

String Algorithm.

KnuthMorrisPratt algorithm.

Problems - NHAY, PERIOD on SPOJ.

Suggested Reading -

Cormen chapter on Strings.

<http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=stringSearching>

Aho Corasick algorithm.

Problems - WPUZZLES on SPOJ.

Suffix Arrays

$O(n^2 * \log n)$ Naive method of suffix array construction

$O(n * \log n^2)$ method of suffix array construction

$O(n * \log n)$ method of suffix array construction.

$O(n)$ method of suffix array construction

$O(n)$ LCA preprocess on Suffix Arrays to solve a variety of string problems.

Suffix Trees

$O(n)$ construction of Suffix trees using Ukkonon's algorithm.

$O(n)$ construction of Suffix Trees if provided with Suffix Arrays using Farach's algorithm.

Suffix Automata

$O(n)$ Suffix Automaton construction.

Dictionary Of Basic Factors

$O(n * \log n)$ method of DBF construction using Radix Sort.

Manacher's algorithm to find length of palindromic substring of a string centered at a position for each position in the string. Runtime $\rightarrow O(n)$.

Searching and preprocessing Regular Expressions consisting of '?', '*'.

Multi-dimensional pattern matching.

Problems on Strings [can be solved with a variety of techniques] -

[DISUBSTR](#), [PLD](#), [MSTRING](#), [REPEATS](#), [JEWELS](#),
[ARCHIVER](#), [PROPKEY](#), [LITELANG](#), [EMOTICON](#),
[WORDS](#), [AMCODES](#), [UCODES](#), [PT07H](#),

[MINSEO](#), [TOPALIN](#), [BWHEELER](#), [BEADS](#), [SARRAY](#),
[LCS](#), [LCS2](#), [SUBST1](#), [PHRASES](#), [PRETILE](#) on SPOJ
http://www.algorithmist.com/index.php/Category:String_algorithms

Till 11 may.

Basic Graphs [beginner].

Representation of graphs as adjacency list,
adjacency matrix, incidence matrix and edge list
and uses of different representations in
different scenarios.

Breadth First Search.

problems -

[PPATH](#), [ONEZERO](#), [WATER](#) on SPOJ

Depth First Search.

Strongly Connected Components.

problems -

TOUR and [BOTTOM](#) on SPOJ.

Biconnected Components, Finding articulation
points and bridges].

problems -

[RELINETS](#), [PT07A](#) on SPOJ.

Dijkstra algorithm -

problems -

[SHPATH](#) on SPOJ.

Floyd Warshall algorithm -

problems -

[COURIER](#) on SPOJ.

Minimum Spanning Tree

problems -

[BLINNET](#) on SPOJ.

Flood-fill algorithm

Topological sort

Bellman-Ford algorithm.

Euler Tour/Path.

problems - [WORDS1](#) on SPOJ.

Suggested reading for most of the topics in Graph
algorithms -

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=graphsDataStructs1>.

Also refer to the tutorial for problems
concerning these techniques.

Cormen chapter 22 to 24.

Till 13 may. (before coming iitk it should be done :))

Flow networks/ matching etc etc.

[Intermediate/Advanced].

Maximum flow using Ford Fulkerson Method.

Suggested Reading -

<http://www.topcoder.com/tc?module=Statistics&d1=tutorials&d2=maxFlow>

problems - [TAXI](#), [POTHOLE](#), [IM](#), [QUEST4](#), [MUDDY](#), [EN](#), [CABLETV](#), [STEAD](#), [NETADMIN](#), [COCONUTS](#), [OPTM](#) on SPOJ.

Maximum flow using Dinic's Algorithm.

Problems - [PROFIT](#) on spoj.

Minimum Cost Maximum Flow.

Successive Shortest path algorithm.

Cycle Cancelling algorithm.

Suggested Reading -

<http://www.topcoder.com/tc?module=Statistics&d1=tutorials&d2=minimumCostFlow1>

Maximum weighted Bipartite Matching (Kuhn Munkras algorithm/Hungarian Method)

problems - [GREED](#), [SCITIES](#), [TOURS](#) on SPOJ | http://www.topcoder.com/stat?c=problem_statement&pm=8143

Stoer Wagner min-cut algorithm.

Hopcroft Karp bipartite matching algorithm.

problems - [ANGELS](#) on SPOJ.

Maximum matching in general graph (blossom shrinking)

Gomory-Hu Trees.aa

i) Problems - [MCQUERY](#) on Spoj.

Chinese Postman Problem.

problems -

<http://acm.uva.es/archive/nuevoportal/data/problem.php?p=4039>

Suggested Reading -

<http://eie507.eie.polyu.edu.hk/ss-submission/B7a/>

Suggested Reading for the full category ->

Network flow - Algorithms and Applications
by Ahuja

Cormen book chapter 25.

Till 20 th may.

Dynamic Programming.

Suggested Reading - Dynamic Programming (DP) as a tabulation method

Cormen chapter on DP

Standard problems (you should really feel comfortable with these types)

http://www.topcoder.com/stat?c=problem_statement&pm=8570&rd=12012&rm=269199&cr=7581406

http://www.topcoder.com/stat?c=problem_statement&pm=10765&rd=14183

State space reduction

http://www.topcoder.com/stat?c=problem_statement&pm=10902

http://www.topcoder.com/stat?c=problem_statement&pm=3001

http://www.topcoder.com/stat?c=problem_statement&pm=8605&rd=12012&rm=269199&cr=7581406

Solving in the reverse - easier characterizations looking from the end

<http://www.spoj.pl/problems/MUSKET>

http://www.topcoder.com/stat?c=problem_statement&pm=5908

Counting/optimizing arrangements satisfying some specified properties

http://www.topcoder.com/stat?c=problem_statement&pm=8306

http://www.topcoder.com/stat?c=problem_statement&pm=784

9 Strategies and expected values

http://www.topcoder.com/stat?c=problem_statement&pm=10765&rd=14183

http://www.topcoder.com/stat?c=problem_statement&pm=10806

http://www.topcoder.com/stat?c=problem_statement&pm=7828

http://www.topcoder.com/stat?c=problem_statement&pm=7316

DP on probability spaces

http://www.topcoder.com/stat?c=problem_statement&pm=7422

http://www.topcoder.com/stat?c=problem_statement&pm=2959

http://www.topcoder.com/stat?c=problem_statement&pm=10335

DP on trees

http://www.topcoder.com/stat?c=problem_statement&pm=10800

http://www.topcoder.com/stat?c=problem_statement&pm=10737

http://www.topcoder.com/stat?c=problem_solution&rm=266678&rd=10958&pm=8266&cr=7581406

DP with data structures

<http://www.spoj.pl/problems/INCSEQ/>

<http://www.spoj.pl/problems/INCDSEQ/>

<http://www.spoj.pl/problems/LIS2/>

http://www.topcoder.com/stat?c=problem_statement&pm=1986

Symmetric characterization of DP state

http://www.topcoder.com/stat?c=problem_statement&pm=8610

A good collection of problems

<http://codeforces.com/blog/entry/325>

<http://problemclassifier.appspot.com/index.jsp?search=dp&usr=>

Till 28 th may.

Greedy.

Suggested Reading -

Chapter on Greedy algorithms in Cormen.

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=greedyAlg>

problems - refer to the topcoder tutorial.

Number Theory.

Modulus arithmetic - basic postulates [Including modular linear equations, Continued fraction and Pell's equation]

Suggested Reading -

Chapter 1 from Number Theory for Computing by SY Yan [Recommended]

31.1, 31.3 and 31.4 from Cormen

www.topcoder.com/tc?module=Static&d1=tutorials&d2=primeNumbers

Problems

<http://projecteuler.net/index.php?section=problems&id=64>

<http://projecteuler.net/index.php?section=problems&id=65>

<http://projecteuler.net/index.php?section=problems&id=66>

http://www.topcoder.com/stat?c=problem_statement&pm=6408&rd=9826

http://www.topcoder.com/stat?c=problem_statement&pm=2342

Fermat's theorem, Euler's Totient theorem (totient function, order , primitive roots)

Suggested Reading

1.6, 2.2 from Number Theory by SY Yan
31.6 , 31.7 from Cormen

Problems

<http://projecteuler.net/index.php?section=problems&id=70>

<http://www.spoj.pl/problems/NDIVPHI/>

Chinese remainder theorem

Suggested Reading

31.5 from Cormen
1.6 from Number Theory by SY Yan

Problems

Project Euler 271

http://www.topcoder.com/stat?c=problem_statement&pm=10551&rd=13903

Primality tests -

Deterministic $O(\sqrt{n})$ approach

Probabilistic primality tests - Fermat

primality test, Miller-Rabin Primality test

Suggested Reading -

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=primalityTesting>

Cormen 31.8

2.2 from Number Theory by SY Yan

Problems -

PON, PRIC, SOLSTRAS on SPOJ

http://www.topcoder.com/stat?c=problem_statement&pm=4515

Prime generation techniques - Sieve of Eratosthenes

Suggested Problems - PRIME1 on SPOJ

GCD using euclidean method

Suggested Reading

31.2 Cormen

Problems -

GCD on SPOJ

<http://uva.onlinejudge.org/external/114/11424.html>

Logarithmic Exponentiation

Suggested Reading -

<http://www.topcoder.com/tc?module=Statistics&d1=tutorials&d2=primalityTesting>

Integer Factorization

Naive $O(\sqrt{n})$ method

Pollard Rho factorization

Suggested Reading

2.3 from Number Theory SY Yan

31.9 Cormen

Problems -

http://www.topcoder.com/stat?c=problem_statement&pm=2986&rd=5862

<http://www.spoj.pl/problems/DIVSUM2/>

http://www.topcoder.com/stat?c=problem_statement&pm=4481&rd=6538

Stirling numbers

Wilson theorem

$nCr \% p$ in $O(p)$ preprocess and $O(\log n)$ query

Lucas Theorem

Suggested Reading for Number Theory -

Number theory for computing by Song Y Yan [Simple book describing concepts in details]
Concepts are also superficially covered in Chapter 31 of Introduction to Algorithms by Cormen

<http://www.codechef.com/wiki/tutorial-number-theory>

http://www.algorithmist.com/index.php/Category:Number_Theory

Problems on Number Theory -

http://www.algorithmist.com/index.php/Category:Number_Theory

<http://problemclassifier.appspot.com/index.jsp?search=number&usr=>

Till 6th june.

Math (Probability, Counting, Game Theory, Group Theory, Generating functions, Permutation Cycles, Linear Algebra)

Probability.

Syllabus

Basic probability and Conditional probability

Suggested problems

<http://www.spoj.pl/problems/CT16E/>

<http://www.spoj.pl/problems/CHICAGO/>

Random variables, probability generating functions

Mathematical expectation + Linearity of expectation

Suggested problems

<http://www.spoj.pl/problems/FAVDICE/>

http://www.topcoder.com/stat?c=problem_statement&pm=10744

Special discrete and continuous probability distributions

Bernoulli, Binomial, Poisson, normal distribution

Suggested Problem

<http://acm.sgu.ru/problem.php?contest=0&problem=498>

Suggested Readings

Cormen appendix C (very basic)

Topcoder probability tutorial

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=probabilities>

http://en.wikipedia.org/wiki/Random_variable

http://en.wikipedia.org/wiki/Expected_value

William Feller, An introduction to probability theory and its applications

Counting

Syllabus

Basic principles - Pigeon hole principle, addition, multiplication rules

Suggested problems

<http://acm.timus.ru/problem.aspx?space=1&num=1690>

http://www.topcoder.com/stat?c=problem_statement&pm=10805

Suggested readings

http://en.wikipedia.org/wiki/Combinatorial_principles

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=combinatorics>

<http://www.maa.org/editorial/knot/pigeonhole.html>

Inclusion-exclusion

Suggested readings

http://en.wikipedia.org/wiki/Inclusion-exclusion_principle

Suggested problems

http://www.topcoder.com/stat?c=problem_statement&pm=4463&rd=6536

http://www.topcoder.com/stat?c=problem_statement&pm=10238

Special numbers

Suggested reading - Stirling, eulerian, harmonic, bernoulli, fibonacci numbers

http://en.wikipedia.org/wiki/Stirling_number

http://en.wikipedia.org/wiki/Eulerian_numbers

[http://en.wikipedia.org/wiki/Harmonic_series_\(mathematics\)](http://en.wikipedia.org/wiki/Harmonic_series_(mathematics))

http://en.wikipedia.org/wiki/Bernoulli_number

http://en.wikipedia.org/wiki/Fibonacci_numbers

Concrete mathematics by Knuth

Suggested problems

http://www.topcoder.com/stat?c=problem_statement&pm=1643

http://www.topcoder.com/stat?c=problem_statement&pm=8202&rd=11125

http://www.topcoder.com/stat?c=problem_statement&pm=8725

http://www.topcoder.com/stat?c=problem_statement&pm=2292&rd=10709

Advanced counting techniques - Polya counting, burnside lemma

Suggested reading

http://en.wikipedia.org/wiki/Burnside's_lemma
<http://petr-mitrichev.blogspot.com/2008/11/burnsides-lemma.html>

Suggested Problems

http://www.topcoder.com/stat?c=problem_statement&pm=9975
<http://www.spoj.pl/problems/TRANSP/>

c. Game theory

Syllabus

Basic principles and Nim game

Sprague grundy theorem, grundy numbers

Suggested readings

http://en.wikipedia.org/wiki/Sprague%E2%80%93Grundy_theorem
<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=algorithmGames>
<http://www.ams.org/samplings/feature-column/fcarc-games1>
<http://www.codechef.com/wiki/tutorial-game-theory>

Suggested problems

http://www.topcoder.com/stat?c=problem_statement&pm=3491&rd=6517
http://www.topcoder.com/stat?c=problem_statement&pm=3491&rd=6517

Hackenbush

Suggested readings

<http://en.wikipedia.org/wiki/Hackenbush>
<http://www.ams.org/samplings/feature-column/fcarc-partizan1>

Suggested problems

<http://www.cs.caltech.edu/ipsc/problems/g.html>
<http://www.spoj.pl/problems/PT07A/>

d. Linear Algebra

Syllabus

Matrix Operations

Addition and subtraction of matrices

Suggested Reading

Cormen 28.1

Multiplication (Strassen's algorithm), logarithmic exponentiation

Suggested reading

Cormen 28.2

Linear Algebra by Kenneth

Hoffman Section 1.6

Problems

<http://uva.onlinejudge.org/external/111/11149.html>

Matrix transformations [Transpose, Rotation of Matrix, Representing Linear transformations using matrix]

Suggested Reading

Linear Algebra By Kenneth

Hoffman Section

3.1,3.2,3.4,3.7

Problems

[http://www.topcoder.com/stat?](http://www.topcoder.com/stat?c=problem_statement&pm=6877)

[c=problem_statement&pm=6877](http://www.topcoder.com/stat?c=problem_statement&pm=6877)

JPIX on Spoj

Determinant , Rank and Inverse of Matrix [Gaussian Elimination , Gauss Jordan Elimination]

Suggested Reading

28.4 Cormen

Linear Algebra by Kenneth

Chapter 1

Problems

[http://www.topcoder.com/stat?](http://www.topcoder.com/stat?c=problem_statement&pm=8174)

[c=problem_statement&pm=8174](http://www.topcoder.com/stat?c=problem_statement&pm=8174)

[http://www.topcoder.com/stat?](http://www.topcoder.com/stat?c=problem_statement&pm=6407&rd=9986)

[c=problem_statement&pm=6407&rd=9986](http://www.topcoder.com/stat?c=problem_statement&pm=6407&rd=9986)

[http://www.topcoder.com/stat?
c=problem_statement&pm=8587](http://www.topcoder.com/stat?c=problem_statement&pm=8587)
HIGH on Spoj

Solving system of linear equations

Suggested Reading

28.3 Cormen

Linear Algebra by Kenneth

Chapter 1

Problems -

[http://www.topcoder.com/stat?
c=problem_statement&pm=3942&r
d=6520](http://www.topcoder.com/stat?c=problem_statement&pm=3942&rd=6520)

Using matrix exponentiation to solve
recurrences

Suggested Reading

[http://www.topcoder.com/tc?mo
dule=Static&d1=features&d2=01
0408](http://www.topcoder.com/tc?module=Static&d1=features&d2=010408)

Problems

REC, RABBIT1 , PLHOP on spoj

[http://www.topcoder.com/stat?
c=problem_statement&pm=6386](http://www.topcoder.com/stat?c=problem_statement&pm=6386) ,
[http://www.topcoder.com/stat?
c=problem_statement&pm=7262](http://www.topcoder.com/stat?c=problem_statement&pm=7262),
[http://www.topcoder.com/stat?
c=problem_statement&pm=6877](http://www.topcoder.com/stat?c=problem_statement&pm=6877)

Eigenvalues and Eigen-vectors

Problems

[http://www.topcoder.com/stat?
c=problem_statement&pm=2423&r
d=4780](http://www.topcoder.com/stat?c=problem_statement&pm=2423&rd=4780)

Polynomials

Roots of a polynomial [Prime
factorization of a polynomial, Integer
roots of a polynomial, All real roots
of a polynomial]

Problems

[http://www.topcoder.com/stat?
c=problem_statement&pm=8273&r
d=10798](http://www.topcoder.com/stat?c=problem_statement&pm=8273&rd=10798)

POLYEQ , ROOTCIPH on Spoj

Lagrange Interpolation

Problems

[http://www.topcoder.com/stat?
c=problem_statement&pm=10239](http://www.topcoder.com/stat?c=problem_statement&pm=10239)

[http://www.topcoder.com/stat?
c=problem_statement&pm=8725](http://www.topcoder.com/stat?c=problem_statement&pm=8725)

e. Permutation cycles

Suggested Reading

Art of Computer Programming by Knuth
Vol. 3

Problems

ShuffleMethod, Permutation and WordGame
on topcoder.

f. Group Theory

Burnside Lemma, Polya's theorem

Suggested Reading

Hernstein's topics in algebra
[http://petr-mitrichev.blogspot.com
/2008/11/burnsides-lemma.html](http://petr-mitrichev.blogspot.com/2008/11/burnsides-lemma.html)

Problems

TRANSP on spoj

[http://www.topcoder.com/stat?c=pro
blem_statement&pm=9975](http://www.topcoder.com/stat?c=problem_statement&pm=9975)

Generating functions

Suggested Reading

Herbert Wilf's generating
functionology/

Robert Sedgewick and Flajolet's
Combinatorial analysis

Data Structures.

Basic

Arrays/Stacks/Queues :

Problems

<https://www.spoj.pl/problems/STPAR/>
<https://www.spoj.pl/problems/SHOP/>
<https://www.spoj.pl/problems/WATER/>

Reading:

CLRS: section 10.1

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=dataStructures>

b. Singly/Doubly Linked List :

Problems

<https://www.spoj.pl/problems/POSTERS/>

Reading: CLRS: section 10.2, Mark Allen

Weiess Chapter 3

c. Hash Tables :

Problems

<https://www.spoj.pl/problems/HASHIT/>

<https://www.spoj.pl/problems/CUCKOO/>

Reading: CLRS: Chapter 11, Mark Allen Weiess

Chapter 5

d. Circular linked list / queue

Problems

<https://www.spoj.pl/problems/CTRICK/>

e. Binary/nary Trees

Reading

CLRS: section 10.4

CLRS: Chapter 12

Mark Allen Weiess Chapter 4

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binarySearchRedBlack>

f. Heaps

Problems

<https://www.spoj.pl/problems/PRO/>

<https://www.spoj.pl/problems/EXPEDI/>

Reading : Mark Allen Weiess Chapter 6

ii. Advanced

Trie (Keyword tre

Problems

<https://www.spoj.pl/problems/MORSE/>

<https://www.spoj.pl/problems/EMOTICON/>

Reading

Interval trees / Segment Trees

Problems

<https://www.spoj.pl/problems/ORDERS/>

<https://www.spoj.pl/problems/FREQUENT/>

Reading

Fenwick(Binary Indexed) trees

Problems

<https://www.spoj.pl/problems/MATSUM/>

Reading:

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binaryIndexedTrees>

Disjoint data structures

Problems

<https://www.spoj.pl/problems/BLINNET/>

<https://www.spoj.pl/problems/CHAIN/>

Reading:

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=disjointDataStructure>

Mark Allen Weiss Chapter 8

Range minimum Query (RMQ)

Problems

<https://www.spoj.pl/problems/GSS1/>

Reading

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=lowestCommonAncestor>

Customized interval/segment trees (Augmented DS)

Problems

<https://www.spoj.pl/problems/GSS3/>

<https://www.spoj.pl/problems/RRSCHED/>

Reading: CLRS: Chapter 14 (augmented DS)

g. AVL Trees

Problems

1. <https://www.spoj.pl/problems/ORDERS/>

Reading

iii. Miscellaneous (Not to be covered)

Splay Trees

B/B+ Trees

k-d Trees

Red-black Trees

Skip List

Binomial/Fibonacci heaps

iv. Exercises

<https://www.spoj.pl/problems/LAZYPROG/> (Hint: Heaps) t

<https://www.spoj.pl/problems/HELPR2D2/> (Hint: Interval Trees)

<https://www.spoj.pl/problems/SAM/> (Hint: Heaps)

<https://www.spoj.pl/problems/PRHYME/> (Hint: Trie)

<https://www.spoj.pl/problems/HEAPULM/> (Hint: Interval Trees)

<https://www.spoj.pl/problems/CORNET/> (Hint: Disjoint)

<https://www.spoj.pl/problems/EXPAND/>
<https://www.spoj.pl/problems/WPUZZLES/>
<https://www.spoj.pl/problems/LIS2/>

**Search Techniques/Bruteforce writing
techniques/Randomized algorithms.**

Backtracking - [Beginner].

problems ->

N queens problems

Knight's Tour

Sudoku Problem

Tiling Problem.

15 puzzle.

Dancing Links and Algorithm X given by Knuth -
[Advanced]

problems - PRLGAME, SUDOKU, NQUEEN on SPOJ

Suggested reading -

<http://www-cs-faculty.stanford.edu/~uno/papers/dancing-color.ps.gz>

Binary Search - [Beginner].

problems - AGGRCOW on SPOJ. Refer the
tutorial for more problems.

finding all real roots of a polynomial using
binary search. [intermediate].

Suggested Reading -

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binarySearch>

Ternary Search - [Intermediate].

problems -

<http://www.spoj.pl/problems/KPPOLY/>

<http://www.codechef.com/DEC09/problems/K1/>

http://www.topcoder.com/stat?c=problem_statement&pm=4705&rd=7993

http://www.topcoder.com/stat?c=problem_statement&pm=7741&rd=10671

http://www.topcoder.com/stat?c=problem_statement&pm=6464&rd=9994

http://www.topcoder.com/stat?c=problem_statement&pm=3501&rd=6529

http://www.topcoder.com/stat?c=problem_statement&pm=4567&rd=6539

Meet in the middle [Intermediate].

problems -

<http://www.spoj.pl/problems/MAXISET/>

Hill Climbing [Advanced].

Regular Iteration to reach a fixed point
[Advanced].

Newton-Raphson method to find root of a
mathematical function.

Iterations to solve linear non homogeneous
system of equations.

General programming issues in contests ->

Arithmetic Precision - [Beginner].

Suggested Reading -

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=integersReals>

Representing sets with bitmasks and manipulating
bitmasks - [Beginner].

Suggested Reading -

<http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=bitManipulation>

problems - refer to the tutorial link in
Suggested reading section.