BOA ML

1. Talk about inheritance. Give an example.
2. How to store object? I said to use pointer.
3. What problems might it cause? He wrote an example { pter = new class() } 我以为new出来的东西会被自动delete掉……二了……
4. Have you used smart pointer? No...
5. What would happen if you pass a derived object into a function expecting a base object? Automatic conversion. Called slicing.
6. When is a matrix a covariance matrix? 对称半正定
7. How to check positive semi-definite?我说看那一串行列式.
8. How to compute determinant in practice? What decomposition might you use?我说singular value decomposition? diagonalization? QR? 结果他想要Cholesky decomposition. 没学过……这个不是只能用在已知半正定的矩阵吗？
9. If you are a trader, with only a put option pricer. Only one thing you can control: strike K.  
       How would you also price a call? Put-call parity.
10. How do you find the distribution of the stock price with your pricer? Take derivative.
11. A brownian motion starting at 0, probability of hitting a before hitting -b? Derive it?
12. How about a brownian motion with a drift? 没答上，想了一会他不让想了……
13. Some people advocate achieving polymorphism with purely template. What would be their argument? 瞎说了一些，最后他说Template based polymorphism 比较unpredictable。

其实不难，很容易能想到 n^2算法，但他们想问的都是n算法：

Given a series of float numbers as stock price, suppose you can only buy once and sell once (1 share), and you must buy before you sell, find an algorithm to compute the maximum profit. (Suppose you know the whole series from the beginning, which is definitely not true in real world.)

O(n^2) 算法就是暴力二重循环，对每个buy point找对应最大profit的sell point:

double maxProfit(vector<double> prices){

    double max = 0;   //设为0而不是INT\_MIN的原因是如果是一直跌的情况就不买不卖，相当于买卖在同一天，利润为0，而不会为负

    for(int i = 0; i < prices.size(); i++){

         double buy = prices[i];

         for(int j = i; j < prices.size(); j++){

              if(prices[j] - buy > max)

                   max = prices[j] - buy;

         }

    }

    return max;

}

你回答这个以后他们肯定会说这个太慢，于是你就要写一个O(n) 方法，想法就是只扫一次，但每次记录已经经过的那些数字里最小的那个，同时记录已经有的最大利润：

double maxProfit(vector<double> prices){

    double max = 0;

    double minPrice = INT\_MAX; //注意一开始minPrice设成正无穷而不是负无穷

    for(int i = 0; i < prices.size(); i++){

         if(prices[i] < minPrice)

             minPrice = prices[i];

         double diff = prices[i] - minPrice;

         if(diff > max)

             max = diff;

    }

    return max;

}

最近不止一次被问到这个题，第一次被问没有能答上来O(n)算法，于是回家学习了一个，结果很快又在另一个地方被问了，于是就都能答两个答案了，论提高姿势水平的重要性。 上面写的代码都是直接在帖子里写的，没调过，可能有bug，不过大概思路是这个。

Ellington  
  
1) Random walk 从1出发，以1/3概率向上，2/3概率向下，多大可能到达0。 应该是以1/2分界，面试官非要说在1/3...

2) 每月Default概率是beta分布，系数给定alpha beta，一个人连续N月没有default，下个月default的概率的期望是多少.  alpha/(alpha+beta+N)  
  
3) 好多关于mortgage的题，interest rate上升，prepayment risk怎么变化；interest rate下降，cash flow part of a mortgage pool的value 怎么变化？discount value of cash flow上升了，但是prepayment risk也上升了，所以future cash flow变少了。  
这两个effect哪个大？  
 一般是后者比较大。

4) 一个人去依次面试一些工作，面完拿到的offer打一个分，0-1均匀分布，必须接受或拒绝才能去下一个。strategy？期望的通项？  
  
5) what is big data？  
  
6) a stream of tick data, print array: time lag-price current-price lead-price  
  
后来有一个人没有准备，问了一大堆零碎问题  
-什么是AR，MA model

-任意一个measure，怎么定义一个函数的积分

-Girsanov theorem？

-经典的一个圈n桶油，加起来够走一圈，能不能找到一个起点走一圈。归纳

-2014^2015的最后一位数字？一位数字？用log

-why do we use abstract class?

Bloomberg 第一轮  
1) ABC independent uniform 0-1  
P(A>B|A>C)

2) Prove Cos(Wt) is not a Martingale. Asked me to use ito lemma.

3) Why virtual function? why virtual destructor?

How to call base class's foo from the derived class?   
base::foo()  
  
4) What is the cost for inverting a matrix?

5) Monte Carlo  
What are the methods for reducing variance?

6) 他们组主要用pde，可惜不懂pde……  
finite difference method?

SIG  
第一轮全是glassdoor上的比较简单的概率题，应该是HR面的  
第二轮还没面。  
  
Bridgewater的investment associate  
这个非常扯，竟然辩论社会问题……我们讨论了Should corporations be allowed to contribute to political campaigns......

KCG第一轮

-You have a fair coin. You get heads you win $1 and can continue to play. You get tails, you collect your winnings and stop the game. How much would you pay to play this game?   
    1\*1/4+2\*1/8+3\*1/16...=1!  
    OR X = 0.5\*0 + 0.5\*(1+X) X=1

Now what if the winnings increase by 1 each additional H?  
    X is the winning from above.  
    Y-X = 1/2 \* Y  so Y=2

Now what if the winnings double each time you get heads.   
    Expectation is infinity, so is variance.

How much would you personally pay?

-Algorithm:Triple sum to zero   我说quant test里都考了……

-Reading in unknown number of objects. Being able to store only one object. How do you make it a uniform distribution among them?

有个同学被问到的：if you know I'm buying 10000 shares of Microsoft, what would you do?

KCG 电话

两个题：  
1，linear regression：  
已知五个点：(0,0)  (0,1)  (1,1)  (0,-1)  (-1,-1)  
求回归函数；  
如果把x和y对调，求回归函数；  
如果不是最小二乘，而是绝对值最小，求回归函数。

2，算法：  
已知一列互不相同正实数，再已知一个参数k，求满足下面条件的子集：  
子集中任选两个数，他们加起来的和都大于等于k；  
且如果在子集中再添加一个元素，则上面性质不再成立。  
  
求时间代价小的算法。

Jane Street first round

1. Given two positive integers A and B, we have A/B is in the range [0.48, 0.52], what are the possible value of B?

2. We have an elevator going up at a constant speed, if Bob runs up with 1 step/s, it takes 20 steps, if run 2 steps/s, it takes 30 steps, how many steps does it take when he runs 3 steps/s? And what if the speed of Bob approaches infinity ?

3. If you play scissors paper and rock (石头剪子布) with someone who promises will never show rock:

    a. If you guys play for 100000000000 times and you win $1 for each win, lose $1 for each loss, $0 for each draw, what is your strategy?

    b. If you guys just play until one of you wins, and the winner takes money, what is your strategy?

4.(Behaviorial) Do you like making decisions for tons of dollars in a second?

也post JansStreet第一轮，

no paper or pencil allowed, do all calculations in your head.

what's prob of even heads if we toss fair coin 4, 7, n times.

99^10 how many digits? is it true 99^n has 2n digits? when will break? 70% CL.

100 coins, >=1 fair, >=1 unfair, strategy get max prob of even heads. don't quite understand problem

man at 1/4 of bridge, train running towards bridge, meet at edge of bridges no matter what direction the man run, find relative speed of train to man?

First round  
1，一个扶梯匀速上升，如果你用1step/sec向上走，你能经历20个steps，如果是2step/sec，是30个，问如果是3step/sec，能经历多少台阶？再问如果你无限快的上，能经历多少台阶？

2，一叠52张的扑克牌，26红26黑，随机抽两张，问颜色一样的概率？再问如果是拿走一半变成13红13黑，随机抽两张，问颜色一样的概率？再问如果是随机拿出去26张以后，从剩余的26张中还是随机抽两张，问颜色一样的概率？最后问，如果52张，连着两次随机抽两张，问颜色一样的次数的期望？

Jane Street第二轮

1. There is a school with a bunch of professors and students, each student can take several courses and each professor can teach several courses.

    Given the fixed number of students and professors as well as the fixed courses that each student takes and each professor teaches (there is no randomness), now consider two processes:

    A. Choose one student randomly, and choose one of the courses he takes randomly, and count the number of students in that course.

    B. Choose one professor randomly, and choose one of the courses he teaches randomly, and count the number of students in that course.

Suppose you do these two processes a lot of times for this school, and you get expectation numbers for A and B respectively.

Question1: Is there a definite large/small relation between the two numbers? What is the percentage you are sure about your answer? What is the intuition?

Question2: What if we add the constraint that each professor can only teach one course? Now what is your confidence percentage? What is the intuition?

Question3: What if we do the experiment on real American schools? What result do you expect to see?

Question4: For a school, what kind of information will affect the result you see? In what direction they are affecting the result?

2. There are 100 coins and you randomly flip them all, throw them on the floor and cover them, so you can not see them.

     Now play a game: you ask a yes/no question to some wise man, and you will get the correct answer (in yes/no). Then you start betting on the heads/tails: one coin is revealed at one time, all 100 coins will be revealed one-by-one, you put a bet for each coin before it is revealed. For each coin you bet $1, you get $1 more if you are correct, lose $1 if wrong. All 100 coins must be revealed and bet on and thus you can not stop before revealing the 100th.

Question: how much do you want to pay to play this game?

(The interview time remained for this problem was quite limited. The interviewer asked me about my confidence interval of the answer even before I figured out any idea of tackling the problem, so be prepared or this kind of stuff, seems the interviewer is trying to test your sense for numbers, not necessarily the precise solution of the problem.  The question I figure out from first thought was "Are there more heads?", but definitely there should be better solutions, discussion welcomed.)

Second round  
1，给下面一段伪代码：

function(int A[], int n)   //n是数组长度  
{

     for(i=0 to n-1)  
     {

            choose j randomly from 0 to n-1;

            swap(i,j);

     }

}

问这个函数在干嘛？怎么改进？

2，一个shuttle bus走一个环形的线路，regularly的每10分钟走一圈。如果我某天随机的时间站在一个shuttle站，问平均等待时间？再问，如果在环形沿线上面有个餐馆，司机每次经过餐馆的时候都随机扔硬币，如果Head就花10分钟在餐馆吃饭，如果是Tail就keep going，还是问如果我随机的时间出现在shuttle站，问平均等待时间？

Jane Street 3rd round (with a developer)

题目：有一个公司，公司的结构是有一个CEO，他有几个直属下级，每个直属下级又有几个直属下级。。。。一直到最底层员工。大家举行一个party，每个人都有一个属性叫fun value是给定的，但是每当任何一个人的直属上级在这个party里，这个人的fun value就为0. 整个party的fun value是所有出席party的人的fun value的总和。

1.怎么implement这个公司的结构？

2.编一个函数maxFun，来确定出席party的人员都是谁的时候整个party的fun value最大。

我乱写的一个recursive算法，一开始写错了，那边提醒我我的code里面没有修改party的部分，然后我改了，电话那边听起来还是挺满意的，希望能过。

Jane street

Trader

1. You have a 12 - sided dice. Roll once, and you can decide to stop or continue. If you stop, you can get dollars equal to the face amount. If you choose to continue,  and if the sum of the two rolls is smaller or equal to 13, you get dollars equals to the sum, otherwise you get zero. What is the best strategy?

1. 2. Find a series of numbers between 2 - 30 that have maximum sum, and they do not share mutual factors (excluding 1). What is the sum?   
   Suppose you do the same problem for numbers between 2 - 1000. What is the sum? 90% confidence level.

1. 3. You have a 6 - sides dice. You can keeping rolling the dice, and you can get dollars equal to the amount of the sum. However, if at some point, the sum is a square number (16,25…), you must stop, and you will get 0 dollars.   
   For example, if currently your sum is 23, and you stop , you will get 23 dollars. But if you choose to continue, and you get a 2 in the next roll, you will get 0 dollars and the game stops.   
     
   (1) If at some point, your sum is 35. Should you stop at 35 or should you keep rolling?   
   (2) In (1), if you choose to continue, and this is your strategy: You will keep rolling until you exceed 43. What is the most probable amount of dollar you win when you stop? How confident are you about your answer?   
   (3) Is there a best strategy for this game? Is there some number that you should stop?

个人感觉Jane Street招的比较少，但是面试的人很多，电话面试的次数也很多。有人跟我说他们的trading比较看感觉,这个看缘分了。

一面跟肖潇的一面题一样，

二面

1 不均匀的硬币，head 的概率是p, 怎么构造出0.5的概率？投两次，如果是HT就是第一种可能，TH是第二种可能，其他的就继续投。这是不是最有效的方法？如何提高效率（这个很难，我没有想出更有效的方法，纠结了很长时间）

2 肖潇的原题，地上有100个硬币，黑暗中你要猜H还是T，猜对了得一分，猜错了扣一分，要分数最高，能够问智者一个yes or no的问题。我告诉他我看过，他还是问我答案，我的问题是H比T多吗？得到肯定的回答以后全部猜H，否则全部猜T。问这样的情况下预期是得多少分？他应该是算过。

3 因为我看过第二题，问了另外一道，是学校里面有学生老师和课程，每个学生可以选几门课，每个老师可以教几门课，问两种表述哪个预期高？也是肖潇提到的原题。我也说看过

三面

编程面试，不是考算法，应该是实现他工作中的一个功能。

有很多transaction，包括id 和data，要实现提交submit(id),  更改correct(id)数据和id都需要更改, 取消cancel(id)删掉id和数据.首先要你实现这个功能，然后考虑一些特殊情况，比如网络延迟，correct(id)先发送给服务器，submit(id)才到，如何处理这种情况。还有一种功能是给定一个id，能不能找出这个交易最原始的id名。

当时的记录是[https://code.stypi.com/k0u0uhrz](https://code.stypi.com/k0u0uhrz" \t "_blank)，感觉不是特别适应。

四面

问的是trading 的感觉，问中国的公路总长是多少？给个90%的区间，不停地询问你是否确定，为什么。中国和美国的公路长之比是多少？ 如何估计？

可能我trading的感觉不是很好，然后就挂了

2rd round:

30-sided die with number 1 to 30, player 1 choose first, player 2 choose 2nd. roll die, the player closer to the rolled number wins and get payoff equal to the rolled die number.

would you prefer to be player 1 or 2, what's your strategy?

a set of integers smaller than 30, no common factor with each other, find the set that maximize the total sum

toss 10 fair coins, find expectation of # of heads times # of tails. Finish in one minute…

3rd round:

how to simulate 10 sided die with 6 sided die. Expected number of roll? (11/5)

1000 people in circle, 1 shoot 2, 3 shoot 4, etc. which people will survive? how much confident you are with your answer? if you have $10000, how much will u bet? (don't be too aggressive even though your are 90% confident, since you are risk going bankruptcy)

Fermi question: estimate number of different kind of books published in human history. give 90 CL. what if I tell you it's not in the range? do you think it's too high or too low? why? (google says 130 million)

one question about 3x3x3 magic cube. never understand the question... 张老师实验室有，一次没玩成功过魔方。。

bet $10 on fair coin, H add 1 point, T add -1 point. I win if reach 2 points, lose if reach -2 points. I have option to double bet. Can use as many times as u want. what's you strategy? what's the expected value of the game in this scenario? What if you can choose to bet $10 or $20 at the very beginning, which you prefer? why? Be careful with the risk of going bankruptcy.. what if the bet of the game also doubles every time it is at 0 point? what's the value of the game then? why? (Failed miserably with this question which takes more than half of the interview time.. don't think can get chance for next round..)

先brief前三轮：  
第一轮和第三轮参考xiaoxiao前两轮，几乎完全一样。  
第二轮：给定一个字符串的array，把其中互为anagram的group在一起，leetcode原题。然后稍微变化了一下，不要求anagram，但是要求互相之间相差一个circular变换，比如 abcd  --> bcda

然后是刚挂掉的第四轮：是个design的题，有一个sheet，上面有很多cell，每一个cell要么是一个常数，要么包含另外两个cell的位置。现在要定义读取每个cell的值的操作，如果是常数返回常数，如果是第二种情况返回那两个cell的值之和。怎么设计？改变一个cell的值，其他cell的值怎么update？

**jump second round**

coding part:

1 Realize a data structure called heap. It is a variant of min-heap. But every child has two parents(essentially it is a triangle). Write the constructor, size function, insert, min-pop and find-element function. Write it with cpp on a lap-top, we have half an hour time.

2. In a triangle, write a pesodo code to calculate the maxpath sum(from leetcode).

3. write function to return std of a float array.  Discuss the numerical problems might arise.

Behavior part:

what is your great achievement?

what did you regret most in your life?

what factor you consider most in job hunting?

Do you enjoy teaching? why?

quantitative part 1:

1.find the eigenvalues of I + a a^T, where a is a column.

2.A submarine is in the x axis. Its starting position is an integer, its speed is also an integer, but we do not know this two number. Each time, we can check a position to see if the submarine is there. Design an algorithm to make sure find the submarine in finite time.

3. n Random variable with correlation rho between each other, find the range of rho.

4.5 houses are located in a row. A mouse is in one of the houses. Each time, it runs to its neighbors with probability 0.5( if is in the leftmost and rightmost house, then it go to its neighbors in the next for sure).At each step, we can check a house to see if the mouse is there. Design an algorithm to find the mouse with probability 1 with minimum steps.

1. k sided dice, throw n times. Xi is the number of throw when ith face up. Find the covariance of X1 and X2

2. an infinite series {X\_n}, X\_n = sqrt(2) ^X\_{n-1}. Question: if X\_0 is 0, is this series converge, if it is , find the limit. what if X\_0 =3.

3. A betting game, wining probability p is greater than 0.5. if we have initial cash X. design a betting strategy, to maximize the expectation of long term growth rate.

Jump:campus interview

1Four balls with four colors in a box. Each time, get two of them out of the box and randomly paint one with another's color. Find the expectation steps to the event that all four balls have the same color.

2.coding problem:

For each number, we can get its square sum of the digits, eg, for 16, we can get 1+36 = 37. Repeat this process,  an interesting result is that the final number is either 1 or a cycle contains 89.

Question: Find all the number less than n, that will result in 89cycle.

其实我有个问题, 关于投N个甩子或者硬币，最后求和算概率的问题，经常被问。他们到底要考察什么， 只是考知不知道中心极限定理么，还是有其他可以挖掘的东西？

Mogan stanley

MS second phone interview:

1,many resume question.

2, x'=(1-x)x, solve it.

3, 100 dices, find the probability that the sum is greater than 400.

MS third phone interview:

1,spend almost all time talking about resume.

2, a game, wining probability is 51%. play it every day, what is the sharpe ration.

3, apply ito's lemma to W(t)^3.

发一下早晨optiver的电话问题：

1.挛生素数， 5,7之间是6， 11,13之间是12，17,19之间是18，。。。。两个挛生素数之间的数字都能被6整除，问这是不是general的，原因是什么，有没有特例？

2.两个dice，roll完了你不去看它们，现在告诉你它们至少有一个是6，问两个都是6的概率

3.一个dice，最多可以roll三次（下面请脑补，你脑补的就是这个题）

You are given ten rocks and you would like to find the heaviest one. With each weighing you randomly select two of the rocks and determine which of the rocks is heavier. What is the expected number of weighing you need in order to tell which rock is the heaviest?

Morgan Stanley电面:

Interest Rate Group, 自我介绍背景以后，问了很多PDE的问题。问我怎么解PDE，有哪些数值方法，heat equation能不能solve backwards, 如果已知某个security在所有strike price的价格，能不能算出它在时刻T的payoff function, 如果能，怎么算。这方面他特别懂，估计设计了一些陷阱我都掉下去了。然后问了我一道概率题，有两种灯泡，好灯泡能工作10天，坏灯泡能工作1天，现在房间里面随机安装一个灯泡，好坏灯泡的概率都是0.5，然后灯泡坏掉的时候有人立刻更换，更换的时候同样是随机挑选。很长时间以后我随机进入房间，观察到灯泡第一次坏掉的平均时间是多少？然后悲剧了。

Foreign Exchange Group,

电面一，面试官哥大本科，CMU master,看名字是ABC. go over Resume, 问了简历的很多细节，最后问了一道题，每天投一次硬币，正面的概率是0.51，结果是正面就得1刀，是反面就得-1刀，一年的期望值是多少，sharp ratio是多少？我不知道sharp ratio定义，她解释了，sharp ratio = annualized return/ annualized standard deviation. 我问了下反馈，她说一般是不给的，但是建议我多练习下自我介绍和简历的介绍。

电面二， 面试官清华毕业的物理博士，人非常好，问了很多科研的东西，然后最后问我擅长什么方面，问了一道简单概率题，投掷硬币100次，正面概率是1/2，正面总数的期望值是多少？正面总数大于等于51的概率是多少?

觉得两个人都是有心帮忙，不过机会不太好，我JP Morgan onsite以后催了一下说其他家快结束了，过了两天告诉我悲剧了。如果不是已经拿到offer，不建议催。

Morgan Stanley superday (Mortgage team & Credit desk strats team)

题目未必全，但大概都在这里，涉及数字的地方可能有偏差，有些题我到现在还不会，如果有想法欢迎讨论:)

1. You toss a dice again and again until certain pattern appears:

    What is the expected number of tosses for 66(two consecutive 6)?

How about 56 (6 following 5)? Without calculation, can you tell if the answer for 56 should be larger or smaller than 66 or they are the same?

2. 100 stairs, each step 1 or 2 stairs, how many ways?

3. Suppose you go out every night, and for each night you have probability 1% to see a celebrity, then how many days you are expected to go until you see him? What if there are two celebrities?

4. There is a box, it has 6 sides, 3 of the sides are "right" and 3 are "wrong", now you have a blue ball and a red ball, you can put one of them into the box and send it to your friend. If your friends opens from one of the "right" sides, the ball inside does not change color, but if he opens from one of the "wrong" sides, the ball changes color. Now you want to send message to your friend with this and you can figure out a protocol with him beforehand, what protocol should you guys use?

5. Now you have a n\*n grid, one point on the grid is specified as "start" and the other is "end", now I ask you for an algorithm to find all the paths that starts from "start", passes each of the points on the grid once and ends at "end", what kind of data structure and algorithm would you use?

6. Give example of positive definite but non-symmetric matrix. Given a non-symmetric matrix with certain eigenvalues (suppose this matrix has the same left and right eigenvalues), how do you find a symmetric matrix with the same set of eigenvalues?

7. 2-sum and 3-sum problems in leetcode, describe the algorithm and analyze the time cost.

8. Choose vector x to minimize (x^T A x)/(X^T x), for symmetric positive definite matrix A, what if A is not positive definite?

9. Toss a coin 100 times, You get paid $1 if you get exactly 50 heads, how much you want to pay to play this game?

10. There is a jar and you start with 2 balls inside, one white and one black, now play a game: each time you take a ball randomly from the jar and put it back, also you put an extra ball with the same color back into the jar. Do this 100 times, then what is the probability you end up with the same number of black and white balls?

11. Do you follow market? What did the government do during the crisis? Apart from bailing out companies, what did they do? What would you do to the interest rates during crisis?

12. Now you have 4 balls: their weights are in a geometric series, for example: 1, q, q^2, q^3. Now with a balance (no reading, just for comparing weights), what is the number of times you weigh the balls to get the heaviest one?

13. How does mortgage work? Calculate the monthly payment from the principle and the interest rate (see my citibank mortgage post)

14. What kind of factors you would consider when you decide the rates for mortgage to certain clients (rich/poor people)? (This is largely just a casual chat)

15. Least square regression, what if we put weights on the residues, can you modify the formula?

16. Now you have 100 files filled with random integers, each file is 10GB large, and your computer can only read 10GB at once, then how can we find the number that appears most of the time in all these files in total?

17. What is stack? What is hash table? When do you use a stack?

18. Given int a[10], what happens if we call a[100]? And how to realize an array that starts with index 100 with length 10?

19. Two alarms A and B, the probability that A detecting the signal is 90%, the probability of B detecting is 85%.

      a. If there is a 5% probability that neither detecting the signal, are A and B independent?

      b. Given the probability that ONE of A and B detects (some number I forgot, maybe 11%), what is the probability neither one detects?

20. Can you estimate the approximate number of total house selling happening in U.S. per year?

1. Necklace sort: 4,1,3,5,2 --->2,4,5,3,1 (排序让最大的在中间，越小的越在两边)

   我做的比较笨，是先用O(n lg n)排序，放在一个 O(n)大小的buffer里，然后再一个一个放，面试官也没多要求什么，只是提出了一些简单的test case看我写的代码是不是会出错。这个算法应该是能一下想出来的时间空间代价最大的了，改进空间巨大。

2. MaxProfit问题，以前的帖子里贴过

顺便贴Goldman Sachs问的编程题：

求小于n的所有素数的和，要求用筛法（sift），并且写完以后面试官会提出可以改进的地方并问你怎么改进。

给一个已经排好的带重复的array以及一个target，写一个O(lg N)算法找到target第一次出现的下标。

题目不全，见了13个人，好多题根本记不住，只能写些有印象的

1. 投一个fair coin，可以产生一个无穷的series，比如 HTTTHHHTHTTHHT..... 考虑所有这些series组成的sample space

    a. warm-up: 如何构造概率1/2 ?   (取第一次toss得到H的所有序列)

    b. warm-up 如何构造1/4?    (取前两次得到HH的所有序列)

c. 现在问题来了，如何构造概率1/3 ?

2. 投一个 fair coin，求得到HHH的期望toss次数(14，绿皮)。然后问题来了：这个次数的variance是多少？

3. 算法： 筛法求素数 以及 return 一列带重复的elements中某个target第一次出现的下标， 这两个以前提到过。

4. 算法： 给了一个字符串，里面是一些英文单词，以空格分隔，求最长的两个词长度的乘积，写出代码并且自己检查bug。

                给了一个字符串，是一句话，单词之间以空格分隔，写一个函数把所有单词的次序reverse: 比如 Hello world --->  world Hello

5. C++:  什么是pure virtual function? 如果有个base class里面一个virtual function，我可以选择把它定义成pure virtual，也可以不定义成pure virtual而函数体什么都不干只是throw一个，二者你偏向哪个？ 那如果这个base class里面已经有了一个pure virtual function叫 foo()，那么对于另一个 virtual function  foo2()，我再问以上那个问题，你觉得两种方式有什么不同，你偏向哪个？

6.  从 1 到 N 这些数字排成一圈，从 1 出发，每一步都有0.5概率顺时针或是逆时针，问把所有除N以外的数字都至少遍历一遍最后走到N的期望步数是多少？

7. 一个双变量 linear regression，当R^2 = 1的时候是什么情形？（感谢KCG） 如果两个自变量的correlation是1的话，这个linear regression会有什么问题？

8. X 如果是一个standard normal variable的话，问 Phi(x)是什么分布？ 其中Phi(x)是standard normal的CDF

9. 找一个例子：两个random variables之间有dependence但是correlation是 0.

10. 描述一个算法：

     一个平面上有很多随机分布的点，求一个区域，这个区域要包括所有这些点，且需要是凸（convex）的

11. 一个portfolio有N个assets: P = w\_1 X\_1 + w\_2 X\_2 +.... w\_N X\_N   所有w\_i都是系数，问如果所有 X\_i的variance都是一样的(a)，所有X\_i 和 X\_j之间的covariance都是一样的 (b)，且所有 w\_i都等于 1/N，求 P的variance并且化简。从这个结果你应该能得到两条insights，它们是什么？

12. 如果你需要向客户展示我们为他们做portfolio management进行的各种分析，你觉得应该给他们展示什么data?什么样的分析？

补一个： 一个矩阵

                     1   2   3

        X =        4   5   6

                     7   8   9

求 det( e^X )

答案是 e^15，用  det M = e^Tr(logM) 做，做完会问这个公式为什么是对的，我用eigenvalue证明了一下，再问对不能对角化的矩阵怎么说明，我没答出来

再补：(这人我最喜欢，NYU Corant的概率论博士，做了一个博士后然后来了GS的derivatives analysis组，聊了一个半小时，补了一个不能来的interviewer的时间，都是数学)

1.Make sense of 1 + 2 + 3 + 4 +..... = -1/12 或者make sense of 1 - 1 + 1 - 1 + 1...... = ½

2.一个数列，当N--->infinity的时候 a\_(N+1)/a\_N --> c < 1，求证 S\_N = a\_1 + a\_2 + ... a\_N当N->infinity时候收敛

3. e^x这个函数在复平面上有奇点吗？

4. 解ODE： y' - y = 0 , y'' - y = 0, y'' + y = 0

5. Random chat about Riemann zeta function and the Millenium problem....

6. 中心极限定理：Why people talk about normal distribution?  什么叫概率分布收敛于normal distribution？探讨了几个例子

再补，记性太差只能一点点往外挤了

1. 一个particle，在x - y 平面运动，从原点出发，其速度的绝对值 v = a y + b，目标是到达 (L, 0) 点，求使时间最短的路径 （得到路径满足的ODE就行，不用解）

2. SDE题目，给一个log normal process (mu, sigma)，如何从观察到的数据点infer出来mu和sigma?

dS = u S dt + sigma sqrt(S) dW 求S的expectation value的时间演化（可能记的不准确）

3. Linear regression，从一堆散点得到 coefficient， 所做的是什么test? ( t-test )

first phone interview，问到一题，求[2, 0, 0; 0, 3, 4; 0, 4, 9]的eigenvalues，当时对方说是有一种非常规的办法可以很快算出来。有人知道吗？

Citadel:

1:what is min-max algorithm, A star search algorithm.

2:reverse words in sentence

3:singleton in Java

4:print all permutations.what is the complexity if we use recursion

(2,3,4) are coding problem, need write pseudo code on white paper(it is campus interview), I did really really bad.

5:n balls  put in k buckets,expected number of empty bucket

6:X,Y,Z random variable, know rho between X,Y and X,Z, what is the range of rho of Y,Z. Give a geometrical explanation.

7:why buyside. what is "interesting".

1，如何估计根号5？

2，扔100个fair coins, 有40个向上的概率是？

3，如何用蒙特卡洛法generate出一个2维球面上的均匀分布？

Trexquant(phone interview):

1: Some problems about numerical methods of ODE, PDE.

2: A bunch problems about linear regression,like how to deal

with co-linearity, non iid residue.

3: min-max algorithm, alpha-beta pruning.

4: code optimization problem, how to test if loop unrolling

improve the efficiency.

5: a bunch of problems related to my internship and research.

Summary: will ask you question until you do not know the answer.

Wells Fargo面试题

1、求一个4x4矩阵的eigenvalues和eigenvectors

2、写出brownian motion的分布，以及说出和poisson distribution的区别

3、如何用uniform distribution构造normal distribution

4、解一个ODE方程组，具体记不清了，类似于y'=2x+y, x'=x+y

5、用moment generating function求期望

PDT partners

Interviewer 1:

1. Pick one of your papers and tell me about it (the interviewer did 3 postdocs in theoretical cosmology and I lined up almost all the results in my paper, basically a mini-talk in 45 minutes)

2. What happens if a relativistic cosmic string passes across a stone (or whatever rigid body)

Interviewer 2:

1. Now you have an infinitely large N-dimensional space, there are infinitely many points uniformly randomly distributed in the space, N can vary from 1 to 100000 or whatever, but with different N you just keep the density of the points to be the same (say for N = 1, you keep the line density to be 1, N=2 you keep the area density to be 1 ....)

Question: For generic N, you pick up any particular one of the points and look at all the other points around it, there is a closest neighbor---the point that is closest to the point to pick up. Now for generic N, find the distribution of this closest distance and its most likely value.

Interviewer 3 (HR):

Random chat about your background, where are you from, your high school experience, your university experience, your phD experience, the culture of the firm, your relationship with others in your department especially your advisor, whether you want to do a postdoc or not etc.

1.if we have a A1 paper, in the envelope, each time, we get one out and cut to pieces of A5, and get A5 out. after 16 times, we will get all paper out. Find the expectation of number when we look at the envelope, there is only one piece of paper.

2.design a way to predict the score between two teams in the world-cup.

you can have any data you want.

SIG:  
  
1，我和庄家两个人，庄家制订了一套游戏规则：每个人分别扔3个硬币，如果Head的个数相同，则我赢，赢的钱数等于2^n，n是Head的个数；如果Head的个数不同，则我输，也就是没有钱拿。如果庄家问我要1元钱作为这场游戏的费用，我是否会同意？

2，如果我是一位父亲，有两个孩子，一天孩子们想去看电影，然后我决定让两个孩子分别被关进一个屋子，并且分别给他们一人一个硬币，让他们在屋子里（不允许商量）决定是否拿硬币出来，如果最后两人都拿了硬币，则我都扔，只有都是Head的时候他们才能去看电影；如果只有一个人拿出硬币，则我就扔这一个硬币，如果是Head，他们就能去看电影；如果没有人拿，就不许看电影。问孩子们的最佳策略？以及在这个策略下的看电影的概率是多少？

d.e.shaw:  
  
1，100个人站一圈，编号1到100，最开始1有一把枪，他把2杀死，然后传给他的下一家，也就是3，然后3把4杀死，再传给下一家5，这么循环下去，最后只剩下一个人，问剩下这个人的编号？

2，一个n个bit的数（包括首位可能的0），除去所有包含连续三个0的数以后，剩下多少个数？这个数在n趋于无穷的时候的行为是什么样的？

还有一个Transmarket发来的样题，求大家一块儿做：  
  
1. Which bet do you prefer and why?   
  
Bet 1: $100K with 90% probability OR -$800K with 10% probability   
OR   
Bet 2: $50K with 60% probability OR -$52K with 40% probability

2. What is the difference between a futures contract and a forward contract? If you are long a Forward Rate Agreement and short a EuroDollar future with the same fixing dates, do you have positive convexity or negative convexity? Why? 

3. Why do volatility skews or volatility smile exists in options markets? Why does the stock market exhibit a different skew than most commodities markets?

4. Suppose you have bought a July ITM call and sold an August ATM put.   
What would be your delta in this position? Once you hedged out your detla, are your remaining Greeks positive or negative (gamma, vega, rho, theta) 

5. Suppose you know the following information about a market:   
  
- Future is at 66   
- 70 strike straddle is trading at 27   
- 50-60 put spread is at 2.5   
- 50-60-70 put fly is at .2   
- Assume volatility is constant across strikes   
  
Using the prices given and relationships between options of various strikes, what are the fair values for the 80 Call, 60 Straddle, and 40 Put? Assume we had a volatility smile among the curve, how would this make your markets different? 

6. Suppose a retail investor is considering buying an ETF that tracks the crude oil market.   
- Would the retail investor prefer the underlying futures curve to be in contango (upward sloping) or backwardation (downward sloping?)   
- Which market shape is most advantageous to the owner of a storage facility?

person A has a 30 sided and person B has a 20 sided die. both players role and the person with the highest role win (on a draw B wins). the loser pays the winner the value of the winners die.  
1. calculate expected value of this game for player A (easy)

2. how does this value change if player B can re-roll and when should he re-roll.

3. now how much is it worth for player A to get a re-roll option in this scenario.

4. remove player A reroll. how many re-rolls do player B need in order for him to be a favorite in the game.

domeyard第一轮电面 面完一直没消息 估计挂了。。。把题目post上来吧

Domeyard:

知道哪些PDE？ Bessel function？

如何test stationary？

什么是confidence interval？ narrow confidence interval说明什么？

什么是bootstrapping？

difference between Bayesian statistics and frequentist statistics.

difference between forward and future.

如何long gamma

code给出第n个斐波那契数列

print matrix spiral form

片段找错 design efficiency problem？？？

问bessel function什么的是因为我写了PDE在上面。

对了，倒是还想起来一个问题，问我heat equation， 就把直到的所有都讲出来了。 什么fourier 方法解析解， green‘s function还有各种数值方法以及stability。。

还有一个问题， 问我什么是lagrangian multiplier，以及有什么用。

Stevens Capital management online C++ test

一个做HFT的，research职位都在枫叶国， 所以估计大家也没兴趣了。。。

把C++ online test post上来

Stevens Capital Management:

online c++ test, 每个题目三分钟，时间到了自动跳转。。。

  int n = 12;

  std::cin >> std::hex >> n;

  std::cout << std::setprecision(2) << n << std::endl;

如果输入是12， 输出是多少？ 答案18

class A has user defined default constructor;

difference between A\* a1 = new A; 和 A\* a2 = new A();

A lot of C++ exceptions questions..

class A;

class B: public A;

B\* b = new B();

A\* a = (???)b

选了dynamic\_cast…

in class, where to initialize non-static reference member variable

which of the exceptions is runtime\_error

how to cout both on screen and file

关于 const char\*, char \*const, const char \* const 的题

STL里面什么method可以用来写HasIntersection， 找出两个vector是不是有相同的元素

and a few other STL questions..

which container in STL is associative container? map and set

STL里什么method在一个array中删除所有大于50的元素，以及参数形式

还有几个给出code， 问最后输出，记不太清楚了。

World Quant 面试题

Online test，N多道题，每道题都限时，下面是有印象的不是特别trivial的：  
  
1，16个人排一圈，7男9女，问相邻的是异性的总数的期望

2，有一人每秒扔1个硬币，扔了100年，问下面结论是否正确：这个人扔不出连续100个Head的概率要大于99.99%

3，[0,1]区间随机撒两点，问这两点距离的期望

4，一天以内，时针和分针成90度角的次数

5，一个2\*2实对称矩阵，一共有三个free的实数可以选择，如果这三个数都是从[0,60]的均匀分布中选取，问行列式的期望

6，给一个cube，边长是1，6个内表面均有一面镜子。如果一束光从某个角射进来，恰好经过4次反射以后到达它的对角线位置，问光可以走的最短路线是多长

7，求最小正整数满足如下条件：它最后一位是4,；如果把最后一位4移动到首位（例如从1234到4123），则变成原数的四倍。

8,，2015^(2013^2014)的末四位

9，如果颜色用三位0,1实现，如果令白色是000，红色是101，蓝色是110，紫色是100，问黄色该是几

10，一个portfolio，包含两个可能asset，第一个expected return 是7，第二个是4，已知他们的covariance matrix是（2,1；1,1）问，portfolio的最大的sharpe ratio是几

11，f(x)-f'(x) = x^3 + 3x^2 + 3x + 1,问f(9)等于几

12，一个三角形，三边长度分别是45,60,75，如果在这个三角形区域内均匀的随机撒一点，求这一点到三边引垂线，到三个垂足长度的和的期望

13，甲乙二人在A，B两城市同时出发相向而行，在中午12点的时候他俩相遇，相遇以后继续前行，一个人下午4点到达目的地，另一个人晚上9点到。问他们是几点出发的

14，有10个岛连成一条线，分别命名1到10号岛屿。有一个人想从1号岛屿出发抵达10号岛屿。每相邻两个岛之间都有两个桥，其中一个是硬桥，另一个是软桥，但两桥外形相同无法辨认。如果人走在硬桥上面则顺利通过，如果走的是软桥，桥直接塌方不复存在，人落水，之后被救生人员救回到1号岛屿。问当这个人顺利抵达10号岛屿的时候，他走过的硬桥个数的期望

world quant 电面

1，有一个随机数发生器，20%概率给出0,  80%概率给出1。 问如何产生一个50%和50%的outcome。问产生这么一个outcome的时候，用到发生器次数的期望。如果你想到了那个naive的解决办法，能不能improve让期望值降下来一些？

2，给一组数，找出3个数使得和是0.    给出一个有效率的算法。

3，有（X，Y），如果给了一组data，X的平均值是2.1，Y的平均值是2.0，X和Y的标准差都是0.1，问X和Y是不是很接近？

Five rings capital software engineer phone interview

int i = 5; char c = '5'; char\* s = "5";

printf('%d', s); printf('%d', c) printf('%c', c)

int x = y = 0; int z; while(y < 10){ x += ++y}

问x和y跑完是多少

Now set y = 1; while(y < 10){ x = y++; z = ++y}

问跑完以后x,y,z多少

for(y = 1; y < 10; y++){ x = y;} 问跑完多少

for(y = 1; (x=y) < 10; y++){ ; } 问是不是能compile，跑完多少

char c; int i; float f; c = i = f = 100/3 问都是多少

char c; int i; float f; c = i = f = 100/3. 问都是多少，下同

f = i = c = (float)100/3;

f = i = c = (float)(1000/3);  (Pay attention to the limits on char type)

int w, x, y, z; x= y =1; z = x++-1;

z = 0; x = 2; y = 1; z+= -x+++++y

z = 0; x = 3; y = 2; z = x/++x;

x = 3; y = z = 4; w = z >= y >= x ? 1:0 问w是多少

w = z >= y && y >= x;问w

Citibank mortgage

Technical phone call, basically all C++ questions

1. What is the difference between public, private and protected?

2.  What is the use of 'default' ? When do you want to define your own default constructor?

3. When there are pointer members in a class, is there gonna be trouble?

4. Tell about inline functions.

There may be other questions but I cannot recall.

5. Why jump from physics to finance? (My impression is they in general like honest answer: academia job market is in difficult situation, hard to get real job. It doesn't mean I consider myself incompetent though.)

6. Experience with python? perl? SQL?

7. Questions for interviewer?