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回答問題請列計算過程。

1. (10分) Assume that floating numbers are represented in a 16-bit format as follows:
   - Bit 0 is the sign of the mantissa (0=positive, 1=negative),
   - Bits 1-6 are the exponent. The implied base of the exponent is 8. The 6-bit exponent is stored in binary using excess-32,
   - The 9-bit mantissa is normalized so that the binary point is to the left of the entire mantissa.

   (a) What range of numbers can be represented in this format?
   (b) Represent the decimal number 21 in the format.
   Hint: use base-8 number for the answers.

2. (10分) Consider the recursive paradigm in computational algorithms.
   (a) What is the typical structure of recursive functions? Explain it by implementing the factorial function ($n!$) in recursive manner.
   (b) What are the potential problems in using recursive functions? How the problem can be reduced?

3. (10分) Analyze the computational complexity of selection sort and merge sort algorithms with pseudocodes. Express the complexity in big-O notation. Compare them and draw a conclusion.

4. (10分) A finite-state machine is defined by a set of possible *inputs I*, a set of possible *outputs O*, and a set of finite *states S*, together with two functions: *output* = *f*(*current_state*) and *next_state* = *g*(*current_state*, *input*). Suppose $I = \{0, 1\}$, $O = \{$上, 榜, 了$\}$, $S = \{x, y, z\}$, $f(x)$ =榜, $f(y)$ = 上, $f(z)$ = 了, $g(x,0) = z$, $g(x,1) = y$, $g(y,0) = z$, $g(y,1) = x$, $g(z,0) = x$, $g(z,1) = z$.

   (a) Draw a state graph for the machine.

   (b) Find the output if the initial state is x and the input string is 101.

   (c) Under what situation will the output be "上榜了"?

5. (10分) 是非題每題二分，答錯倒扣一分。

(1) When an object image is reduced in size and enlarged later, the detail of the image can be recovered exactly.

(2) Correcting errors is as easy as detecting them.

(3) Two entire structures *p1* and *p2* can be tested for equality by (*if p1 == p2*) as long as they are the same data type.

(4) Thrashing is caused by the creation of multiple threads in a process.

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6. (8%) Given the following algorithm, please analyze
   (1) the best time complexity of the comparison operation.
   (2) the best time complexity of the exchange operation.
   (3) the worst time complexity of the comparison operation.
   (4) the worst time complexity of the exchange operation.

```
void X-Algorithm(int A[], int N)
{ int j, p, m;
  for (p=0; p < N-2; p++)
      {  m=p;
         for (j=p+1; j < N-1 ; j++)
              if (A[j] < A[m])
                 m=j;
          exchange (A[p], A[m]); };
}
```

7. (6%) Given the modified Merge sort algorithm below, please analyze
(1) the worst time complexity of this modified algorithm.
(2) the best time complexity of this modified algorithm.

```
void Msort(int A[], int Tmp[], int Left, int Right)
{    int M, Center;
     if (Left < Right)
     {  Center=(Left+Right)/2;
        M is the index such that A[M] is the mediam of (A[Left], A[Center], A[Right])
        Msort(A, Tmp, Left, M);
        Msort(A, Tmp, M+1, Right);
        Merge(A, Tmp, Left, M+1, Right);
}
```

8. (6%) Given a binary search tree T, please give the linear time algorithms to list all nodes of this tree
(1) in ascending order of values.
(2) in descending order of values.

9. (8%) Given the following activity graph of a hypothetical project, represented as an adjacency matrix,
(1) please list the earliest completion time for each vertex.
(2) please list the latest completion time for each vertex.
(3) please list the critical path.
(4) please list the slake time for each edge.

備考	試題隨卷繳交

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	V0	V1	V2	V3	V4	V5	V6	V7	V8	V9
V_0	0	3	∞	∞	∞	∞	∞	∞	∞	∞
V1	∞	0	1	4	∞	∞	∞	∞	∞	∞
V2	∞	∞	0	∞	0	∞	∞	∞	∞	∞
V3	∞	∞	∞	0	0	∞	∞	∞	∞	∞
V4	∞	∞	∞	∞	0	1	∞	∞	∞	∞
V5	∞	∞	∞	∞	∞	0	9	5	∞	∞
V6	∞	∞	∞	∞	∞	∞	0	∞	0	∞
V7	∞	∞	∞	∞	∞	∞	∞	0	0	∞
V8	∞	∞	∞	∞	∞	∞	∞	∞	0	2
V9	∞	∞	∞	∞	∞	∞	∞	∞	∞	0

10. (7.5%) 是非題，每題 1.5 分，答錯倒扣 1 分

(1) ( ) When the input keys are strings, hashing techniques does not work.

(2) ( ) Both Prime's algorithm and Kruskal's algorithm for minimum cost spanning tree are based on the greedy strategy.

(3) ( ) The next (failure) function of KMP algorithm, which searches for the occurrence of a pattern B in a string A, is independent of the string A.

(4) ( ) If an NP-complete problem X is polynomial reducible to a problem Y, then Y is an NP-complete problem.

(5) ( ) In depth-first searching of a directed graph, starting from any vertex will traverse the whole graph..

11. (7.5%)選擇題，每題 1.5 分，答錯到扣 1 分

(1) ( ) Which the following sorting algorithm takes the least number of comparisons for sorting of the following sequence of data (9, 16, 66, 80, 96, 137, 170, 229) ?.

(a) insertion sort

(b) quick sort

(c) heap sort

(d) merge sort

(2) ( ) Which the following sequence of data will produce the binary search tree with the least number of depth ?

(a) 1, 2, 3, 4, 5, 6

(b) 6, 5, 4, 3, 2 ,1

(c) 4, 1, 5, 1, 2, 6

(d) 3, 2, 5, 4, 1, 6

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(3) ( ) A logical expression contains three types of operators, namely, **in order of precedence, ~ (not), ∨ (or), ∧ (and)**. Which is the postfix expression of the logical expression G∧ (A∨B)∨ (C ∨ (F∨~D∧E))

(a) GAB∨∧CFD~E∨∨∨∧

(b) GAB∨CFD~∨E∧∨∨∧

(c) GAB∨∧CFD~E∧∨∨∨

(d) GAB∨CF~D∨E∧∨∨∧

(4) ( ) Which of the following data structure is **unlikely** to be useful in the Dijkstra's shortest path algorithm?

(a) queue

(b) stack

(c) heap

(d) none of the above is useful.

(5) ( ) Given the following algorithm, which is likely to be the result if the input variable N is **–5** ?

```
Boolean Magic(int N)
{    if (N==1)
        Return True
     else if (N ==0)
        Return False
     else { N= N-2;
            Return Magic(N);
          };
}
```

(a) True

(b) False

(c) Stack overflow

(d) Arithmetic overflow

12. (7%) A point quad-tree is a 4 way tree used to index two-dimensional data. Each interior node corresponds to a square region in two dimensions and contains a pair of coordinates and pointers to four children which represent four quadrants, NW, NE, SW, and SE. If the number of points in a square is no larger than what will fit in a block, then we can think of this square as a leaf of the tree, and it is represented by the block that holds its points. If there are too many points to fit in one block, then we treat the square as an interior node, with children corresponding to its four quadrants. For example, the first figure below shows the data points organized into regions that correspond to nodes of a quad tree shown in the second figure below. It is assumed that only two

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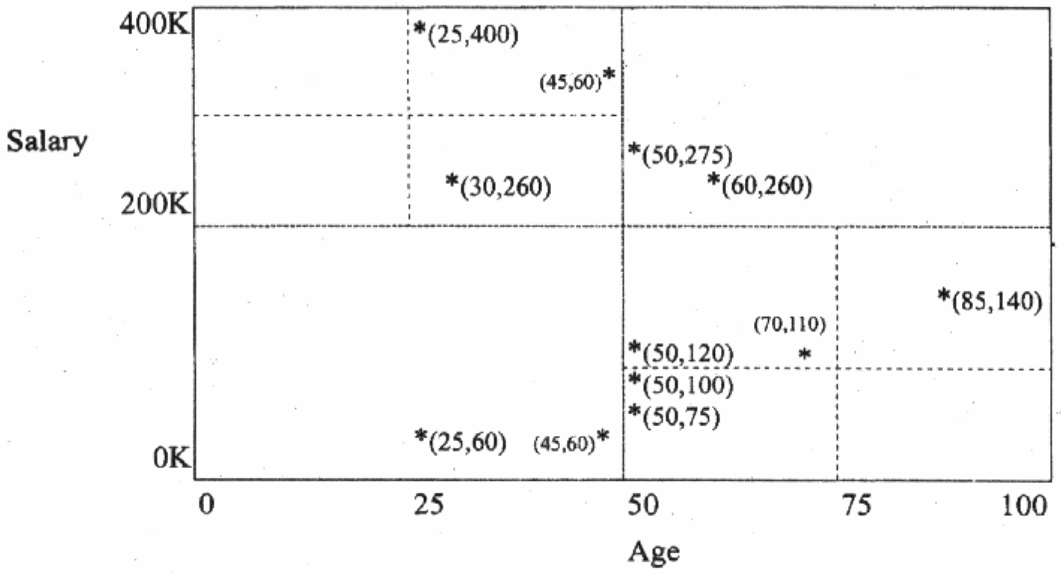
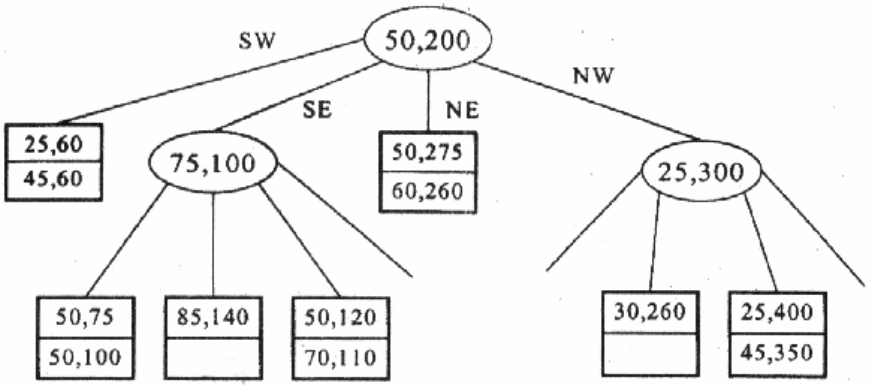
records can fit in a block. Note that if the data is located in the vertical border, it is assigned to the eastern region. If the data is located in the horizontal border, it is assigned to the southern region.





(1) Given the following 12 records describing characteristics of some PC, please construct the quad-tree with dimensions Speed and RAM. Assume that each block can store two records, the range for Speed is 100 to 500, and for RAM it is 0 to 256.

(2) How many interior nodes of the constructed quad-tree are accessed to process the range query that selects the model where (250 < Speed < 370) and (32 < RAM < 96) ?

model	A	B	C	D	E	F	G	H	I	J	K	L
Speed	300	333	400	350	450	400	450	233	266	300	350	400
RAM	32	64	64	32	96	128	128	32	64	64	64	128