2 Programming

1. A problem about the properties of virtual function, asked about the cout
2. Classical problem: #define x*x*x
3. Void pointer (point to nothing/not defined/point to null)
4. How does C++ prevent redefinition (include guards (#program once))
5. A conceptual question about the properties of red-black tree
6. Order of constructors (and virtual functions?) called when an object of a derived class is created.

Math & Statistics

1. Find the missing digit in 2^{29}
2. $\int_0^{\pi/2} \frac{\sin(x)+2\cos(x)}{\cos(x)+2\sin(x)} dx$
3. Taylor expansion of $(1-x+x^2)e^x$
4. $\lim_{x\to\infty} \sqrt{x^2-x}-x$
5. Expected hitting time of (X_t, Y_t) to the boundary $\frac{x^2}{9}+\frac{y^2}{16}=1$, where X_t, Y_t are independent Brownian motions?
6. Divide 1 variable in all entries in input data by 10000. What happens to R^2?
7. Take IID random variables $Z_1, Z_2, \ldots Z_n$. Try to run regression of Z_k-Z_{k-1} on Z_{k-1}. What do you expected the R^2 to look like?
8. Given mean, variance, covariance of X,Y estimate values for a_0 & a_1 in the following regression: $Y = a_0 + a_1 X +$ error.
9. $dS_t = \mu S_t dt + \sigma S_t dW_t$, $E[S_T^n]$?

2 Programming

1. Which of the following is true about linked lists/dynamic arrays?
   - Dynamic arrays are stored in contiguous memory
   - Linked list has constant time random access
   - Growing dynamic arrays when out of space is inexpensive
   - etc.
2. Which data structure is best for implementing a Reverse Polish Notation calculator?
   - Linked list
   - Queue
   - Stack
   - Dynamic Array
   - etc.
3. How do you delete an array allocated as

```
char * foo = new char[10];
```

?

Programming

1. Which of the following snippets calls comp() exactly $\binom{n}{2}$ times and swap() exactly $\lfloor \frac{n}{2} \rfloor$ times? (3 snippets were given for bubble sort)
2. Given an implementation of binary search (which might not be implemented correctly), and some inputs, find the output.
3. Given an implementation of heap, and some sequence of inputs, find the state of heap after all inputs are processed.
4. An implementation for checking "if a binary tree is balanced" is given. Find the time complexity when the input is a balanced or almost balanced binary tree.
5. Some problem about convex hull and extreme points (subset of given points which have the same convex hull) and its time complexity.
6. A programmer optimizes a routine, removes j+=2 from inside loop. Are the two equivalent?
7. Class Basic{

2 Programming

1. Which data structure is best for implementing a Reverse Polish Notation calculator?
   - Linked list
   - Queue
   - Dynamic Array
   - Hash map
   - etc
2. Which one uses divide-and-conquer?
   - Quick sort
   - Selection sort

```
Public:
Basic(){};
~Basic(){};
}
Class Member{
Public:
Member (){};
~ Member (){};
}
Class Derived:Basic{
Private:
Member elem;
Public:
Derived(){};
~Derived(){};
}
```

The execution order of constructors and destructors in

```
Void main(){
Derived d;
}
```

Problem Solving

1. A mouse sits on a toy car at the center of a circular table. The car is fixed to 1 direction and it can be launched at any time. The speed of the car, once launched, is 1 m/s. The mouse can also control the brakes of the car to stop at any time. A person starts rotating this table at a speed of 30 revolutions per minute. Find the area of all the points that can be reached by the mouse in 1s.
2. 4 players are playing a game (sitting in a circle). 1/3 probability to pass turn to the right, 1/3 probability to pass turn to the left, 1/3 probability to win. What is the probability that the person who starts the game wins.
3. Alice and Bob send 50 ants and 20 ants towards each other respectively on a straight line. When 2 ants collide, they reverse directions. How many ants finally reach each of Alice and Bob and what is the total number of collisions that take place?
4. 10 soda containers, 6 flavors, the possible combination of the sodas?

Finance

1. Value of barrier option with spot=100, strike=barrier=80, no dividends, risk-free rate=0.
2. 1 period binomial model hedging
3. Hedging credit risk of Oil (2 options - cash vs third party contract)
4. What happens to Gamma with respect to time, when close to maturity?

JAVA Questions:

1. If you implement the hashcode() function, what other function will you implement?

2. ArrayList<Double> list = new ArrayList<>();
   list.add(null);
   double d = list.get(0);
   What is the output of the above code?

3. What is the time required for garbage collection (mark and sweep)?
   A Order of total allocated memory
   B Order of live objects
   C Order of dead objects
   D <one more option>

4. Which data structure has O(1) insertion time?
   A ArrayList
   B LinkedList
   C TreeMap
   D <one more option>
5. What is the use of finalize()?

6. What does Java compiler do?