

Qishi Quiz 3

Instructions: Please post your solutions by **Thursday, Oct. 22nd**. You are encouraged to discuss the questions with other Qishi members. Please DO NOT share the problems with people outside Qishi.

1 Math/Stat.

1. 9 boys and 7 girls sit in a circle, what's the expectation of the number of boy-girl neighbors?
2. What is the difference between uncorrelated and independent variables. Which statement is stronger? Can you give an example?
3. You are allowed to toss a dice for up to three times. You can decide to stop after each toss, and you will get the same value of dollars as the number shown on your last toss. What is the value of this game?
4. If a rod with length L is cut randomly into N pieces, what is the distribution of the longest piece?
5. Given three random variables X, Y and Z , $\rho(X, Y) = \rho(Y, Z) = r$, $\rho(X, Z) = 0$, calculate the range of r .
6. A drunk man sits 1 step to the left door and 99 steps to the right door. He randomly walks left and right. As soon as he reaches an open door, he will go back home. What is the expected number of steps he takes to go home: a) if both the right and left doors are open; b) if the left door is locked and the right door is open.
7. What is ridge regression?
8. What is lasso regression?
9. Play a coin toss game, you win 2^i dollars if the i -th toss is head. How much would be pay for this game? (Spoiler: the expected payoff is infinity, but are you really willing to pay 1 million dollars for this game?)

2 Programming.

10. What is the use of 'default' ? When do you want to define your own default constructor?
11. Implement a thread safe singleton.

12. Say you have an array for which the i -th element is the price of a given stock on day i . Design an algorithm to find the maximum profit. You may complete at most k transactions.

Note: You may not engage in multiple transactions at the same time (i.e. you must sell the stock before you buy again).
13. A vector of integers, every element appears twice except one. Find the integer which only appears once.
14. Is it okay for a non-virtual function of the base class to call a virtual function?
15. How to generate random numbers? How to evaluate the quality of a random number generator?
16. How to simulate dices with a coin? How to maximize the efficiency?
17. Given two Robots, one of which is currently somewhere at negative axis and the other one positive axis. The two Robots can only take the following commands:
Go left: go left by 1.
Go right: go right by 1.
If at-zero(): return true if the Robert is at 0.
Write a program with the above commands and *ONLY* while() or if-else to make the two Robots meet. The meeting location is not important. Also, the two robots would execute this program at the same time. E.g. if you make go left in you program, the two robots will both go left.