systematica
investments

Graduate Program 2016

RESEARCH DIVISION – EXAMPLE INTERVIEW QUESTIONS

1. Coin toss
    a. If you toss a coin until you see two heads in a row, how many tosses are required on average?
    b. If you toss a coin until you see a head followed by a tail, how many tosses are required on average?
    c. Why are these answers different, given that head-tail and head-head have an equal chance of appearing after two coin tosses?

2. You want to create an open box with a square base and have only a fixed amount of material. How do you maximize the volume of the box, given the constraint on the total surface?

3. Given that A and B are covariance matrices, which of these are also covariance matrices?
    a. A + B
    b. A^2
    c. AB

4. Consider a circle and an equilateral triangle inscribed inside the circle. Write some code to compute the following by simulation:
    a. Take two points randomly on the circumference of the circle. Connect and measure the length of the chord through the two points. What is the probability that the chord is longer than the side of the triangle?
    b. Take a random point inside a circle. This is the midpoint of only one chord. What is the probability that this chord is longer than the side of the triangle?
    c. Take two points randomly inside a circle. Consider the chord that goes through the two points. What is the probability that the chord is longer than the side the triangle?

5. Given two words, the *edit distance* between them is defined as the number of operations needed on the first word to convert into the other, where the allowed operations are insertion, removal and replacing of letters. How do you write a function that computes this distance between two words?

6. A dynamic model is defined as follows:
    - State(n,m,t) is the state of the node (n,m) at time t. This value is either 0 or 1.
    - A neighbourhood of node (n,m) consists of 8 nodes around it. Denote LifeAround(n,m,t) as the number of nodes in the neighbourhood of (n,m) at time t that are in state 1.
    - Evolution:
        - If state(n,m,t)=0 (dead) then state(n,m,t+1)=1 (alive) iff LifeAround(n,m,t)=3
        - If state(n,m,t)=1 (alive) then state(n,m,t+1)=0 (dead) iff LifeAround(n,m,t)<2 or LifeAround(n,m,t)>3

    a. Write a function that starts with the given state and develops the model through n steps on a fixed grid with zeros outside the boundary.
    b. Write a similar function that has no boundary.