

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一 選擇題 (40%)

- 1) If a queue contained the entries w, x, y, z (from head to tail), which of the following would be the contents after three entries were removed and the entries a and b were inserted?
A. z, b, a B. a, z, b C. z, a, b D. a, b, z
- 2) Which of the following is often connected with "dictionary" in data structures?
A. associative array B. set C. priority queue D. none of the above
- 3) Self-balancing binary search tree is often implemented by the following data structures except
A. 2-3 tree B. AVL tree C. Red-Black tree D. R-tree
- 4) The time complexity for fastest possible comparison sort is
A. $O(\log n)$ B. $O(n^2)$ C. $O(n \log n)$ D. none of the above
- 5) _____ is the ability in computer programming to present the same interface for differing underlying forms (data types).
A. Polymorphism B. Inheritance C. Strong coupling D. Abstract data type
- 6) A pointer points to a location in memory, and obtaining the value stored at that location is known as _____ the pointer.
A. disengage B. dereferencing C. disembarking D. none of the above
- 7) Which of the following sorting algorithms gives best time and space complexity?
A. merge sort B. quick sort C. selection sort D. heap sort
- 8) Which of the following sorting algorithms gives optimal data movement?
A. merge sort B. quick sort C. selection sort D. heap sort
- 9) Suppose that a social networking website FRIENDS needs to support two operations: (i) declare A and B to be friends (thus making all of A's friends and all of B's friends friends of each other); and (ii) determine whether A and B are friends.
Which APIs should FRIENDS use to support these operations?
A. Queue.
B. Union-find.
C. Stack.
D. Priority queue.
- 10) Continue the above problem, give the worst case order of growth of the running time that FRIENDS can guarantee for M operations, where N is the number of people listed on the website.
A. $N \log M$. B. $M \log N$. C. $N \log N$. D. M.

二 問答題

1. (5%) How many bits are in the Huffman encoding of the following message?

(Do not count the bits to encode the table.)

a b a a b a c a b a a b a c d a b a a b a c a b a a b a c d e

For reference, the frequency of each symbol is given in the table below.

a	b	c	d	e
16	8	4	2	1

2. (30%) Match up each application with an algorithm or data structure that one can use to solve it. Use each answer exactly once.

- 1) _____ 1D range search
- 2) _____ 2D range search
- 3) _____ Document similarity
- 4) _____ Traveling salesperson problem
- 5) _____ Sudoku solver
- 6) _____ Arbitrage detection in currency exchange rates
- 7) _____ Mark-sweep garbage collector
- 8) _____ Web crawler
- 9) _____ Google maps
- 10) _____ Longest repeated substring

A. Hashing

B. 3-way radix quicksort

C. Binary search tree

D. Kd tree

E. Depth-first search

F. Breadth-first search

G. Dijkstra's algorithm

H. Bellman-Ford

I. Enumerate permutations

J. Enumerate base-R integers

3. (20%) Consider the following code fragment.

```
MaxPQ<Integer> pq = new MaxPQ<Integer>();
int N = a.length;
for (int i = 0; i < N; i++) {
    pq.insert(a[i]);
    if (pq.size() > k) pq.delMax(); /* MARK */
}
for (int i = 0; i < k; i++)
    System.out.println(pq.delMax());
```

Assume that `a[]` is an array of integers, `MaxPQ` is implemented using a binary heap, and $N \geq k \geq 1$.

(a) What does it output?

(b) What is the order of growth of its worst-case running time. Choose the best answer below.

- A. $k \log k$
- B. $k \log N$
- C. $N \log k$
- D. $N \log N$
- E. N^2

Now suppose the marked line was deleted. Repeat the previous two questions.

(c) What does it output?

(d) What is the order of growth of its worst-case running time. Choose the best answer below.

- A. $k \log k$
- B. $k \log N$
- C. $N \log k$
- D. $N \log N$
- E. N^2

4. (5%) Modern computers have memory caches, which speed up reads and writes if they are to locations near recently-accessed memory. This makes sequential access to memory faster, in general, than random access. Which of the sorting algorithms below you would expect to benefit least from caching?

- A. insertion sort
- B. mergesort
- C. quicksort
- D. heapsort