

一、 True/False (10 points)

F	F	F	F	F
T	F	T	T	F

二、 Multiple choice(20 points)

A	A	A	A	A
A	A	C	D	D

三、 Short Answer(24 points)

- Given the following array of 9 elements, trace one iteration of the quick sort algorithm. Use the middle value in the array as the pivot. Assume the array is to be sorted in ascending order.

81 16 4 6 34 11 23 67 52

Answer: pivot = 34 (2 分)

81 16 4 6 34 11 23 67 52

swap the pivot with the last value in the array

81 16 4 6 52 11 23 67 34

swap 81 and 23 (1 分)

23 16 4 6 52 11 81 67 34

swap 52 and 11 (1 分)

23 16 4 6 11 52 81 67 34

swap pivot with the element at the index from the left (element is 52) (2 分)

23 16 4 6 11 34 81 67 52

end of first iteration

- Given the following array, show the comparisons to an array entry that are performed to search for the number 23 if you use the binary search algorithm?

2 3 5 7 11 13 17 19 23 29 31 37

Answer: 23 == 13, 23 < 13 (3 分), 23 == 23 (3 分)

- Given a table size of 19 the hash function $h(k) = k \% \text{table size}$ and the entries 19, 38, 20, 39 and 21 show the hash table after the five entries are inserted into the table using open addressing with linear probing.

Answer: 19 % 19 = 0

38 % 19 = 0 << collision (1 分)

20 % 19 = 1 << collision (1 分)

39 % 19 = 1 << collision (2 分)

21 % 19 = 2 << collision (2 分)

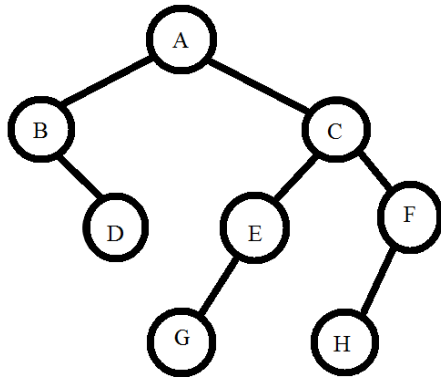
index

0	1	2	3	4	5	6	7	8	9	10	11	12
---	---	---	---	---	---	---	---	---	---	----	----	----

entry

19	38	20	39	21
----	----	----	----	----

4. Give the postorder traversal of the following binary tree.



Answer:DB(2 分)GEHFC (3 分) A (1 分)

四、Application (36 points)

1. A communication system uses eight characters to transmit messages. Before information transmission, it needs to be converted into binary code, and the frequency of each character is shown in Table 1.

Table 1 character frequency distribution table

a	b	c	d	e	f	g	h
0.11	0.03	0.23	0.04	0.08	0.25	0.21	0.05

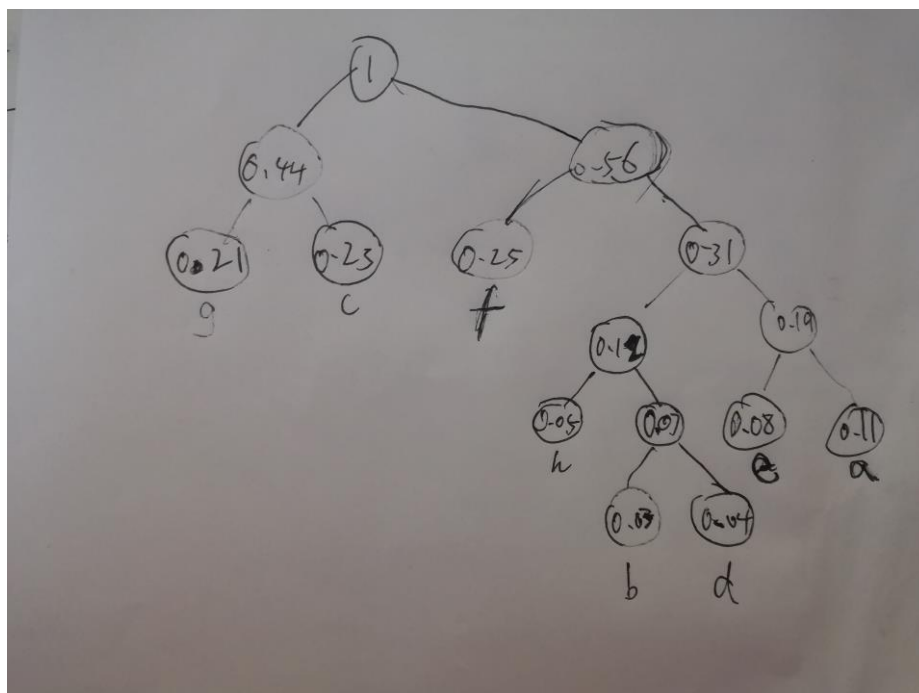
According to the basic principles and algorithms you have learned, complete the following tasks:

- i. Using the optimal binary tree can construct variable length prefix code and shorten the message length. What is the optimal binary tree? (2 points)

Answer: The optimal binary tree is also called Huffman Tree (2 分或者得后面的) . It is a binary tree that has minimum weighted path length(2 分), for n leaf nodes with n weights.

- ii. Please give the algorithm principle, coding process and results of constructing variable length prefix coding with optimal binary tree (when constructing optimal binary tree, keep the weight of left child less than the right child). (10 points)

Answer:



(4 分) 层次不乱, 可得 5 分, 左右错了扣一分

a	1111
b	11010
c	01
d	11011
e	1110
f	10
g	00
h	1100

(4 分) 01 反了不扣分, 树左右错的情况下编码与树相对应不扣分。

2. For the convenience of transporting goods, the road in the scenic area need to be repaired so that any two scenic spots can be connected by cement road (which can be reached through other scenic spots, as long as there is cement road connection). After the investigation of the existing road conditions, some statistical data are obtained. The cost of maintenance of the existing roads in the scenic area is listed in Table 2.

Table 2 scenic spots and repairing costs

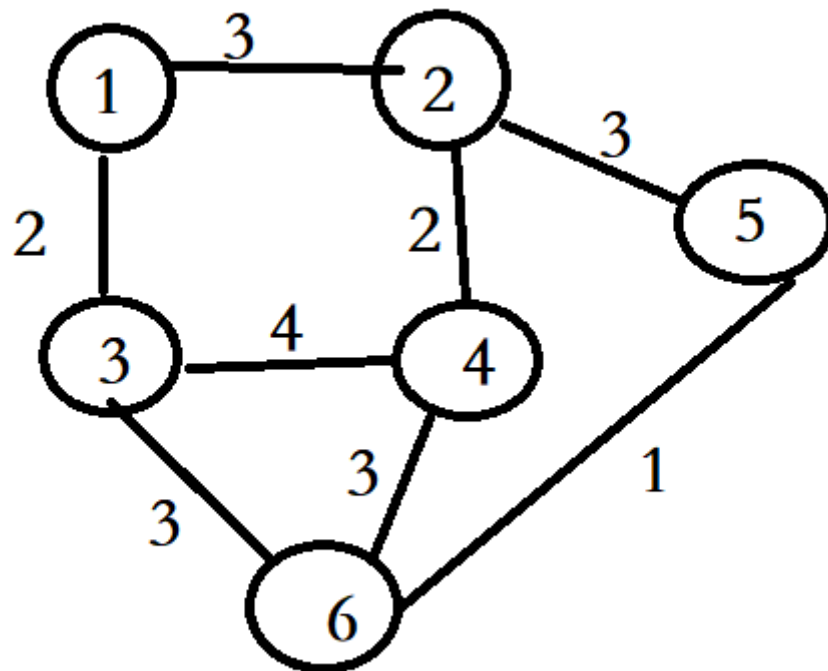
scenic spot ID	scenic spot ID	repairing costs	scenic spot ID	scenic spot ID	repairing costs
1	2	3	2	5	3
1	3	2	3	4	4
2	4	2	3	6	3
4	6	3	5	6	1

Please complete the following tasks based on the basic principles of data structure and algorithm.

- i. Please design a suitable data structure for the above problems, and give

the corresponding logical structure and visual representation. (3 points)

answer:



- ii. Design two kinds of data storage schemes, and give the corresponding virtual storage structure definition and storage structure diagram, at the end compare the advantages and disadvantages of the two storage schemes from the perspective of storage density. (4 points)

answer

1
2
3
4
5
6

∞	3	2	∞	∞	∞
3	∞	∞	2	3	∞
2	∞	∞	4	∞	3
∞	2	4	∞	∞	3
∞	3	∞	∞	∞	1
∞	∞	3	3	1	∞

vertex list

0	1
1	2
2	3
3	4
4	5
5	6

1	3
0	3
0	2
1	2
1	3
2	3

Adjacency matrix

2	2
3	2
3	4
2	4
5	1
3	3

4	3
5	3
5	3
4	1

vertex list

Adjacency list

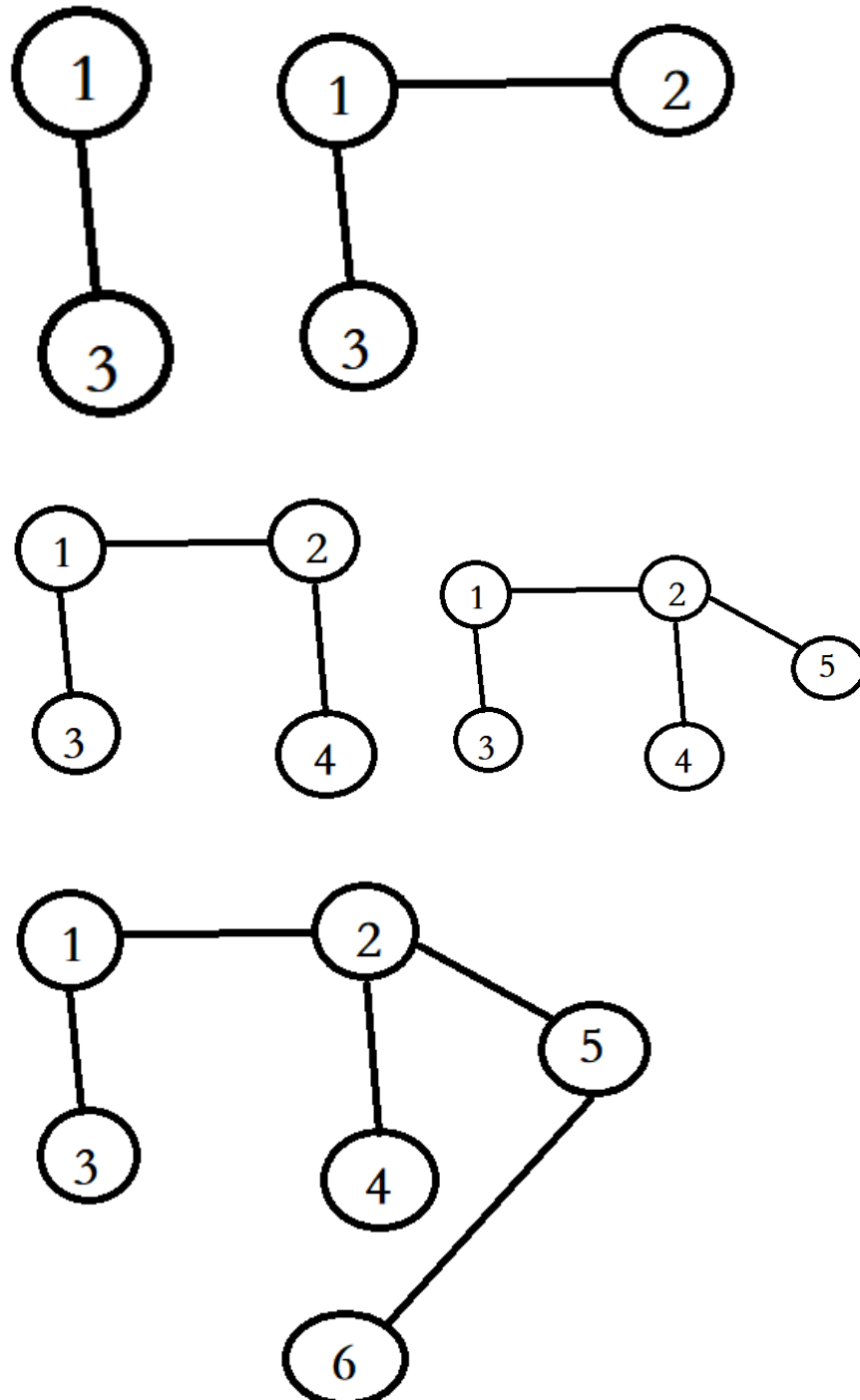
Adjacency matrix based on vertex is suitable for dense graph, Adjacency list only store edges, so it more suitable for sparse graph.

- iii. What is the minimum cost and route to maintain the roads between

scenic spots in order to realize the purpose of connecting scenic spots?
Give the basic principle, analysis process and results of the analysis method you used. (7 points)

answer:

start from vertex 1 using Prime Algorithm, chose the nearest neibour.



答案不唯一，多个权值为 3 的边，选其一均可。使用克鲁斯卡尔算法也可以。

3. English is very important to computer engineers. Electronic dictionary is an

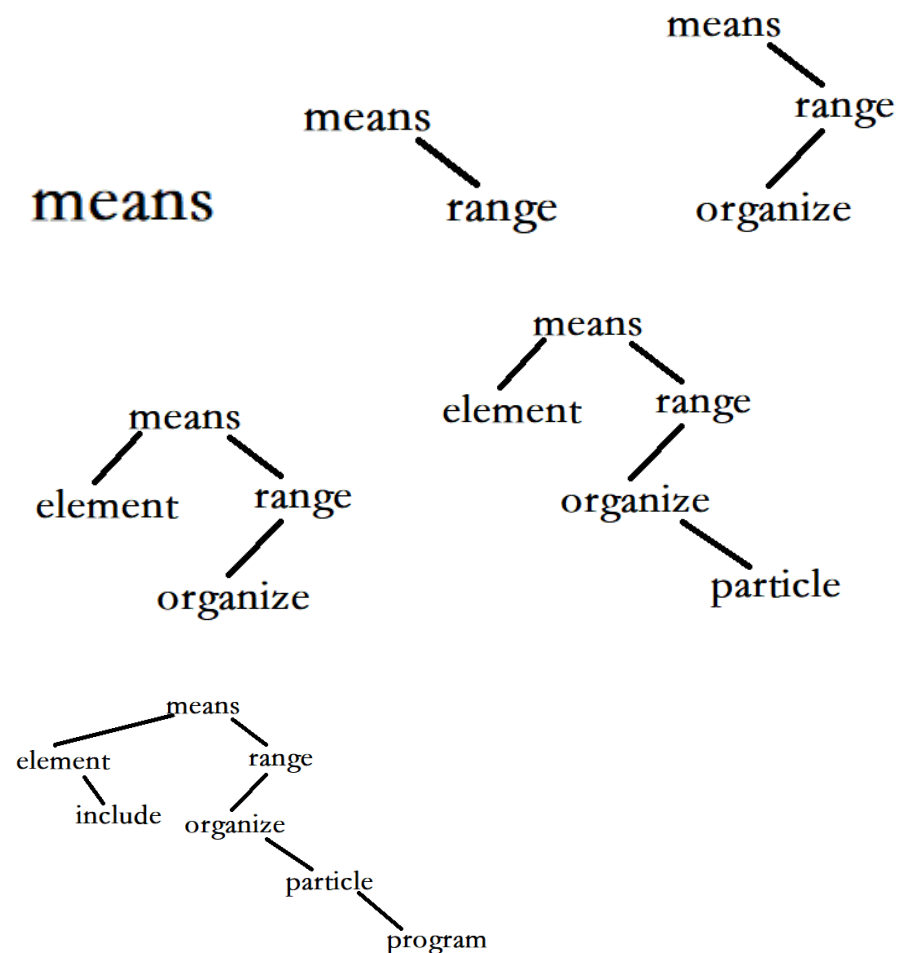
important auxiliary tool for learning English. A student hopes to design an electronic dictionary to meet the following functions. (a) It can insert a word into the dictionary when it fails to find it; (b) when the searching is successful, record the number of times the word has been searched, which can be used to count the error prone words. Please complete the following tasks based on the basic principles of data structure and algorithm.

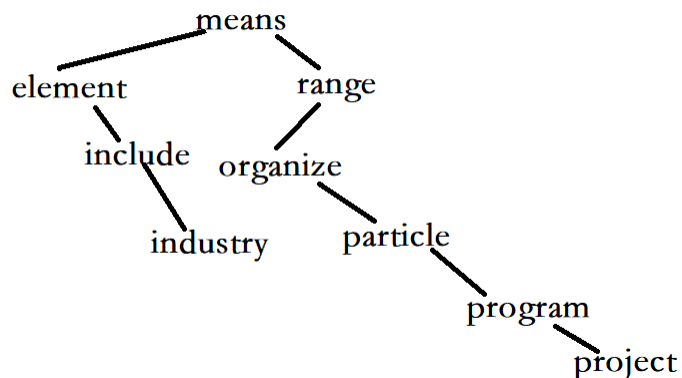
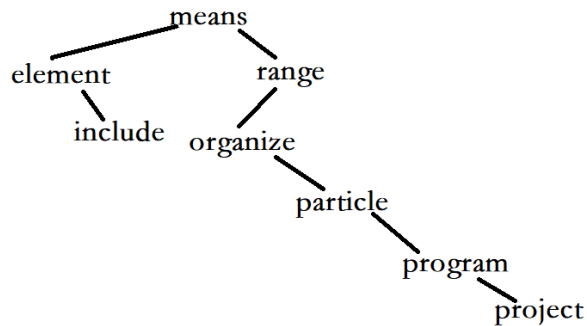
- i. To solve the problem (a), should we use static search algorithm or dynamic search algorithm? Please give the name of the designed search algorithm. (2 points)

answer: dynamic search algorithm, search on binary search tree (or binary sort tree).

- ii. If the e-dictionary is initially empty, query 10 words in turn, they are “means”, “range”, “organize”, “element”, “particle”, “program”, “include”, “project”, “industry” and “expert”. According to the algorithm designed in (i), draw the evolution process of the structure of the electronic dictionary is step by step.(4 points)

answer:





从第二步起，每步一分，只有结果且正确给 3 分

- iii. After (ii) calculate the search length of the search word “include” and the average successful search length of the electronic dictionary (compare the words in dictionary order) (4 points)

answer: search path of word “include” is means -> element->include. So search length of word “include” is 3.(1 分)

$ASL = (1*1 + 2*2 + 3*2 + 4*2 + 5*1 + 6*1) / 9 = 10/3$ (3 分，其中过程 1 分) s

五、Algorithm Design (10 points)

Design a recursive algorithm to find the depth of the binary tree (the data storage type should be defined first).

答案: typedef struct lnode{
 int data;
 struct lnode *lchild, *rchild;
 }lnode * BTree;

```

int deptofBtree(BTree T){
    int dl, dr;
    if (T){
        dl = deptofBtree(T->lchild);
        dr = deptofBtree(T->rchild);
        if (dl < dr){return dr + 1;}
        else{return dl+1;}
    }
  
```

```
    else{  
        return 0;  
    }  
}
```