Qishi Quiz 1

Instructions: Please post your solutions by group to the group folder by **Tuesday, Sep. 29th**. You are encouraged to discuss the questions with other Qishi members. Please DO NOT share the problems with people outside Qishi.

1 Math.

1. What is the probability that three points on a circle will be on a semi-circle?
2. An ant walks randomly on the edges of a cube. It starts from a vertex, and each step it has equal probability to choose one of the three edges and walk to the other vertex of this edge. What is the expectation of the number of steps for the ant to walk from one vertex to the opposite vertex.
3. From a deck of 52 cards, you can pick one card each time without replacement. If the card color is black, you win 1$. If the card color is red, you lose 1$. You can stop the game whenever you want. Questions: Will you play the game? If you want, how much would you pay to play this game?
4. Given a coin with probability p of landing on heads after a flip, what is the probability that the number of heads will ever equal the number of tails assuming an infinite number of flips?
5. You have ten light bulbs. Five have an average life of 100 hours, and the other five have a average life of 200 hours. These light bulbs have a memoryless property in that their current age (measured in how long they have already been on) has no bearing on their future life expectancy. Assuming they are all already on what is the expected number of hours before the first one burns out?
6. If a person tosses a coin once per second and he tosses 100 years,ask whether the following statement is correct or not: the probability of tossing 100 consecutive heads is less than 0.01%.
7. Given a stick, if randomly cut into N pieces, what's the probability that the N pieces can form an N sided polygon?
8. Suppose in a trading environment, to describe 20 mins prices movement, should we choose moving median or moving average? Why?
9. What is the average number of local maxima of a permutation of $1, ..., n$, over all permutations? Maxima at ends also count. (Putnam problem.)

2 Programming.

10. Give a one-line C expression to test whether a number is a power of 2.
11. Implement a smartpointer in C++.

12. Reverse a linked list from position m to n. Do it in-place and in one-pass.

13. Implement a program to find out whether there exist M days within the last $N(N >= M)$ trading days that the average closing price of these M days is at most P. Assume we have collected the history of the closing prices of the last N trading days for a stock. Requirements: Inputs are positive integer M and N, $M <= N$; An array of N float elements containing the closing prices of the last N trading days; And a float P. Please design and implement the program in C, C++, Java or Python to produce the answer in most time/space efficient way.

14. Implement a string indexOf method that returns index of matching string.

15. Write a function to calculate $\exp(x)$.

16. Given streaming data, design an algorithm to get approximate median of all previous data, use constant memory.

17. 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 as many transactions as you like (i.e. buy one and sell one share of the stock multiple times). However, you may not engage in multiple transactions at the same time (i.e. you must sell the stock before you buy again).