Introductory Lecture
Topics: basics, resources, stl, bitwise tricks

League of Programmers

ACA, IIT Kanpur

October 5, 2013

Outline

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- There are handsome rewards - prestige, joy of learning new things, and yes lots of money!

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- But, Java is comparatively very slow, so sometimes an optimal algorithm might time out on the judge
- C has too restrictive and does not support stl/templates /classes
- Use Library functions and Data Structures instead of writing your own every time

Programming competitions

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- IOPC (IITK), Shaastra (IITM), Bitwise (IITKgp)

Websites for practice

- Compete against Indian coders in live contests: Codechef
- Short Programming Contests: Codeforces, Topcoder
- Problem set Archives: SPOJ, Project Euler, livearchive, acm.sgu.ru and many more

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Overflow

```
#include<stdio.h>
int main()
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int a, b;
scanf("%d %d", &a, &b);
printf("%d\n", a+b);
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- Not all the input constraints are explicit
- Always think about the worst case scenario, edge cases, etc.

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- Segmentation fault
  - Invalid memory reference
  - Using too much memory than provided

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- For example, 10 test cases with $N = 10000$ means $O(N^2)$ is required

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7. Debugging (TLE: time limit exceeded, WA : incorrect solution etc.)

Some optimizations

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  operations on unsigned ints/long long are faster
  bitwise operators and shift operators (&ˆ $|\gg\ll$)
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- I/O: do NOT use cin/cout for large input output

Some Standard paradigms

- Sorting
- Searching
- Preprocessing
- Divide-and-Conquer
- Dynamic Programming
- Greedy Algorithms
- Graph
- Network Flow
- Backtracking
- Computational Geometry
- Pure maths
- Ad-hoc problems

Outline

Standard template library

Website: `http://www.cplusplus.com/reference`

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   - swap

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3. C++ and Java have implementations of stack

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Query Operations

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- $IsEmpty(S)$: determine if the stack S is empty

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- $IsEmpty(S)$: determine if the stack S is empty
- $Top(S)$: returns the element at the top of the stack
  Example: If S is $a_1, a_2, \ldots, a_n$, then $Top(S)$ is a_1.

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- $Push(x, S)$: push x at the top of the stack
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  Example: If S is $a_1, a_2, \ldots, a_n$, then after $Push(x, S)$, S becomes
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- $Pop(S)$: delete an element from the top of the stack S.
  Example: If S is $a_1, a_2, \ldots, a_n$, then after $Push(x, S)$, S becomes
  $a_2, \ldots, a_n$

1. Try to write a code for the same and check it here: `http://www2.cse.iitk.ac.in:81/newonj/problem.php?problemID=42`
2. Then later on try this problem: `http://codeforces.com/problemset/problem/344/D`

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- *Dequeue*(Q) : delete the element from the front of the queue.
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2. Then later on try this problem:
   `http://www2.cse.iitk.ac.in:81/newonj/problem.php?problemID=47`
   Hint: Its a Queue problem, now the (x, y) is a queue element.

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4. C++ and Java have implementations of priority queue

1. Try to write a code for the same and check it here:
   `http://www.spoj.com/problems/EZDIJKST/`
   Hint: Its a a tutorial problem for the algorithm Dijkstra.

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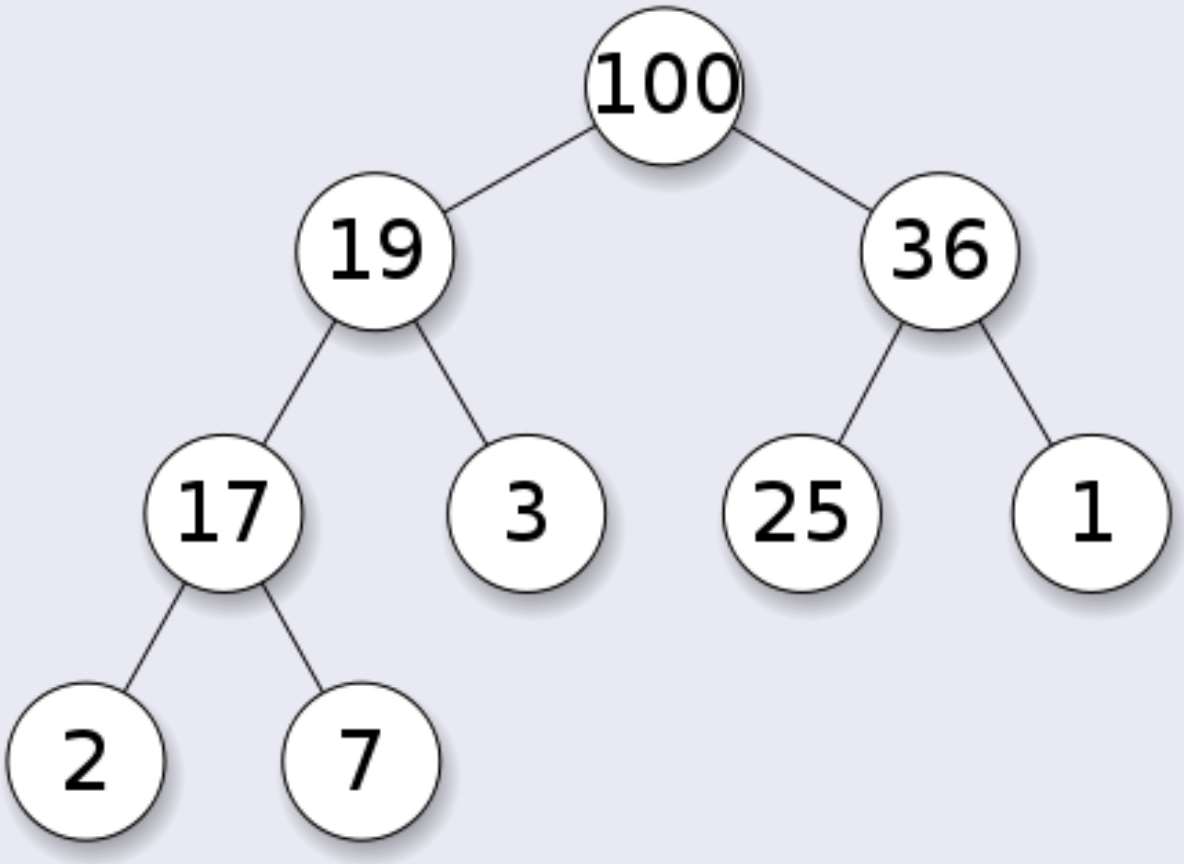
5. May need rearrangement of some nodes

Heap



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3. Solution code is provided but try it out yourself.

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3. Speed up the code by upto 100 times. Caution: try to use bitwise operations on unsigned integers only

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   - Count the number of elements of elements in a set S
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   - Generate all subsets of 1..n changing one bit at a time
   - Generate all subsets of S which have exactly t elements
   - Count the number of elements of elements in a set S
   - Remove smallest element from S
   - Check if $|S| = 1$

Beauty of Bitwise

1. Example:
   - Any subset of 0,1. . . 31 is a single int
   - Do set union/intersection/complement in one operation increment/decrement all elements by x in one operation
2. Even more:
   - Find if $x \in S$.
   - Generate all subsets of S in $2^{|S|}$ time
   - Generate all subsets of 1..n changing one bit at a time
   - Generate all subsets of S which have exactly t elements
   - Count the number of elements of elements in a set S
   - Remove smallest element from S
   - Check if $|S| = 1$
3. Never multiply or divide or take remainder modulo power of 2

Outline

Problems

Links:

1. http://spoj.pl/problems/WEIRDFN
2. http://www.spoj.pl/problems/HOMO/
3. http://spoj.pl/problems/HISTOGRA
4. http://spoj.pl/problems/SUBSEQ
5. http://www.spoj.pl/problems/NGM2/
6. http://www.spoj.pl/problems/JOCHEF
7. http://www.spoj.pl/problems/SWTHIN/
8. http://www.spoj.pl/problems/LAZYPROG/
9. http://www.spoj.com/problems/NAKANJ/
10. http://www.spoj.com/problems/PPATH/