Statistics

Match Editorial

SRM 151
Tuesday, June 17, 2003

Archive
Normal view
Discuss this match

Match summary

The two matches prior to SRM 151 saw very few submissions on both the division one medium and hard problems, but this time the coders in both divisions submitted merrily. In division one, newcomers **aneubeck** (2nd place) and **tomek** (4th place) pushed hard, but it was for the "oldster" **radeye** to take the top spot. It is notable that bilingual **tomek** submitted in both C++ and Java, an event rarely seen with the top finishers. **noah** won division two finishing only 9 points ahead of **JWizard**. First timer **m00tz** finished third and was the only first timer to hit the yellow rating category.

The Problems

PrefixCode Discuss it

Used as: Division-II - Level 1:

Value	250
Submission Rate	177 / 213 (83.10%)
Success Rate	109 / 177 (61.58%)
High Score	**farsight** for 248.08 points

Surprisingly many submissions on this problem failed, mainly because not the lowest index of a prefix was returned, but any index of a word that had a prefix.

Simply consider the words in the given order and for each word, check if it is the prefix of another word.

```
Java

public String isOne(String[] words)
{
    for (int i=0; i<words.length; i++)
        for (int j=0; j<words.length; j++)
            if (i != j && words[j].startsWith(words[i]))
                return "No, " + i;
    return "Yes";
}
```

Birthday Discuss it

Used as: Division-II - Level 2:

Value	500
Submission Rate	161 / 213 (75.59%)
Success Rate	73 / 161 (45.34%)
High Score	**Ceranith** for 486.64 points

There are several possibilities for solving this one. One of the possibilities is the following: Extract the day and the month from the current date and from all birthdays. In a loop, first check if the current day coincides with any of the birthdays. If so, return that day. If not, set the current date to the following day (paying attention to the start of a new month/year).

The shorter and less error-prone solution is to sort the birthdays, unmodified, as strings (in ascending order). Go through the sorted birthdays until the first birthday that occurs on or after the current date is found and return it. If no such birthday is found, all given birthdays occur before the current date (looking at a fixed year), so return the first birthday in the sorted list, which is the first birthday occurring when a new year begins.

C++

```
string getNext(string date, vector<string> birthdays)
{
    sort(birthdays.begin(), birthdays.end());
        for (int i=0; i<(int)birthdays.size(); i++)
            if (birthdays[i].substr(0, 5) >= date)
                return birthdays[i].substr(0, 5);
    return birthdays[0].substr(0, 5);
}
```

MergeSort Discuss it

Used as: Division-II - Level 3:

Value	1000
Submission Rate	75/ 213 (35.21%)
Success Rate	45 / 75 (60.00%)
High Score	**m00tz** for 893.29 points

Used as: Division-I - Level 2:

Value	500
Submission Rate	140 / 145 (96.55%)
Success Rate	109 / 140 (77.86%)
High Score	**Yarin** for 481.98 points

Implement the MergeSort algorithm as described, run it on the input, and count the number of comparisons made.

C++

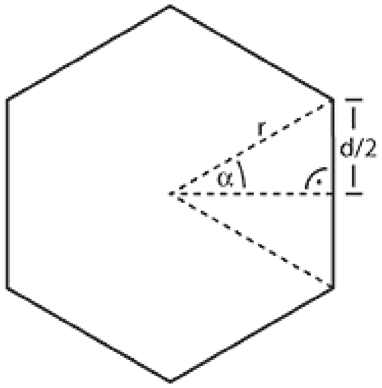
```
int howManyComparisons(vector<int> a)
{
    return mergeSort(a);
}
int mergeSort(vector<int>& a)
{
    if (a.size() <= 1)
        return 0;
    int k = a.size() / 2;
    vector<int> b = vector<int>(a.begin(), a.begin()+k);
    vector<int> c = vector<int>(a.begin()+k, a.end());
    int cb = mergeSort(b);
    int cc = mergeSort(c);
    return cb + cc + merge(a, b, c);
}
int merge(vector<int>& a, vector<int>& b, vector<int>& c)
{
    unsigned ai = 0, bi = 0, ci = 0, comps = 0;
    while (bi != b.size() && ci != c.size() && ++comps)
        if (b[bi] == c[ci])
        {
            a[ai++] = b[bi++];
            a[ai++] = c[ci++];
        }
        else
            if (b[bi] < c[ci])
                a[ai++] = b[bi++];
            else
                a[ai++] = c[ci++];
    while (bi != b.size())
        a[ai++] = b[bi++];
    while (ci != c.size())
        a[ai++] = c[ci++];
    return comps;
}
```

Archimedes

Discuss it

Used as: Division-I - Level 1:

Value	250
Submission Rate	129 / 145 (88.97%)
Success Rate	122 / 129 (94.57%)
High Score	**antimatter** for 248.78 points



The solution to this problem may be the shortest a TopCoder problem has ever seen. However, there is some basic geometry to be done before the return statement can be written.

Taking the perimeter of a n-sided regular polygon (n * d, d: sidelength) inscribed into a circle as an approximation for the perimeter of that circle (2 * Pi * r) we get n * d = 2 * appr_Pi * r <=> **appr_Pi = n * d / (2 * r)**.

To calculate the length of a side from the polygon, take a look at the image on the left: For the little right triangle we get sin *alpha* = (d/2) / r with *alpha* = 2 * Pi / (2 * n) = Pi / n (in radian). Inserting **d = 2 * r * sin (Pi / n)** into the approximation we get appr_Pi = n * 2 * r * sin (Pi / n) / (2 * r) <=> **appr_Pi = n * sin (Pi / n)**.

Java

```
public double approximatePi(int numSides)
{
    return numSides * Math.sin(Math.PI / numSides);
}
```

Gauss

Discuss it

Used as: Division-I - Level 3:

Value	1000
Submission Rate	72 / 145 (49.66%)
Success Rate	43 / 72 (59.72%)
High Score	**radeye** for 939.97 points

What came to my mind first is the following (it is too slow on the given constraints, but the technique may be useful for other problems): Start with lower = 1, upper = 1 and sum = 1 (sum is supposed to be the sum of all numbers from lower to upper). Do a loop while upper <= target/2 + 1: If sum equals target, add [lower, upper] to the solution. If sum <= target expand the interval (upper++ and sum += upper), and if sum > target shorten the interval (sum -= lower and lower++). This way all intervals can be found but the running time is linear in target, which is too much since target can be as high as 100.000.000.000.

First, observe that the maximum number of numbers added to get target occurs in the case where adding starts from 1. Assume that target is the sum of the numbers from 1 to n for some n: target = n*(n+1) / 2 =>
n = -0.5 + sqrt(0.25+2*target). Second, observe that for a given number of numbers to be added there can be only one or no solution at all.
So target can potentially be the sum of anywhere from 2 to n consecutive numbers. A single check as to whether target is the sum of m numbers (2 <= m <= n) can be done in constant time, also yielding the numbers to be added. Consider the cases where m is odd and m is even for an example, n = 30:

```
n = 30   m = 5   4 5 6 7 8   n / m = 6     n % m = 0
n = 30   m = 4   6 7 8 9     n / m = 7.5   n % m = m/2
```

If m is odd and n/m is integral, n/m is the number in the middle of the numbers that add up to target. If n/m is not integral, there is no solution for m. (Informally, n/m is the 'average weight' of the numbers that need to be added; take n/m and (m-1)/2 numbers to the left and to the right of n/m, respectively.)
If m is even, n/m must be x.5 for a solution to exist (for some integer x). The solution is the next m/2 integral numbers less than and greater than n/m, respectively. (Again informally, n/m is the 'average weight' of the numbers that need to be added, and if n/m = x.5 each 'pair' of numbers from the left and the right of n/m has this average weight.) The complexity is O(sqrt(target)).

Java

```
public String[] whichSums(String target)
{
    java.util.Vector v = new java.util.Vector();
    long t = Long.parseLong(target);
    int n = (int)(Math.sqrt(0.25+2*t) - 0.5);
    for (int i=n; i>=2; i--)
    {
        if (i % 2 == 1 && t % i == 0)
            v.add("[" + (t/i-i/2) + ", " + (t/i+i/2) + "]");
        if (i % 2 == 0 && t % i == i/2)
            v.add("[" + (t/i-i/2+1) + ", " + (t/i+i/2) + "]");
    }
    return (String[])v.toArray(new String[0]);
}
```

The number of ways to represent n as the sum of consecutive positive numbers is equal to the number of odd divisors of n. Try to prove it yourself or take a look at the proof at the end of this old newsgroup post and read more at the On-Line Encyclopedia of Integer Sequences.

By **Wernie**
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