CS203 B Data Structure

Final

Part 1 choices (50%)

1. Suppose that we use *struct node* to represent binary trees, and use function *test* to process a binary tree.

```
struct node
{
    int data;
    struct node *left, *right;
};
struct node *y;
void test(struct node *p)
{
    struct node *q;
    if (p->left!=NULL)
        test(p->left);
    if (p->right!=NULL)
        test(p->right);
    q = p->left;
    p->left = p->right;
    p->right =q;
}
```

1A. Which order does function *test(r)* use to traverse the tree with root node pointed by the pointer r? (4%)

(a) Preorder

(b) Inorder

(c) Postorder

(d) Level order

1B. Suppose the binary tree is of *n* nodes What is the time complexity of the function *test*? (4%)

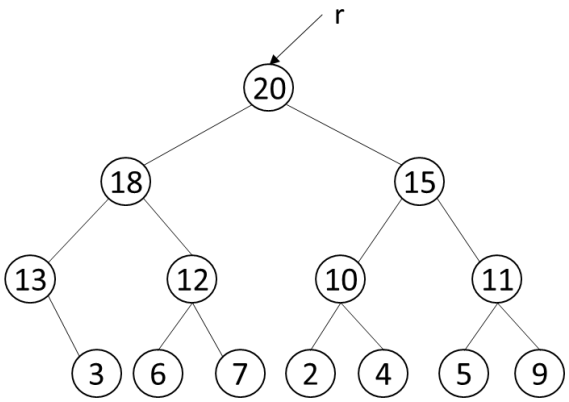
(a) O(log n)

(b) O(n)

(c) O(nlogn)

(d) $O(n^2)$

1C. Consider the following binary tree. After the execution of function *test(r)*, what is the value of the data of the rightmost node? (4%)



(a) 3
(b) 7
(c) 6
(d) None of above

2. A list L consists of n objects with one root pointer and one tail pointer pointing to its first and last object. As shown in the following table there are two data structures used to form the list L. What is the asymptotic worst-case running time for each dynamic-set operation listed? (14%)

	unsorted doubly linked	Sorted, doubly linked
Search(L, k)	2A B	2H B
Insert(L, p)	2B A	2I B
Delete(L, p)	2C A	2J A
Successor(L, p)	2D A	2K A
Predecessor(L, p)	2E A	2L A
Minimum(L)	2F B	2M A
Maximum(L)	2G B	2N A

Where Search(L, k) return the object whose key equals k in L; Insert(L, p) inserts an object pointed by p into L; Delete(L, p) deletes an object pointed by p from L; Successor(L, p)/Predecessor(L, p) returns the next/previous object of the current one pointed by p in L; Minimum(L)/maximum(L) returns the minimum/maximum key in L.

Please choose from the following items as the answers:

(a) O(1)
(b) O(n)
(c) O(logn)
(d) O(nlogn)

3. A job priority queue is implemented using a min-heap in which a lower key value means a higher priority. The jobs are entered and stored in the min-heap as shown in the following array Q.

index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
keyvalue	-	6	8	10	12	24	15	13	20	18	26						

3A. Next job is extracted from the job queue for execution. What is the value of Q[4] in the remaining job queue? (4%)

(a) 15

(b) 18

(c) 20

(d) 26

3B. After step 3A is executed, next job is extracted from the job queue for execution. What is the value of Q[5] in the remaining job queue? (4%)

(a) 13

(b) 15

(c) 18

(d) 24

3C. After step 3B is executed, a new job with priority 11 is inserted into the job queue. What is the value of Q[9] in the remaining job queue? (4%)

(a) 18

(b) 20

(c) 24

(d) 26

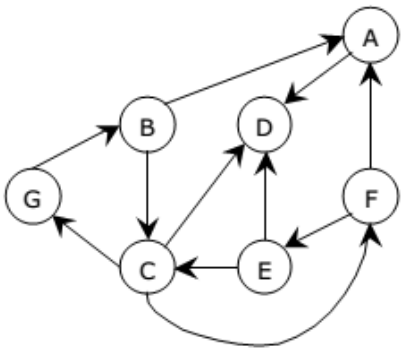
4. For the figure as below, which edge does not occur in the depth first spanning tree resulting from depth first search staring at node B. (4%)

(a) F -> E

(b) E -> C

(c) C -> G

(d) C -> F



Node	Adjacency List
A	D
B	A C
C	G D F
D	----
E	C D
F	E A
G	B

5. The recurrence relation formed for the complexity of binary search is. (4%)

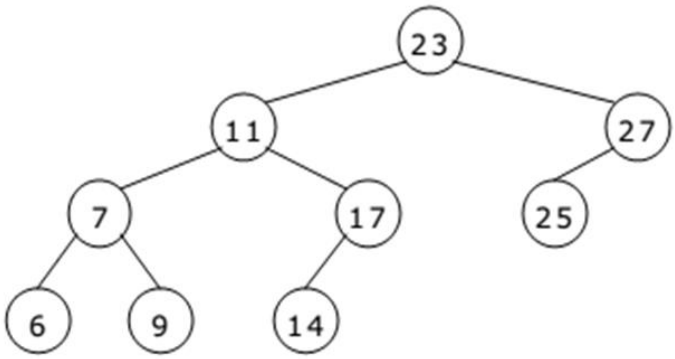
   (a) $T(n) = T\left(\frac{n}{2}\right) + k, k$ is constant

   (b) $T(n) = 2T\left(\frac{n}{2}\right) + k, k$ is constant

   (c) $T(n) = T\left(\frac{n}{2}\right) + logn$

   (d) $T(n) = T\left(\frac{n}{2}\right) + n$

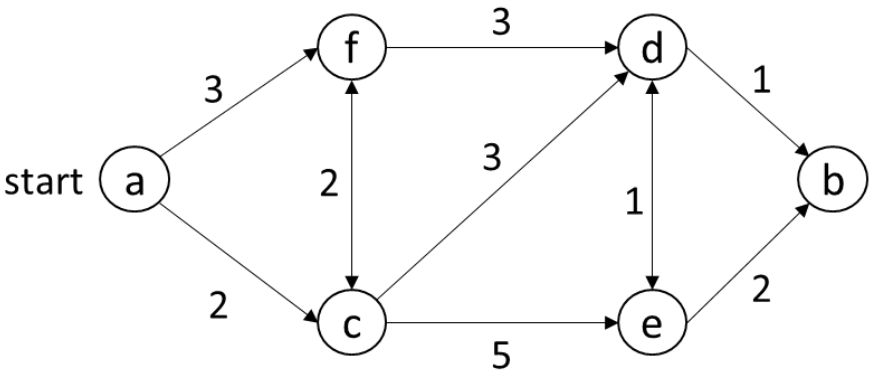
6. For the binary search tree shown in following figure, after deleting 23 from the binary search tree what parent->child pair does not occur in the tree?



   (a) 25->27
   (b) 27->11
   (c) 11->7
   (d) 7->9

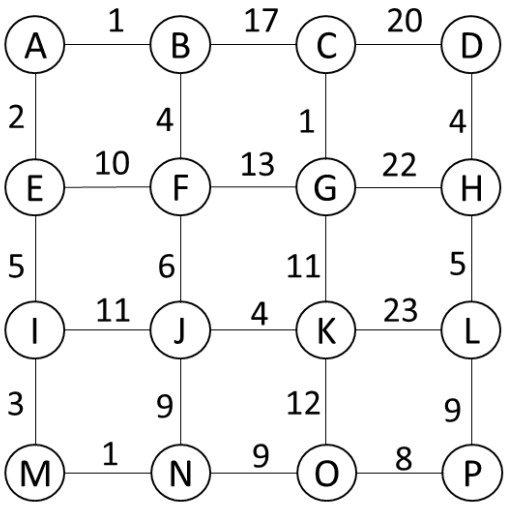
Part 2 Essay (60%)

1. Consider the single source shortest path problem: form a given vertex called the source in a weight di-graph G = (V, E), find shortest paths to all its other vertices. Dijkstra's algorithm is a famous algorithm for this problem. At each stage, the algorithm finds a shortest path from the source to a vertex. Describe such a process clearly (fulfill the table) on the following di-graph with vertex *a* as the source. (8%)



S	Vertex Selected	a	b	c	d	e	f
{a}	c	0	∞	2	∞	∞	3
{a,c}	f	0	∞	2	5	7	3
{a,c,f}	d	0	∞	2	5	7	3
{a,c,f,d}	b	0	6	2	5	6	3
{a,c,f,d,b}	e	0	6	2	5	6	3
{a,c,f,d,b,e}		0	6	2	5	6	3

2. For the following graph G, answer the following questions. Break all ties by picking the vertices in alphabetical order (i.e., A before Z)



2A. Report the order of the vertices encountered on a breadth-first search of G starting from vertex A. (2%) ABECFIDGJMHKNLOP

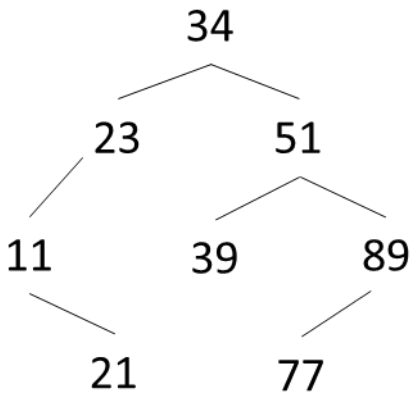
2B. Report the order of the vertices encountered on a depth-first search of G starting from vertex A (2%) ABCDHGFEIJKLPONM

2C. Find the minimum spanning tree of G. Write the answer in DFS order starting from vertex A. (5%) ABFJKGCEIMNOPLHD

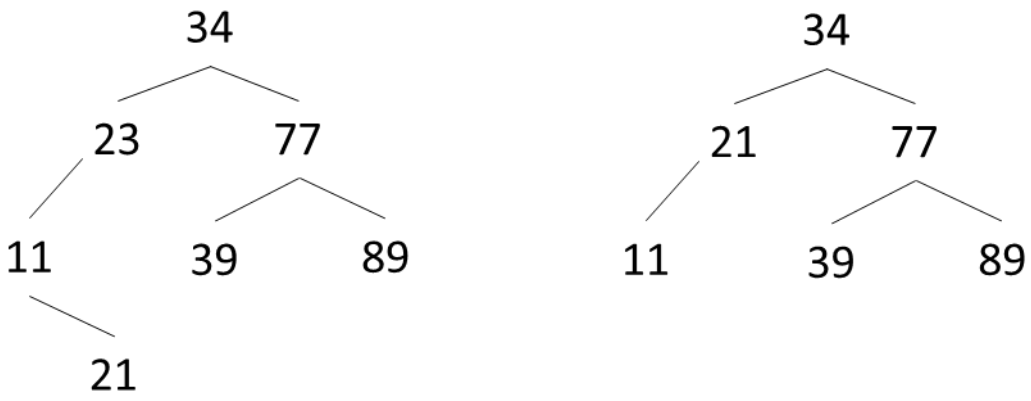
2D. Find the shortest path spanning tree of G rooted in vertex A. Write the answer in DFS order starting from vertex A. (Hint: Dijkstra's algorithm)(7%) ABCDFGHJKEIMNOPL

3. Consider a binary search tree for storing a set of integer values. Answer the following questions.

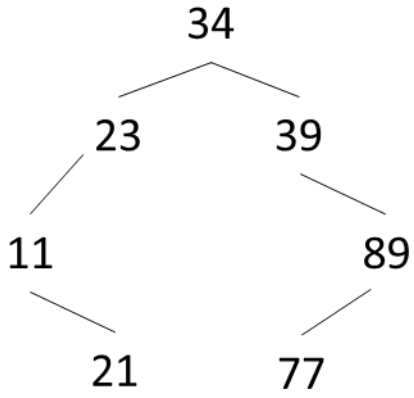
3A. Show the structure of the binary search tree after inserting eight integer values {34, 51, 23, 11, 89, 39, 77, 21} in this order as a diagram. (4%)

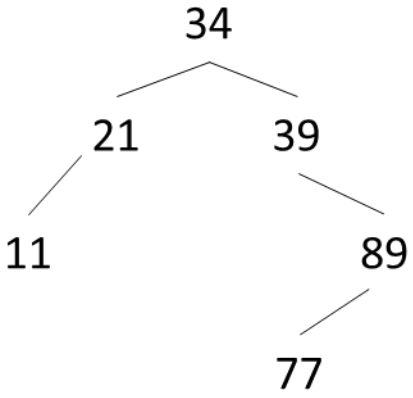


3B. Show the strucrute of the above binary search tree after deleting two integer values {51, 23} in this order as a diagram. (4%)



或





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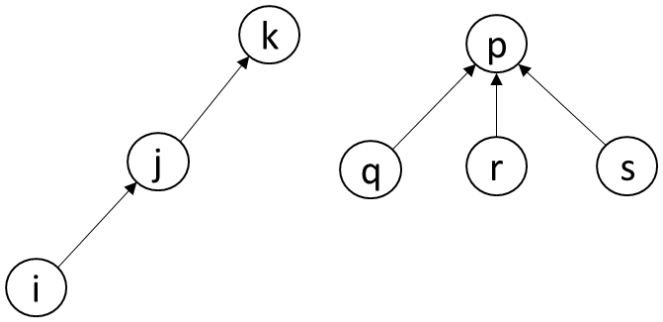
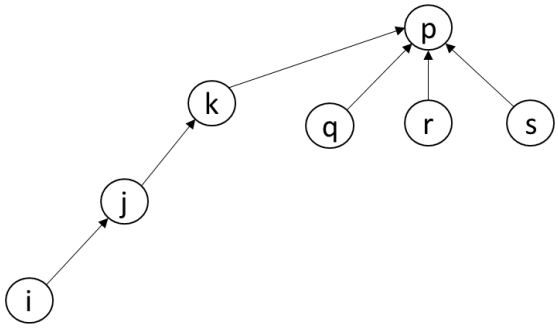
3C. In what situations does the height of the binary search tree become n after inserting n integer values? (2%)

當 input 為已排序過的資料

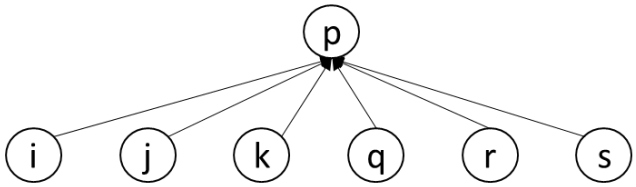
4. Forest representation for the Union-Find operations: given two sets shown in following figure.



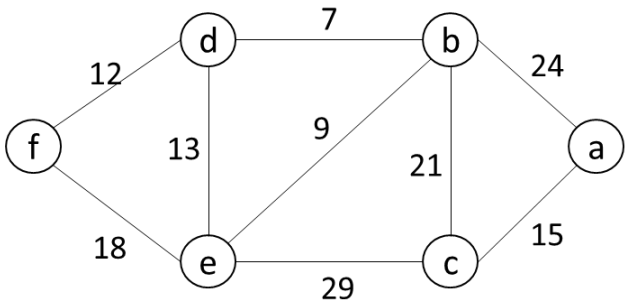
4A. What is the result after Union of the two sets, if the weighting rule is applied. (4%)



4B. Given the set after Union, what is the result after the Find(i) operation if the collapsing rule is applied. (4%)

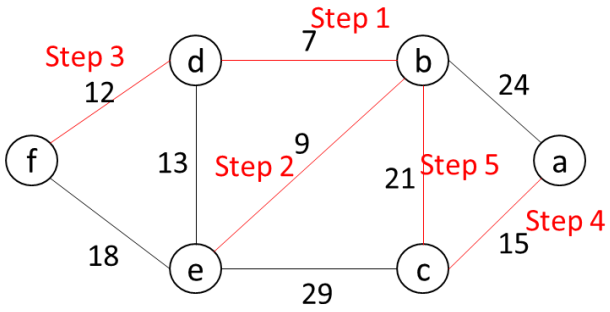


5. Consider the following graph:

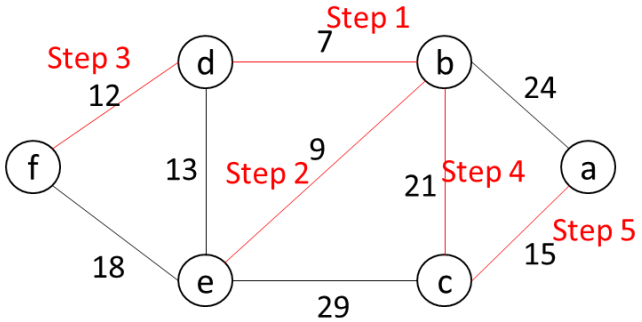


Compute minimum cost and construct minimum spanning tree step by step by using:

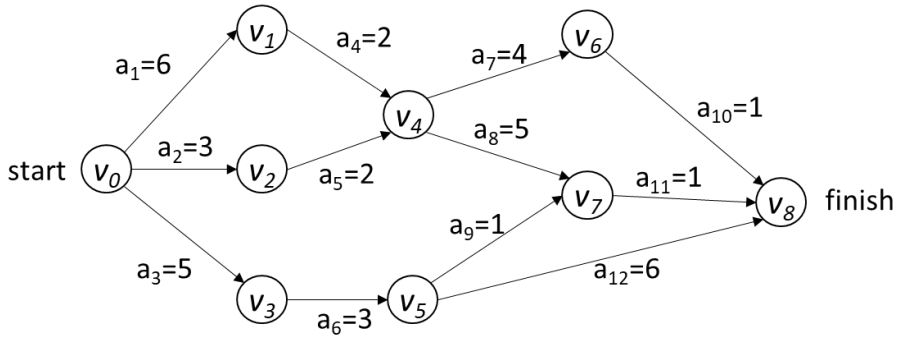
5A. Kruskal's algorithm. (4%)



5B. Prim's algorithm. (4%)



6. Consider the following AOE network



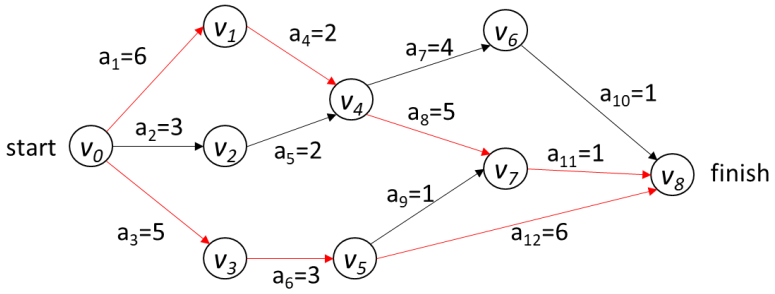
6A. Obtain *e(i)* and *l(i)* for all activity *i*.(4%)

	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}	a_{11}	a_{12}
e(i)	0	0	0	6	3	5	8	8	8	12	13	8
l(i)	0	3	0	6	6	5	9	8	12	13	13	8

6B. List all critical activities. (3%)

a_1 a_3 a_4 a_6 a_8 a_{11} a_{12}

6C. List all critical paths. (3%)



Part 3 Bonus (20%)

1. 給學弟妹的一段話，請考試結束後掃描 QRcode 填寫 (10%)

2. 請寫出作業三，在 linux 環境中處理中文 UTF8 編碼的程式碼(包含 include). (請依照你的作業三內容寫，如無繳交則直接作答) (10%)