PROGRAMMING IS BEST UNDERSTOOD BY EXAMPLES.

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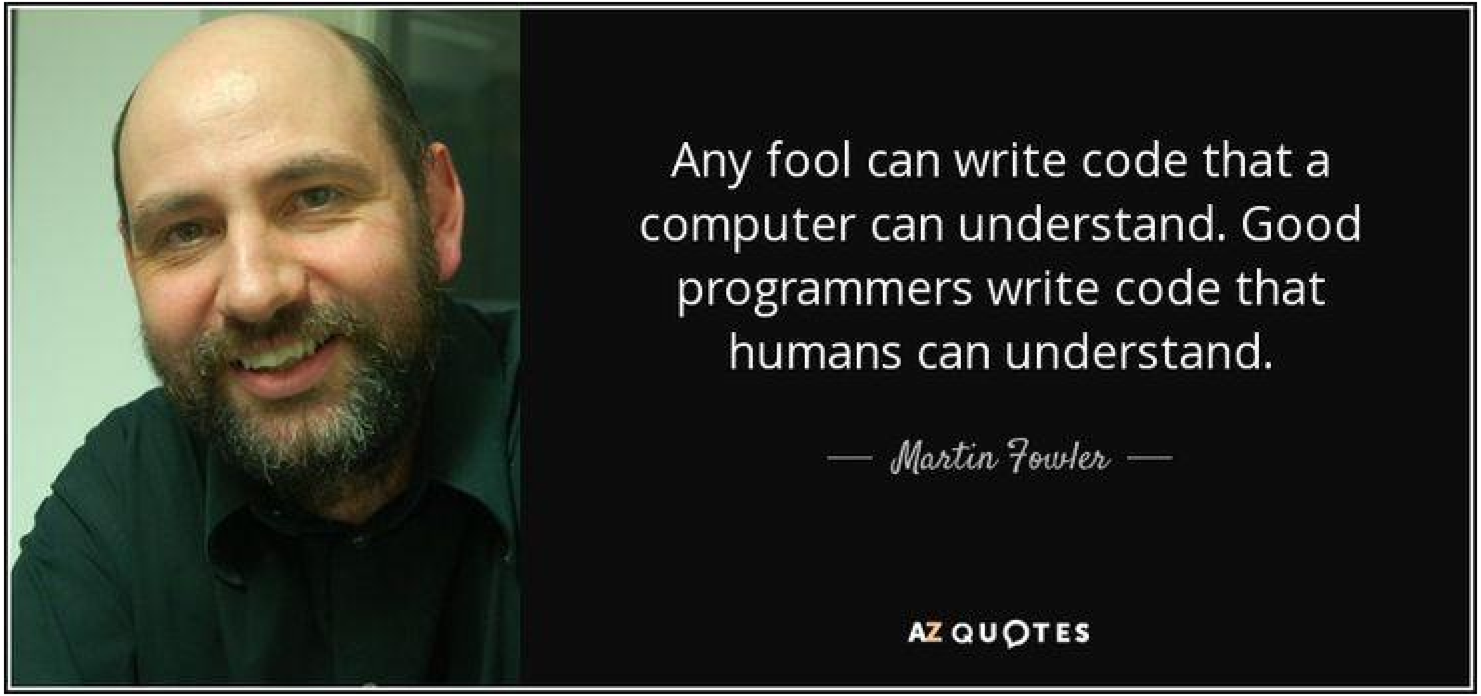
&
KAILASH



> Any fool can write code that a computer can understand. Good programmers write code that humans can understand.
>
> — Martin Fowler —

Prefix sum

Cumulative sum.

Lots of Queries about range sum. Answer in O(1)

Countless other applications
MinMax subarray
https://csacademy.com/contest/beta-round-3/#task/minmax_subarray

Complexity??

Can we do better??

Tricky Prefix sum

Lots of queries

Say index 5,9

Return a[5]*1 + a[6]*2 +a[7]*3 + a[8]*4 + a[9]*5
Again in O(1).

https://www.hackerrank.com/contests/novice-programming-challenge/challenges

Variations of Prefix sum

Prefix sum in a matrix
https://www.hackerearth.com/altizon-hiring-challenge/algorithm/grid-count-1

Rabin Karp
Can there be any better application than this??
http://www.geeksforgeeks.org/searching-for-patterns-set-3-rabin-karp-algorithm/

Time complexity O(n)

Q1) Find whether the pattern ‘X’ is present in large text ‘Y’
Q2) Count number of times the pattern ‘X’ is present.
Q3) Find count of all distinct substrings (of any length) in a large text ‘X’.

Sliding Window & Two pointer approach

Two pointer approach [[Blog - http://codeforces.com/blog/entry/5687]]

Two Pointer Approach
****Value Compression technique**
Non-Secret Cypher
http://codeforces.com/contest/190/problem/D

Sliding Window
Count distinct elements in every window of size k
http://www.geeksforgeeks.org/count-distinct-elements-in-every-window-of-size-k/

Maximum of all subarrays of size k
http://www.geeksforgeeks.org/maximum-of-all-subarrays-of-size-k/

Round C Google APAC Test 2016
https://code.google.com/codejam/contest/4284487/dashboard#s=p3

Binary Search to find the solution

Minmax Revisited
https://csacademy.com/contest/beta-round-3/#task/minmax_subarray

Enduring Exodus
http://codeforces.com/contest/655/problem/C

Number Theory

Friends and Presents
http://codeforces.com/problemset/problem/483/B

Greedy

Standard problems : Interval Scheduling
Given a set of intervals choose maximum number of non clashing intervals
Approach : choose the interval which ends first .

Problem i solved in recent contests : https://www.codechef.com/COOK66/problems/DESTROY
Just took some test cases and tried if it works , worked :P

Proving is usually difficult
Assumptions : Choosing optimal value at this step makes the global value optimal

Some Number Theory tricks

C++ STL (set , multiset , map … etc)
(1/M)%p where p is prime
Here we have to use fermet's little theorem
http://mathworld.wolfram.com/FermatsLittleTheorem.html

a^(p-1)%p = 1
How do you find inverse of a number ?

Fast exponentiation technique
GCD , LCM
Euler's phi function
Prime number seive (phi function can be calculated using seive)
Bit masking
Codeforces Educational Rounds
Ladders

Some Graph (Topological Sort)

Difference between graph and a tree.
https://www.hackerearth.com/code-monk-graph-theory-i/algorithm/monk-at-the-graph-factory/

Cycle in an undirected graph.

Cycle in a directed graph.
http://www.geeksforgeeks.org/detect-cycle-in-a-graph/

Topological Sort
http://www.geeksforgeeks.org/topological-sorting/

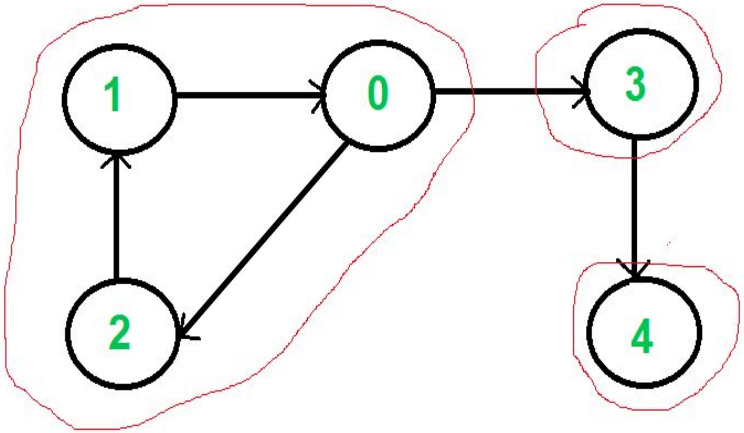
Fox and Names
http://codeforces.com/contest/510/problem/C

Robot Rapping Results
http://codeforces.com/contest/655/problem/D

Strongly Connected Component (Graph continued)

We can find all strongly connected components in O(V+E) time using **Kosaraju's algorithm**
http://www.geeksforgeeks.org/strongly-connected-components/

http://www.spoj.com/problems/WEBISL/



ARTICULATION POINT

A vertex in an undirected connected graph is an articulation point (or cut vertex) iff removing it (and edges through it) disconnects the graph.
http://www.geeksforgeeks.org/articulation-points-or-cut-vertices-in-a-graph/

Kingdom Unity
https://www.codechef.com/problems/KINGCON

Segment Tree

Use this link for further reference : http://se7so.blogspot.in/2012/12/segment-trees-and-lazy-propagation.html
Node : [i , j]
Left Child : [i , (i+j)/2]
Right Child : [(i+j)/2 + 1, j]
Note: that the height of the tree is [log N] + 1 {as every time the interval is almost halved}
if(i==j) then it is a leaf node
Proof for Runtime:
http://stackoverflow.com/questions/27185066/segment-tree-time-complexity-analysis (time constraint)
For Update : Recursively go to the leaf node and then backtrack (same as query)
IMP : what should be the size of the array allocated for the segment tree?

Direct application : https://www.codechef.com/problems/CHEFHILL
(usually there won't be any direct application problems , combined with dp or binary search on the answer)
Recent problems i solved : https://www.codechef.com/BITC2016/problems/TVP
Usually segment tree is slower if the input is very large , so we combine it with lazy propogation

Segment Tree + Lazy propagation

In the previous version for update function u go till the end of the tree but here you just mark that it has to be updated and update when needed.

http://se7so.blogspot.in/2012/12/segment-trees-and-lazy-propagation.html

Change from the previous version :
1.If node has to be updated first update it in the query and update function call.
2.Do not pass update function till the leaf , break it if the interval is entirely inside.

When is building seg tree an overkill ????

Z algorithm (Linear time pattern searching Algorithm)

http://www.geeksforgeeks.org/z-algorithm-linear-time-pattern-searching-algorithm/

```
 ->aabxaabxcaabxaabxay
   0100410008100510010
```

Complexity O(m+n)

Password
http://codeforces.com/problemset/problem/126/B

KMP
http://www.geeksforgeeks.org/searching-for-patterns-set-2-kmp-algorithm/

DYNAMIC PROGRAMMING (My personal favourite)

Overlapping problem & **Optimal substructure**.

Lets take example of Fibonacci numbers.

Colorful-balls
https://www.hackerearth.com/lucid-tech-sol-java-hiring-challenge/algorithm/colorful-balls/

Jake and MatchSticks
https://www.hackerrank.com/contests/acm-knapsack16/challenges/jake-and-matchsticks

Awesome Number Theory & DP combination
XOR Equation
http://codeforces.com/problemset/problem/627/A

Dp with bitmask
http://www.spoj.com/problems/ASSIGN/

BINARY INDEXED TREE

Most famous link
https://www.topcoder.com/community/data-science/data-science-tutorials/binary-indexed-trees/
-Isolating the last set bit.
-Always finds from beginning.
-Applicable only when the inverse exists.

Problems:
1)Counting inversion
https://uva.onlinejudge.org/index.php?option=com_onlinejudge&Itemid=8&page=show_problem&problem=1751

2)Shil and Palindrome Research
https://www.hackerearth.com/code-monk-binary-indexed-tree/algorithm/shil-and-palindrome-research/description/

3)Enemy is weak [[Awesome -can’t be solved with merge-sort approach]]
http://codeforces.com/problemset/problem/61/E

Disjoint Set Union Find Algorithm

Easy to code, easy to understand with very complex run-time analysis.

What makes it so special??

-Union by Rank
-Path Compression

Ackerman Function to estimate its run-time complexity.

1)Queries with connected components.

2)Kruskal Algorithm (Take any MST problem solve using disjoint set union)
https://www.hackerearth.com/code-monk-minimum-spanning-tree/algorithm/maximum-spanning-tree/
Problem statement usually looks like : From a set of edges , find the edges of minimum total cost so that all the cities are connected

Fast Matrix Exponentiation

Very efficient way to find nth term of a recurrence relation.

-Like find 10^15th fibonacci number.

1.Given a recursive relation, our aim is to find a matrix M which can lead us to the desired state from a set of already known states.

2.Assume we know k states of a given recurrence reln, and want to find the (k+1)th state.

Rahul & Fibonacci Series
https://www.hackerearth.com/problem/algorithm/rahul-and-fibonacci-series/

https://www.hackerrank.com/contests/acm-knapsack16/challenges/solve-the-recurrence