

-Basic Geometry/Euclidean Geometry/ordinate Geometry/[3-D variants of everything].

1. Computational Geometry.

Graham Scan algorithm for Convex Hull $O(n * \log(n))$.

a. Online construction of 3-D convex hull in $O(n^2)$.

b. Bentley Ottmann algorithm to list all intersection points of n line segments in $O((n + I) * \log n)$.

■ Suggested Reading -

1. http://softsurfer.com/Archive/algorithm_0108/algorithm_0108.htm

c. Rotating Calipers Technique.

■ Suggested Reading - <http://cgm.cs.mcgill.ca/~orm/rotcal.html>

■ Problems - Refer the article for a list of problems which can be solved using Rotating Calipers technique.

d. Line Sweep/Plane Sweep algorithms -

■ Area/Perimeter of Union of Rectangles.

■ Closest pair of points.

■ Suggested Reading -

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

■ Problems - Follow the tutorial for list of problems.

e. Area of Union of Circles.

f. Delaunay Triangulation of n points in $O(n * \log n)$.

g. Voronoi Diagrams of n points in $O(n * \log n)$ using Fortune's algorithm.

h. Point in a polygon problem -

■ $O(n)$ solution without preprocessing.

■ $O(\log n)$ algorithm with $O(n * \log n)$ preprocessing for convex polygons.

i. Problems on computational geometry -

■ [BSHEEP](#), [BULK](#), [SEGVIS](#), [CONDUIT](#), [RUNAWAY](#), [DIRVS](#), [RAIN1](#), [SHAMAN](#), [TCUTTER](#), [LITEPIPE](#), [RHOMBS](#), [FSHEEP](#), [FLBRKLIN](#), [CERC07P](#), [BAC](#), [ALTARS](#), [CERC07C](#), [NECKLACE](#), [CH3D](#), [RECTANGL](#), [POLYSSO](#), [FOREST2](#), [KPPOLY](#), [RAIN2](#), [SEGMENTS](#), [ARCHPLG](#), [BALLOON](#), [CIRCLES](#), [COMPASS](#), [EOWAMRT](#), [ICERINK](#) on SPOJ.

■ [CultureGrowth](#), [PolygonCover](#) on Topcoder.

j. Suggested Reading -

■ Computational Geometry: Algorithms and applications. Mark De Burg.

To be Done till 6th may.

■ **String Algorithm.**

1. **KnuthMorrisPratt** algorithm.

a. Problems - NHAY, PERIOD on SPOJ.

b. Suggested Reading -

i. Cormen chapter on Strings.

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

2. Aho Corasick algorithm.

2. Problems - WPUZZLES on SPOJ.

a. 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.

b. 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.

c. Suffix Automata

■ $O(n)$ Suffix Automaton construction.

d. Dictionary Of Basic Factors

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

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

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

g. Multi-dimensional pattern matching.

h. 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.

3. Basic Graphs [beginner].

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

b. Breadth First Search.

- problems -
 1. [PPATH](#), [ONEZERO](#), [WATER](#) on SPOJ
- c. Depth First Search.
- d. Strongly Connected Components.
 - problems -
 1. TOUR and [BOTTOM](#) on SPOJ.
- e. Biconnected Components, Finding articulation points and bridges].
 - problems -
 1. [RELINETS](#), [PT07A](#) on SPOJ.
- f. Dijkstra algorithm -
 - problems -
 1. [SHPATH](#) on SPOJ.
- g. Floyd Warshall algorithm -
 - problems -
 1. [COURIER](#) on SPOJ.
- h. Minimum Spanning Tree
 - problems -
 1. [BLINNET](#) on SPOJ.
- i. Flood-fill algorithm
- j. Topological sort
- k. Bellman-Ford algorithm.
- l. Euler Tour/Path.
 - problems - [WORDS1](#) on SPOJ.
- m. Suggested reading for most of the topics in Graph algorithms -
 - <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=graphsDataStrucs1>.
 - 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 :))

4. Flow networks/ matching etc etc. [Intermediate/Advanced].

- a. Maximum flow using Ford Fulkerson Method.
 - Suggested Reading -
 1. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=maxFlow>
 - problems - [TAXI](#), [POTHOLE](#), [IM](#), [QUEST4](#), [MUDDY](#), [EN](#), [CABLETV](#), [STEAD](#), [NETADMIN](#), [COCONUTS](#), [OPTM](#) on SPOJ.
- b. Maximum flow using Dinic's Algorithm.
 - Problems - [PROFIT](#) on spoj.
- c. Minimum Cost Maximum Flow.
 - Successive Shortest path algorithm.
 - Cycle Cancelling algorithm.
 - Suggested Reading -
 1. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=minimumCostFlow1>
- d. 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
- e. Stoer Wagner min-cut algorithm.
- f. Hopcroft Karp bipartite matching algorithm.
 1. problems - [ANGELS](#) on SPOJ.
- g. Maximum matching in general graph (blossom shrinking)
- h. Gomory-Hu Trees.aa
 - i) Problems - [MCOQUERY](#) on Spoj.
- i. 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/>
- j. Suggested Reading for the full category ->
 - Network flow - Algorithms and Applications by Ahuja
 - Cormen book chapter 25.

Till 20 th may.

5. Dynamic Programming.

- a. Suggested Reading - Dynamic Programming (DP) as a tabulation method
 - Cormen chapter on DP
- b. 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
- c. 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
- d. 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
- e. 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
- f. 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
- g. 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
- h. 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
- i. Symmetric characterization of DP state
 - http://www.topcoder.com/stat?c=problem_statement&pm=8610
- j. A good collection of problems
 - <http://codeforces.com/blog/entry/325>
 - <http://problemclassifier.appspot.com/index.jsp?search=dp&usr=>

Till 28 th may.

6. Greedy.

- a. Suggested Reading -
 - Chapter on Greedy algorithms in Cormen.
 - <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=greedyAlg>
- b. problems - refer to the topcoder tutorial.

7. Number Theory.

- a. Modulus arithmetic - basic postulates [Including modular linear equations, Continued fraction and Pell's equation]
 - Suggested Reading -
 1. Chapter 1 from Number Theory for Computing by SY Yan [Recommended]
 2. 31.1, 31.3 and 31.4 from Cormen
 3. www.topcoder.com/tc?module=Static&d1=tutorials&d2=primeNumbers
 - Problems
 1. <http://projecteuler.net/index.php?section=problems&id=64>
 2. <http://projecteuler.net/index.php?section=problems&id=65>
 3. <http://projecteuler.net/index.php?section=problems&id=66>
 4. http://www.topcoder.com/stat?c=problem_statement&pm=6408&rd=9826
 5. http://www.topcoder.com/stat?c=problem_statement&pm=2342
- b. Fermat's theorem, Euler's Totient theorem (totient function, order , primitive roots)
 - Suggested Reading
 1. 1.6, 2.2 from Number Theory by SY Yan
 2. 31.6 , 31.7 from Cormen
 - Problems
 1. <http://projecteuler.net/index.php?section=problems&id=70>
 2. <http://www.spoj.pl/problems/NDIVPHI/>
- c. Chinese remainder theorem
 - Suggested Reading
 1. 31.5 from Cormen
 2. 1.6 from Number Theory by SY Yan
 - Problems
 1. Project Euler 271
 2. http://www.topcoder.com/stat?c=problem_statement&pm=10551&rd=13903
- d. Primality tests -
 - Deterministic $O(\sqrt{n})$ approach
 - Probabilistic primality tests - Fermat primality test, Miller-Rabin Primality test
 1. Suggested Reading -
 - a. <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=primalityTesting>
 - b. Cormen 31.8
 - c. 2.2 from Number Theory by SY Yan
 2. Problems -
 - a. PON, PRIC, SOLSTRAS on SPOJ
 - b. http://www.topcoder.com/stat?c=problem_statement&pm=4515
- e. Prime generation techniques - Sieve of Eratosthenes
 - Suggested Problems - PRIME1 on SPOJ
- f. GCD using euclidean method
 - Suggested Reading
 1. 31.2 Cormen
 - Problems -

1. GCD on SPOJ
2. <http://uva.onlinejudge.org/external/114/11424.html>
- g. Logarithmic Exponentiation
 - Suggested Reading -
 1. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=primalityTesting>
- h. Integer Factorization
 - Naive $O(\sqrt{n})$ method
 - Pollard Rho factorization
 - Suggested Reading
 1. 2.3 from Number Theory SY Yan
 2. 31.9 Cormen
 - Problems -
 1. http://www.topcoder.com/stat?c=problem_statement&pm=2986&rd=5862
 2. <http://www.spoj.pl/problems/DIVSUM2/>
 3. http://www.topcoder.com/stat?c=problem_statement&pm=4481&rd=6538
- i. Stirling numbers
- j. Wilson theorem
 - $nCr \% p$ in $O(p)$ preprocess and $O(\log n)$ query
- k. Lucas Theorem
- l. 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
- m. 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.

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

a. Probability.

Syllabus

- Basic probability and Conditional probability
 1. Suggested problems
 - a. <http://www.spoj.pl/problems/CT16E/>
 - b. <http://www.spoj.pl/problems/CHICAGO/>
- Random variables, probability generating functions
- Mathematical expectation + Linearity of expectation
 1. Suggested problems
 - a. <http://www.spoj.pl/problems/FAVDICE/>
 - b. http://www.topcoder.com/stat?c=problem_statement&pm=10744
- Special discrete and continuous probability distributions
 1. Bernoulli, Binomial, Poisson, normal distribution
 2. Suggested Problem
 - a. <http://acm.sgu.ru/problem.php?contest=0&problem=498>
- Suggested Readings
 1. Cormen appendix C (very basic)
 2. Topcoder probabiltly tutorial
<http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=probabilities>
 3. http://en.wikipedia.org/wiki/Random_variable
 4. http://en.wikipedia.org/wiki/Expected_value
 5. William Feller, An introduction to probability theory and its applications

b. Counting

Syllabus

- Basic principles - Pigeon hole principle, addition, multiplication rules
 1. Suggested problems
 - a. <http://acm.timus.ru/problem.aspx?space=1&num=1690>
 - b. http://www.topcoder.com/stat?c=problem_statement&pm=10805
 3. Suggested readings
 - a. http://en.wikipedia.org/wiki/Combinatorial_principles
 - b. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=combinatorics>
 - c. <http://www.maa.org/editorial/knot/pigeonhole.html>
- Inclusion-exclusion
 1. Suggested readings
 - a. http://en.wikipedia.org/wiki/Inclusion-exclusion_principle
 2. Suggested problems
 - a. http://www.topcoder.com/stat?c=problem_statement&pm=4463&rd=6536
 - b. http://www.topcoder.com/stat?c=problem_statement&pm=10238
- Special numbers
 1. Suggested reading - Stirling, eulerian, harmonic, bernoulli, fibonacci numbers
 - a. http://en.wikipedia.org/wiki/Stirling_number

- b. http://en.wikipedia.org/wiki/Eulerian_numbers
- c. [http://en.wikipedia.org/wiki/Harmonic_series_\(mathematics\)](http://en.wikipedia.org/wiki/Harmonic_series_(mathematics))
- d. http://en.wikipedia.org/wiki/Bernoulli_number
- e. http://en.wikipedia.org/wiki/Fibonacci_numbers
- f. Concrete mathematics by Knuth

2. Suggested problems

- a. http://www.topcoder.com/stat?c=problem_statement&pm=1643
- b. http://www.topcoder.com/stat?c=problem_statement&pm=8202&rd=11125
- c. http://www.topcoder.com/stat?c=problem_statement&pm=8725
- d. http://www.topcoder.com/stat?c=problem_statement&pm=2292&rd=10709

■ Advanced counting techniques - Polya counting, burnside lemma

1. Suggested reading

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

2. Suggested Problems

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

c. Game theory

Syllabus

■ Basic principles and Nim game

1. Sprague grundy theorem, grundy numbers

2. Suggested readings

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

3. Suggested problems

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

■ Hackenbush

1. Suggested readings

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

2. Suggested problems

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

d. Linear Algebra

Syllabus

■ Matrix Operations

1. Addition and subtraction of matrices

- a. Suggested Reading
 - i. Cormen 28.1

2. Multiplication (Strassen's algorithm), logarithmic exponentiation

- a. Suggested reading
 - i. Cormen 28.2
 - ii. Linear Algebra by Kenneth Hoffman Section 1.6
- b. Problems

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

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

- a. Suggested Reading
 - i. Linear Algebra By Kenneth Hoffman Section 3.1,3.2,3.4,3.7
- b. Problems

- i. http://www.topcoder.com/stat?c=problem_statement&pm=6877
- ii. JPIX on Spoj

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

- a. Suggested Reading
 - i. 28.4 Cormen
 - ii. Linear Algebra by Kenneth Chapter 1
- b. Problems

- i. http://www.topcoder.com/stat?c=problem_statement&pm=8174
- ii. http://www.topcoder.com/stat?c=problem_statement&pm=6407&rd=9986
- iii. http://www.topcoder.com/stat?c=problem_statement&pm=8587
- iv. HIGH on Spoj

5. Solving system of linear equations
 - a. Suggested Reading
 - i. 28.3 Cormen
 - ii. Linear Algebra by Kenneth Chapter 1
 - b. Problems -
 - i. http://www.topcoder.com/stat?c=problem_statement&pm=3942&rd=6520
6. Using matrix exponentiation to solve recurrences
 - a. Suggested Reading
 - i. <http://www.topcoder.com/tc?module=Static&d1=features&d2=010408>
 - b. Problems
 - i. REC, RABBIT1 , PLHOP on spoj
 - ii. 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=6877
7. Eigenvalues and Eigen-vectors
 - a. Problems
 - i. http://www.topcoder.com/stat?c=problem_statement&pm=2423&rd=4780
- Polynomials
 1. Roots of a polynomial [Prime factorization of a polynomial, Integer roots of a polynomial, All real roots of a polynomial]
 - a. Problems
 - i. http://www.topcoder.com/stat?c=problem_statement&pm=8273&rd=10798
 - ii. POLYEQ , ROOTCIPH on Spoj
 2. Lagrange Interpolation
 - a. Problems
 - i. http://www.topcoder.com/stat?c=problem_statement&pm=10239
 - ii. http://www.topcoder.com/stat?c=problem_statement&pm=8725
- e. Permutation cycles
 - Suggested Reading
 1. Art of Computer Programming by Knuth Vol. 3
 - Problems
 1. ShuffleMethod, Permutation and WordGame on topcoder.
- f. Group Theory
 - Burnside Lemma, Polya's theorem
 1. Suggested Reading
 - a. Hernstein's topics in algebra
 - b. <http://petr-mitrichev.blogspot.com/2008/11/burnsides-lemma.html>
 2. Problems
 - a. TRANSP on spoj
 - b. http://www.topcoder.com/stat?c=problem_statement&pm=9975
- b. Generating functions
 - Suggested Reading
 1. Herbert Wilf's generating functionology/
 2. Robert Sedgewick and Flajolet's Combinatorial analysis

9. Data Structures.

i. Basic

a. Arrays/Stacks/Queues :

- Problems
 1. <https://www.spoj.pl/problems/STPAR/>
 2. <https://www.spoj.pl/problems/SHOP/>
 3. <https://www.spoj.pl/problems/WATER/>
- Reading:
 1. CLRS: section 10.1
 2. <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=dataStructures>

b. Singly/Doubly Linked List :

- Problems
 1. <https://www.spoj.pl/problems/POSTERS/>
- Reading: CLRS: section 10.2, Mark Allen Weiss Chapter 3

c. Hash Tables :

- Problems
 1. <https://www.spoj.pl/problems/HASHIT/>
 2. <https://www.spoj.pl/problems/CUCKOO/>
- Reading: CLRS: Chapter 11, Mark Allen Weiss Chapter 5

d. Circular linked list / queue

- Problems
 1. <https://www.spoj.pl/problems/CTRICK/>

- e. Binary/nary Trees
 - Reading
 1. CLRS: section 10.4
 2. CLRS: Chapter 12
 3. Mark Allen Weiss Chapter 4
 4. <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binarySearchRedBlack>
 - f. Heaps
 - Problems
 1. <https://www.spoj.pl/problems/PRO/>
 2. <https://www.spoj.pl/problems/EXPEDI/>
 - Reading : Mark Allen Weiss Chapter 6
 - ii. Advanced**
 - a. Trie (Keyword tree)
 - Problems
 1. <https://www.spoj.pl/problems/MORSE/>
 2. <https://www.spoj.pl/problems/EMOTICON/>
 - Reading
 - b. Interval trees / Segment Trees
 - Problems
 1. <https://www.spoj.pl/problems/ORDERS/>
 2. <https://www.spoj.pl/problems/FREQUENT/>
 - Reading
 - c. Fenwick (Binary Indexed) trees
 - Problems
 1. <https://www.spoj.pl/problems/MATSUM/>
 - Reading: <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binaryIndexedTrees>
 - d. Disjoint data structures
 - Problems
 1. <https://www.spoj.pl/problems/BLINNET/>
 2. <https://www.spoj.pl/problems/CHAIN/>
 - Reading:
 1. <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=disjointDataStructure>
 2. Mark Allen Weiss Chapter 8
 - e. Range minimum Query (RMQ)
 - Problems
 1. <https://www.spoj.pl/problems/GSS1/>
 - Reading
 <http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=lowestCommonAncestor>
 - f. Customized interval/segment trees (Augmented DS)
 - Problems
 1. <https://www.spoj.pl/problems/GSS3/>
 2. <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)**
 - a. Splay Trees
 - b. B/B+ Trees
 - c. k-d Trees
 - d. Red-black Trees
 - e. Skip List
 - f. Binomial/Fibonacci heaps
 - iv. Exercises**
 1. <https://www.spoj.pl/problems/LAZYPROG/> (Hint: Heaps) t
 2. <https://www.spoj.pl/problems/HELPR2D2/> (Hint: Interval Trees)
 3. <https://www.spoj.pl/problems/SAM/> (Hint: Heaps)
 4. <https://www.spoj.pl/problems/PRHYME/> (Hint: Trie)
 5. <https://www.spoj.pl/problems/HEAPULM/> (Hint: Interval Trees)
 6. <https://www.spoj.pl/problems/CORNET/> (Hint: Disjoint)
 7. <https://www.spoj.pl/problems/EXPAND/>
 8. <https://www.spoj.pl/problems/WPUZZLES/>
 9. <https://www.spoj.pl/problems/LIS2/>
10. **Search Techniques/Bruteforce writing techniques/Randomized algorithms.**
- a. Backtracking - [Beginner].
 - problems ->
 1. N queens problems
 2. Knight's Tour
 3. Sudoku Problem
 4. Tiling Problem.

5. 15 puzzle.
- b. Dancing Links and Algorithm X given by Knuth - [Advanced]
- problems - PRLGAME, SUDOKU, NQUEEN on SPOJ
 - Suggested reading -
 1. <http://www-cs-faculty.stanford.edu/~uno/papers/dancing-color.ps.gz>
- c. 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 -
 1. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=binarySearch>
- d. Ternary Search - [Intermediate].
- problems -
 1. <http://www.spoj.pl/problems/KPPOLY/>
 2. <http://www.codechef.com/DEC09/problems/K1/>
 3. http://www.topcoder.com/stat?c=problem_statement&pm=4705&rd=7993
 4. http://www.topcoder.com/stat?c=problem_statement&pm=7741&rd=10671
 5. http://www.topcoder.com/stat?c=problem_statement&pm=6464&rd=9994
 6. http://www.topcoder.com/stat?c=problem_statement&pm=3501&rd=6529
 7. http://www.topcoder.com/stat?c=problem_statement&pm=4567&rd=6539
- e. Meet in the middle [Intermediate].
- problems -
 1. <http://www.spoj.pl/problems/MAXISET/>
 2. Hill Climbing [Advanced].
- f. 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 ->**
- g. Arithmetic Precision - [Beginner].
- Suggested Reading -
 1. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=integersReals>
- h. Representing sets with bitmasks and manipulating bitmasks - [Beginner].
- Suggested Reading -
 1. <http://www.topcoder.com/tc?module=Static&dl=tutorials&d2=bitManipulation>
 - problems - refer to the tutorial link in Suggested reading section.