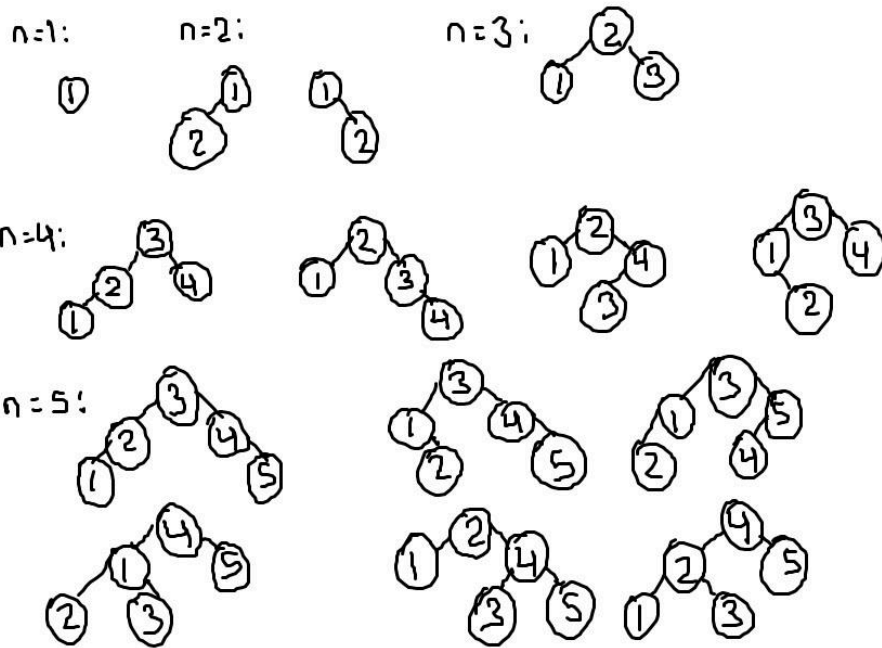
Source-Removal =>

f 7, 1
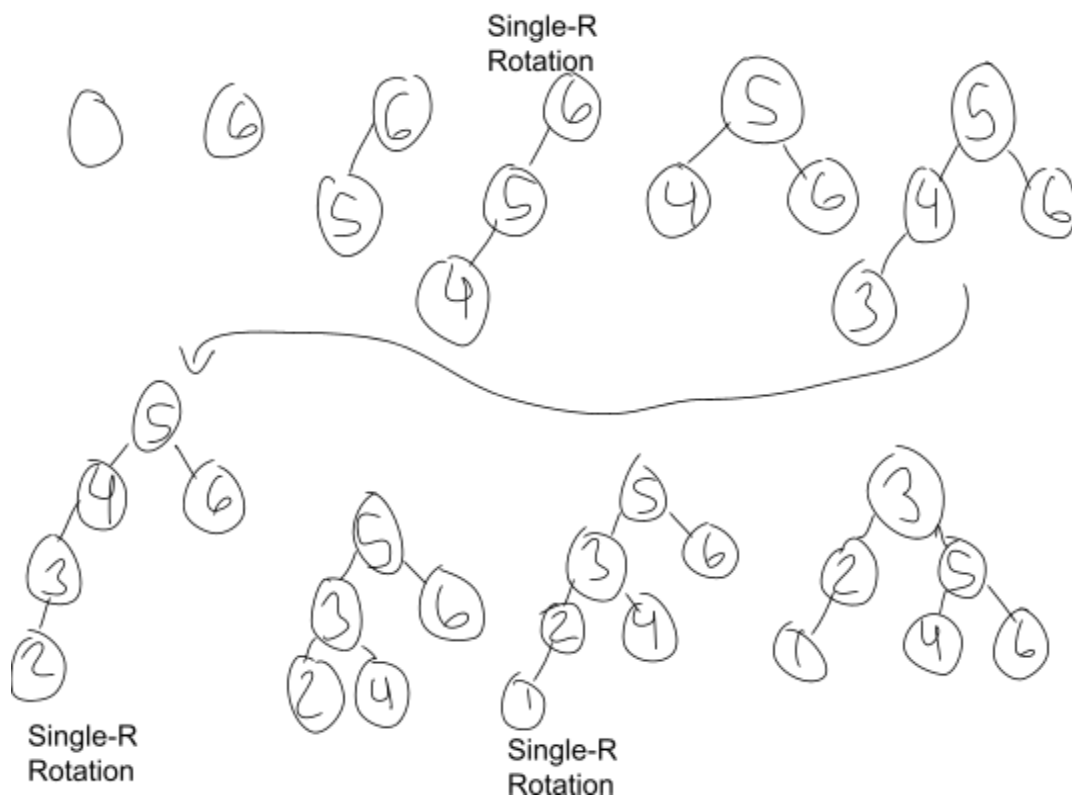e 6, 2
g 5, 3
c 4, 4
b 3, 5
a 2, 6
d 1,7

graph b)
Not a directed acyclic graph, so cannot be topologically sorted.

2)

3)

4)

	Unordered array		Ordered array		Binary search tree		Balanced search tree		hashing	
	Average case	Worst case	Average case	Worst case	Average case	Worst case	Average case	Worst case	Average case	Worst case
search	O(n)	O(n)	O(log n)	O(log n)	O(log n)	O(n)	O(log n)	O(log n)	O(1)	O(n)
insert	O(1)	O(1)	O(n)	O(n)	O(log n)	O(n)	O(log n)	O(log n)	O(1)	O(1)
delete	O(n)	O(n)	O(n)	O(n)	O(log n)	O(n)	O(log n)	O(log n)	O(1)	O(n)

5)
a)
<u>**Selection Sort:**</u>

$$\sum_{i=0}^{n-1} \sum_{j=i+1}^{n-1} (1) \implies \sum_{i=0}^{n-1} (n-i-1+1)$$

$$= n \sum_{i=0}^{n-1} (1) - \sum_{i=0}^{n-1} (i)$$

$$= n(n-1+1) - ((n-1)(n-1+1))/2$$

$$= (2n^2/2) - ((n^2 - n)/2)$$

$$= n(n-1)/2$$

$$\implies \theta(n^2)$$

Insertion Sort:

$$\sum_{i=0}^{n-1} \sum_{i=0}^{i-1} 1 \quad => \quad \sum_{i=0}^{n-1} (i-1-0) + 1$$

$$= \sum_{i=0}^{n-1} (i)$$

$$= ((n-1)(n-1+1))/2$$

$$= n(n-1)/2$$

$$=> \theta(n^2)$$

Quick Sort:

$q(n) = 2q(n/2) + n$

Using the Master Theorem,
a = 2, b = 2, d = 1

$a = b^d$

$2 = 2^1$

So, complexity is:

$\theta(n \log n)$

5)
b)
In selection sort and insertion sort, we can see how the time duration increases by 100, or 10^2, each increase in complexity.

In quick sort, we can see the time goes up by a factor of $2 \log_{10}(2)$, which is slightly more than 10, but much less than the duration increase from insertion or selection sorts.

Results from assignment:
```
+-----------------------------------------------+
| Number of elements: 1000
|   Selection sort time: 1487.0 sec
|   Insertion sort time: 782.0 sec
|   Quick sort time: 67.0 sec
+-----------------------------------------------+
| Number of elements: 10000
|   Selection sort time: 145872.0 sec
|   Insertion sort time: 78504.0 sec
|   Quick sort time: 696.0 sec
+-----------------------------------------------+
| Number of elements: 100000
|   Selection sort time: 14531123.0 sec
|   Insertion sort time: 7770646.0 sec
|   Quick sort time: 7672.0 sec
+-----------------------------------------------+
```
6)
a)
Text: CCCCCCCCABC
Pattern: ABC

b)
Text: ABABABABC
Pattern: ABC

Horspool:
```
ABABABABC
ABC
    ABC
      ABC
          ABC
```

Boyer-Moore:
```
ABABABABC
        ABC
       ABC
      ABC
```

They are different since Boyer-Moore checks from both sides of the text, rather than Horspool which checks from the left. Horspool will take longer as it will have more false positives while checking.