-**Basic Geometry/Euclidean Geometryordinate Geometry/ [3-D** variants **of verything].**

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) * logn).
      - 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 * logn).
   g. Voronoi Diagrams of n points in O(n * logn) using Fortune's algorithm.
   h. Point in a polygon problem -
      - O(n) solution without preprocessing.
      - O(logn) algorithm with O(n * logn) 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, POLYSSQ, 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 * logn) Naive method of suffix array construction
      - O(n * logn^2) method of suffix array construction
      - O(n * logn) method of suffix array construction.
      - **O(n) meth**od 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'salgorithm.
   c. Suffix Automata
      - O(n) Suffix Automaton construction.
   d. Dictionary Of Basic Factors
      - O(n * logn) 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 -> 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, MINSEQ, 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&d1=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 :))

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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&d1=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&d1=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 - MCQUERY 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
        - 9Strategies 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 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 Erastothenes
   - 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&d1=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 probabilty tutorial_ http://www.topcoder.com/tc?module=Static&d1=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&d1=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, eurlerian, harmonic, bernoulli, fibonnacci 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)
     d. http://en.wikipedia.org/wiki/Bernoulli_number
     e. http://en.wikipedia.org/wiki/Fibonnaci_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, burnsides 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 [ Gaussean 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. Eigen values 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 Flajoulet'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 Weies 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 Weies 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 Weies 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 Weies Chapter 6

ii. **Advanced**

**a.** Trie (Keyword tre

- 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 Weies 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. Exercices**

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. Knights 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&d1=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&d1=tutorials&d2=integersReals

h. Representing sets with bitmasks and manipulating bitmasks - [Beginner].
    - Suggested Reading -
        1. http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=bitManipulation
    - problems - refer to the tutorial link in Suggested reading section.