

1. Black-Scholes assumptions, close form formula, what $N(d_1)$ and $N(d_2)$ means.
 2. Monte Carlo
 - what kind of options have you priced
 - convergence rate and why is that?
 3. Implied Volatility
 - how does Newton's method work and where does it come from
 - what if you don't know the first derivative
 4. Random Walk
 - starting from 0, the prob of up and down are both 1/2, expected number of steps to hit 1?
 - starting from 0, the prob of up is 60%, down is 40%, expected number of steps to hit 1?
 5. two normal rv X and Y, what is the distribution of $X+Y$?
3 by 3 grids, you have number 1 - 9, requirements: each row and col sum up to 15. how many different combinations of solutions and algorithm to output a solution.
- three toss, you can stop anytime with the money indicated by the toss, what is the expected payoff
- three ways of fibonacci and complexity
1. stochastic calculus, random walk
 2. how to calculate the covariance matrix
 3. how you model CDS
 4. Is the hazard rate and the value of the CDS convex or concave?
 5. If the hazard rate is not constant but with a volatility, what will the price go? (increase or decrease)
 6. How to find the kth largest number of an array with size of 100 million
 7. write the algorithm of merge sort
 1. How to find square root of 2 numerically
 2. 100 fair coin, what's the probability of the number of heads larger than 60, why using this formula (CLT)
 3. How to find 10 largest numbers from n numbers ($n > 10$)
 1. (resume) numerical methods: compare tree and monte carlo; what if derivative is on two assets or more
 2. variance reduction in monte carlo; compare performance?
 3. derivative pricing: basket of ten stocks, if any has return $> 5\%$ next year, MS pay \$1M. How will the correlation between the stocks in the basket change?
 4. (resume) talk about your research experience
 5. Object oriented programming: compare inheritance and composition
 6. answer to my question: MS is probably the largest credit market maker, so we can do interesting things that other companies cannot handle.
 1. Talk about pricing of Barrier options and Lookback options
 2. You and 9 other people are around a conference table. You pass a pen to either the left or to the right. And every person then randomly chooses to pass the pen to the left or to the right. What is the probability that everyone touches the pen before it returns to you.
 3. MS enters the following contract: If the best performer in a basket of stock goes up 10% next year, MS pays \$1 million. Will the correlation between MS and the stocks go up or go down.

1. Integrate a standard winner process with respect to time t, ie, $\int_0^T Wdt$. What distribution does this r.v follow? Is it a martingale?

2. Use Monte Carlo method to estimate $e=2.71828\dots$

3. What is GARCH? What is GARCH(1,1) formula.

4. In ARIMA, what method do you use to decide the orders of differentiation, i.e., the orders of differentiation to make the time series stationary?

5. What is polymorphism in C++?

6. Can we use virtual function for constructors in C++?

7. Why we use virtual function for destructors?

8. About a smart pointer called "auto_pointer" in C++ STL. After we assign the value of the original pointer to a new pointer, what happened to the original pointer?

9. What is stochastic volatility? Which model do you know?

10. What is volatile function in VBA?

11. How to do error handling in VBA?

1. There are 2 points A and B, and the distance between A and B is 100 meters. A person go from A to B, each step can be 1 meter or 2 meters. How many possible paths in total? Use Fibonacci. $F(n) = F(n-1) + F(n-2)$, $F(1)=1$, $F(2)=2\dots$

2. How to implement Fibonacci above in C++, use 2 methods separately? Use recursion and loop.

3. How to use MC method to calculate $\pi=3.14159\dots$? choose a point uniformly in the 2×2 square. $-1 \leq x \leq 1$, $-1 \leq y \leq 1$ then rejecting it if it falls outside the unit circle. ie, accept if $X^2+Y^2 \leq 1$. The total pairs of number is N, the accepted pairs is A. Then $\pi=4*A/N$

4. What is the relation between call value and strikes? Negatively related, convex.

5. A die, 6 facets, what is the expectation of throws times of getting 2 six in a row? 42.

6. A die, 6 facets, consider the expectation of getting a five after a six, will it be greater than, less than or equal to 42, ie. the number in last question? Less than.

7. A CDS, you are the protection buyer, you buy the 5-year CDS in 100bp. 1 year later, the CDS has only 4 year to maturity, and the market spread become 110bp. Your position gain money or loss money? Gain.

8. What is shared pointer in Boost? How do you implement reference count? When will the reference count number be increased or decreased? How do you ensure the pointer will be deleted automatically when the object goes out of scope? How would you implement the destructor of shared pointer? and questions about smart pointer's copy constructor and assignment operator.

9. The C++ container, Stack(LIFO) and Queue(FIFO). You use what data structure to implement them separately?

10. There are 2 threads: a producer and a consumer. There is a queue, producer push elements into the queue, and consumer pull elements out of the queue. The pushing speed of the producer is very fast, but the pulling speed of the consumer is very slow. What problem can be incurred? Memory exhausted. What interface would you build into the queue to prevent such a problem?

- Difference between co-integration and regression
- Tell me about equity structured products, why clients want to buy?
- Expected number of throws to get two 6 in a row?
- Expected number of throws to get 56 in a row? More or less compared with previous one?
- Write code for binary search
- Write code to find k-th smallest number in an array of size n
- Black-scholes framework, relationship of theta and sigma?
- How to calculate eigenvalue?
- Why covariance matrix is spd?
- What is t-test? How to perform it?
- Pair of data (x,y), purely random. What is beta in $y = \alpha + \beta x + u$? Why is the estimated line asymmetrical with respect to x and y?

- Simple probability. Given A,B two events, their prob, and prob of (AUB) calculate A/B, B/A, A/B+B/A...
- Poisson process with $\lambda=5$. A random variable X, $X=1$ with prob 75% and makes $\lambda=3$, $X=0$ with prob 25% and keeps $\lambda=5$. If for $T=1$, poisson process=2, what is the probability that $X=1$?
- $\int W_s^* ds$ from 0 to t.
- Derived BS PDE.
- What is quadratic variation? What does it mean?

- How to calculate A^N efficiently? A is a matrix.
- What is $\exp(A)$, A is a matrix. How to calculate it?
- 4 balls, weighted 1,r,r^2,r^3, r being positive real number. You have a balance, how many weighs do you have to do to find the heaviest one?

- Derive BS PDE.
- A stock with no dividend, $r=0$, $T=\infty$, Spot=60. An option pays \$1 if stock hits 100, how to price it?
- What is rho in Black-Scholes? Why is it positive for Call?
- Some casual talk..

- If asset follows normal instead of lognormal, and you use BS formula to calculate implied vol, do you get larger or smaller vol?
 - Calculate square root of 2
 - Write code to output permutation of n
 - A biased coin gets head with probability p, p itself is uniformly distributed in 0 to 1. You throw it and get head, throw it again, what's the probability that you get head again?
 - How does delta change with sigma?
- "

1. What is delta
 2. How would volatility change influence the price and delta
 3. A pool of infinite numbers of coins whose H occurrence follows uniform distribution, say, $p(H)=p$ where p is an uniform random variable on $[0,1]$. When first toss is H, what's the probability that next toss is also an H(same coin)?
 4. using numerical method to calculate $\sqrt{2}$
 5. proof Newton Method
- Any quantitative projects?
- Derive BS PDE
- Any numerical methods to solve this?
- How volatility will affect delta(positively related for ITM call, and negatively related for OTM call)
- Have you done any binomial trees methods?
1. Talk about your background.
 2. Go through finite difference methods and compare convergence speed of each method.
 3. A pool of infinite numbers of coins whose H occurrence follows uniform distribution, say, $p(H)=p$ where p is an uniform random variable on $[0,1]$. When first toss is H, what's the probability that next toss is also an H?
 4. How does the volatility affect the delta? No formula, just intuitively explain.
1. What are the assumptions for Black Scholes formula?
 2. If the volatility is not constant but a function of time, what is the formula for the option price?
 3. Roll a dice, if you roll 1 to 5, you get the money as the amount shows; if you roll 6, you get \$7. What is the fair price to play the game? If you can choose to play a second round, what is the fair price for the game?
Answer: first question 11/3, second 9/2
 4. Consider any point on the surface of the earth which is more than 1km away from the south pole. From this point, you go 1km south, then 1km east, then 1km north. What are the initial points that are invariant to this movement?
Answer: Besides north pole, all points that are $1+1/(2\pi k)$ away from south pole. (k is any positive integer)
 5. (I am still confused what he meant) Assume you and I each have an envelop with money in it. We know one envelop contains twice as much as the other. If you open your envelop and find \$10, do you think it would be advantageous to switch your envelop with mine?
1. For each of the financial modeling skills, describe a project you worked on. (Questions are very detailed.)
 2. Describe one of your C++ project. (Again very detailed questions on the project.)
 3. For binomial tree method, how do you set up parameters (up/down factors, probability, etc) and why? Is it the only way? How do you decide which way to choose?
 4. Why does binomial tree method work?
1. Can you derive Black Scholes equation?
 2. Price this option using Black Scholes equation: Assume no dividend, zero interest rate. A stock is currently \$60. If it ever goes above \$100, you get \$1. There is no maturity (perpetual option).
Answer: the price is not explicitly a function of time, so the partial differential term to t is zero. r is zero, so two terms with r are zero. Only the second order derivative is left and it has to be zero. Price is a linear function of spot price.
 1. can you derive BS PDE? (I said probably not.)
 2. what's the BS formula.
 3. Rho's sign. And why
 4. what's risk neutral? (in retrospect, I should've answered with an example)
 5. why do we price option with risk neutral measure. (because we can replicate the payoff)
 6. if you cannot replicate the payoff (replicating portfolio doesn't exist), what probability would you use to price an option?

- 1.A pool of infinite numbers of coins whose H occurrence follows uniform distribution, say, $p(H)=p$ where p is an uniform random variable on $[0,1]$. When first toss is H, what's the probability that next toss is also an H?
- 2.How does the volatility affect the delta? No formula, just intuitively explain.
- 3.When is delta equal to 1/2?
- 4.Programming: input an integer n , output all the permutations of $\{1,2,3,\dots,n\}$, how to program? What is the number of permutations?
- 5.Three call option with different strikes and prices. How to arbitrage?
- 6.Why is price convex with respect to K ?
- 7.Tell me a quantitative project
- 8.How to calculate square root of 2? (newton's method) how to do it?
- 9.How to derive BS PDE

- 1.blue-eyed islander puzzle. What's the answer and how to prove? (It seems a famous puzzle from Terence Tao, but I haven't heard of it before.)
- 2.calculate the integral of the pdf of standard normal
- 3.what is $E(X|Y)$, X and Y are joint normal
- 4.how to price this payoff $\text{MAX}(0,S_1-T-S_2-T)$? and all kinds of change of measure question related to this
- 5.If sigma is a deterministic function of t, how to price European call

Mainly resume questions

How to do cubic spline?(very detailed)

How to derive BS formula?

How do you do AR(1) and linear regression? What is R^2 ? What is the error of the coefficients?

1. dS_t and $d(\ln S_t)$
- 2.what's the assumption of black scholes model?
- 3.what is the volatility like as a function of K ?
- 4.How to estimate $e^{0.001}$
- 5.What is linear regression and least square?
- 6.Derive BS PDE
- 7.No dividend and interest rate. A stock is currently \$60, if it ever goes above \$100, you get \$1. This option is perpetual. Price this option. How to hedge it?
- 8.What is delta under BS framework? What is rho?