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**Bool Shift!** 

1 2D Geometry

```
16 // Algorithm
17 // Algorithm
18 // Algorithm
19 // From 3 Lines
    1.1 Primitives
 1 typedef complex<double> point;
                                                                         20 // Algorithm
21 // Algorithm
   struct circle {
  point c; double r;
                                                                         22 // Algorithm
23 // Algorithm
      circle(point c, double r):c(c),r(r){}
     circle(){}
                                                                         24 // Algorithm
 6 };
   double cross(const point &a, const point &b) {
 7
                                                                             1.4 Heron Triangle Area
     return imag(conj(a)*b);
 9 }
                                                                          1 // Formula
double dot(const point &a, const point &b) {
                                                                          2 // Formula
11
      return real(conj(a)*b);
                                                                          3 // Formula
12
                                                                             1.5 Polygon Centroid
    1.2 Intersections
                                                                          1 for(int i = 1; i < n-1; i++) {</pre>
 1 // Line - Line
                                                                               pt ai = pts[i] - pts[i-1],
  ib = pts[i+1] - pts[i];
   // Algorithm
 3 // Algorithm
                                                                               area += (conj(ai)*ib).imag();
 4 // Algorithm
 5 // Algorithm
 6 // Algorithm
                                                                             1.6 Point In Polygon
 7 // Line - Segment
 8 // Algorithm
 9 // Algorithm
                                                                          1 // Algorithm
                                                                          2 // Algorithm
10 // Algorithm
11 // Algorithm
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                                                                          4 // Algorithm
12 // Algorithm
                                                                          5 // Algorithm
6 // Algorithm
13 // Segment - Segment
14 // Algorithm
15 // Algorithm
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16 // Algorithm
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18 // Algorithm
19 // Circle - Line
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25 // Circle - Segment
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28 // Algorithm
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31 // Circle - Circle
                                                                             1.7 Convex Hull
32 // Algorithm
33 // Algorithm
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34 // Algorithm
35 // Algorithm
                                                                          3 // Algorithm
4 // Algorithm
36 // Algorithm
                                                                          5 // Algorithm
                                                                          6 // Algorithm
37 // Line - Point
                                                                          7 // Algorithm
8 // Algorithm
38 // Algorithm
39 // Algorithm
40 // Algorithm
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                                                                         10 // Algorithm
41 // Algorithm
                                                                         11 // Algorithm
12 // Algorithm
42 // Algorithm
43 // Segment - Point
44 // Algorithm
                                                                         13 // Algorithm
45 // Algorithm
                                                                         14 // Algorithm
46 // Algorithm
                                                                         15 // Algorithm
47 // Algorithm
                                                                         16 // Algorithm
                                                                         17 // Algorithm
48 // Algorithm
                                                                          18 // Algorithm
                                                                          19 // Algorithm
   1.3 Circle Generation
                                                                          20 // Algorithm
 1 // From 3 Points
 2 // Algorithm
3 // Algorithm
                                                                             1.8 Line Segment Set Intersection
 4 // Algorithm
5 // Algorithm
                                                                          1 // Algorithm
                                                                          2 // Algorithm
                                                                          3 // Algorithm
4 // Algorithm
 6 // Algorithm
 7 // From 1 Line 2 Points
                                                                          5 // Algorithm
6 // Algorithm
 8 // Algorithm
 9 // Algorithm
                                                                          7 // Algorithm
8 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
                                                                          9 // Algorithm
                                                                          10 // Algorithm
13 // From 2 Lines 1 Point
14 // Algorithm
                                                                          11 // Algorithm
15 // Algorithm
                                                                         12 // Algorithm
```

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13 // Algorithm
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30 // Algorithm
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31 // Algorithm
32 // Algorithm
                                                                      2.3 Great Circle Distance
33 // Algorithm
34 // Algorithm
                                                                    1 // Code
35 // Algorithm
                                                                    2 // Code
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8 // Code
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42 // Algorithm
43 // Algorithm
                                                                   10 // Code
44 // Algorithm
45 // Algorithm
                                                                      3 Combinatorics
46 // Algorithm
                                                                      3.1 Basics
47 // Algorithm
48 // Algorithm
49 // Algorithm
                                                                      // catalan numbers
                                                                      long long C(int n) {
   1.9 Voronoi Diagrams
                                                                        return (C(n-1)*2*n*(2*n-1))/(n*(n+1));
                                                                        return NCR(2*n, n) - NCR(2*n, n+1);
1 // Algorithm
                                                                        return NCR(2*n, n)/(n+1);
2 // Algorithm
3 // Algorithm
                                                                    6 }
                                                                    7
                                                                      // derangements
                                                                      long long D(int n) {
  return n*D(n-1) + pow(-1, n);
  return (n-1)*(D(n-1) + D(n-2));
                                                                    8
4 // Algorithm
5 // Algorithm
                                                                    9
                                                                   10
6 // Algorithm
                                                                   11 }
7 // Algorithm
                                                                   12 // iterate over all subsets with < m elements
8 // Algorithm
                                                                   13 for (int i = 0; i < (1<<n); i=Integer.bitCount(i) < m ? i</pre>
9 // Algorithm
                                                                            +1 : (i|(i-1))+1)
10 // Algorithm
                                                                   14 // iterate over all the subsets
11 // Algorithm
                                                                   15 for (int i=0; i < (1<<n); i++)
12 // Algorithm
                                                                        // iterate over all the subsets of the i-th subset
13 // Algorithm
                                                                   16
                                                                      for(int i2 = i; i2 > 0; i2 = (i2-1) & i)
14 // Algorithm
15 // Algorithm
16 // Algorithm
                                                                      4 Data Structures
17 // Algorithm
                                                                      4.1 Palindromic Tree
18 // Algorithm
19 // Algorithm
                                                                      // Algorithm
20 // Algorithm
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   2 3D Geometry
                                                                      // Algorithm
   2.1 Primitives
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  // Code
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  // Code
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12 // Code
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15 // Code
                                                                      4.2 Treap
   2.2 Convex Hull
                                                                    1 // Algorithm
 1 // Algorithm
                                                                      // Algorithm
 2 // Algorithm
                                                                      // Algorithm
```

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13 // Algorithm
 4 // Algorithm
 5 // Algorithm
6 // Algorithm
                                                                     14 // Algorithm
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 8 // Algorithm
                                                                    17 // Algorithm
18 // Algorithm
 9 // Algorithm
10 // Algorithm
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11 // Algorithm
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12 // Algorithm
                                                                        4.6 Segment Tree + Lazy Propagation
13 // Algorithm
14 // Algorithm
15 // Algorithm
                                                                      1 // Algorithm
16 // Algorithm
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17 // Algorithm
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                                                                      4 // Algorithm
18 // Algorithm
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28 // Algorithm
                                                                    14 // Algorithm
   // Algorithm
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30 // Algorithm
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                                                                     17 // Algorithm
   4.3 Sparse Array
                                                                     18 // Algorithm
                                                                     19 // Algorithm
 1 // Code
                                                                     20 // Algorithm
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 4 // Code
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10 // Code
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11 // Code
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12 // Code
13 // Code
                                                                        4.7 Weighted Union Disjoint Sets
14 // Code
15 // Code
                                                                      1 // Algorithm
                                                                        // Algorithm
// Algorithm
   4.4 Skip Lists
                                                                      4 // Algorithm
5 // Algorithm
 1 // Code
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13 // Code
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                                                                     15 // Algorithm
                                                                        5 Game Theory
14 // Code
15 // Code
                                                                        5.1 Nim Game
16 // Code
17 // Code
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18 // Code
19 // Code
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21 // Code
                                                                      2 // Algorithm
                                                                      3 // Algorithm
                                                                      4 // Algorithm
                                                                      5 // Algorithm
                                                                      6 // Algorithm
22 // Code
                                                                        // Algorithm
   4.5 BIT + Search
                                                                        // Algorithm
                                                                        // Algorithm
 1 // Algorithm
                                                                     10 // Algorithm
 2 // Algorithm
                                                                        5.2 Grundy Numbers
 3 // Algorithm
 4 // Algorithm
 5 // Algorithm
                                                                      1 // Algorithm
 6 // Algorithm
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                                                                     3 // Algorithm
4 // Algorithm
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11 // Algorithm
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9 // Algorithm
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14 // Algorithm
   5.3 General Josephus Problem
                                                                            15 // Algorithm
       General Mathematics
                                                                            16 // Algorithm
         Inclusion-Exclusion Patterns
                                                                            17 // Algorithm
                                                                             18 // Algorithm
 1 // Algorithm
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   6.2 Determinant
                                                                             30 // Algorithm
1 // Algorithm
                                                                                7 Graph Theory
2 // Algorithm
3 // Algorithm
                                                                                7.1 Primitives
4 // Algorithm
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13 // Algorithm
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11 // Algorithm
14 // Algorithm
15 // Algorithm
                                                                            12 // Algorithm
13 // Algorithm
   6.3 Gaussian Elimination
                                                                             14 // Algorithm
   double* GaussianElimination(int N, double **mat) {
                                                                            15 // Algorithm
      int i, j, k, L; double t;
for (i = 0; i < N - 1; i++)</pre>
                                                                                7.2 Articulation Points & Bridges
3
        L = i;
        for (j = i + 1; j < N; j++)
  if (fabs(mat[j][i]) > fabs(mat[L][i]))
5
                                                                             1 // Algorithm
 6
                                                                             2 // Algorithm
7
                                                                             3 // Algorithm
        for (k = i; k \le N; k++)
                                                                             4 // Algorithm
        swap (mat [i] [k], mat [L] [k]);
for (j = i + 1; j < N; j++)
  for (k = N; k >= i; k--)
9
                                                                             5 // Algorithm
10
                                                                             6 // Algorithm
11
                                                                             7 // Algorithm
             12
13
     double *res = new double[N];
for (j = N - 1; j >= 0; j--) {
  for (t = 0.0, k = j + 1; k < N; k++)
  t += mat[j][k] * res[k];</pre>
14
                                                                            10 // Algorithm
15
                                                                            11 // Algorithm
16
                                                                            12 // Algorithm
17
                                                                            13 // Algorithm
18
        res[j] = (mat[j][N] - t) / mat[j][j];
                                                                            14 // Algorithm
19
                                                                            15 // Algorithm
20
      return res;
                                                                            16 // Algorithm
                                                                            17 // Algorithm
21
                                                                            18 // Algorithm
   6.4 Fast Fourier-Transform
                                                                             19 // Algorithm
                                                                            20 // Algorithm
1 // Algorithm
2 // Algorithm
3 // Algorithm
4 // Algorithm
                                                                                7.3 SCC
                                                                             1 // Algorithm
5 // Algorithm
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3 // Algorithm
6 // Algorithm 7 // Algorithm
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9 // Algorithm
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10 // Algorithm
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   6.5 Misc. Formulas
                                                                             9 // Algorithm
```

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10 // Algorithm
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15 // Algorithm
   7.4 2-SAT
                                                                       16 // Algorithm
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19 // Algorithm
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5 // Algorithm
                                                                       20 // Algorithm
6 // Algorithm
                                                                           7.8 Euler Cycles
7 // Algorithm
8 // Algorithm
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// Algorithm
9 // Algorithm
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11 // Algorithm
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12 // Algorithm
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   7.5 Edmonds-Karp Max Flow
                                                                       15 // Algorithm
                                                                       16 // Algorithm
1 // Algorithm
                                                                       17 // Algorithm
18 // Algorithm
2 // Algorithm
3 // Algorithm
                                                                       19 // Algorithm
4 // Algorithm
                                                                       20 // Algorithm
5 // Algorithm
6 // Algorithm
                                                                           7.9 Maximum Matching
7 // Algorithm
8 // Algorithm
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11 // Algorithm
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14 // Algorithm
15 // Algorithm
   7.6 Dinic's Max Flow
                                                                       16 // Algorithm
1 // Algorithm
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18 // Algorithm
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4 // Algorithm
                                                                       20 // Algorithm
5 // Algorithm
6 // Algorithm
                                                                           7.10 HL Decomposition
7 // Algorithm
 8 // Algorithm
                                                                        1 // Algorithm
9 // Algorithm
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13 // Algorithm
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   7.7 Min-Cost Max Flow
                                                                        15 // Algorithm
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 1 // Algorithm
                                                                       17 // Algorithm
```

```
18 // Algorithm
19 // Algorithm
                                                                         Linear Programming
                                                                      8
                                                                           Simplex
20 // Algorithm
                                                                   1 // Algorithm
   7.11 Modelling Inequalities
                                                                      // Algorithm
                                                                   3 // Algorithm
1 // Algorithm
                                                                   4 // Algorithm
2 // Algorithm
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3 // Algorithm
                                                                   6 // Algorithm
                                                                   7 // Algorithm
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7 // Algorithm
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11 // Algorithm
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13 // Algorithm
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                                                                  14 // Algorithm
15 // Algorithm
   7.12 Max Flow Tricks
                                                                  16 // Algorithm
17 // Algorithm
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                                                                  18 // Algorithm
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21 // Algorithm
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                                                                  28 // Algorithm
29 // Algorithm
12 // Algorithm
13 // Algorithm
14 // Algorithm
                                                                  30 // Algorithm
                                                                  31 // Algorithm
15 // Algorithm
                                                                      9 Number Theory
   7.13 Bellman Ford
                                                                          Extended GCD
1 // Algorithm
2 // Algorithm
                                                                   1 long long gcd( long long a, long long b )
                                                                   2 { return(b == 0 ? a : gcd(b, a % b)); }
3 //USED BY: egcd, msolve, inverse, ldioph
3 // Algorithm
4 // Algorithm
5 // Algorithm
                                                                   4
                                                                      template< class Int > struct Triple {
6 // Algorithm
                                                                   5
                                                                       Int d, x, y;
7 // Algorithm
                                                                   6
                                                                       Triple(Int q, Int w, Int e):d(q), x(w), y(e){}
8 // Algorithm
                                                                   7 };
9 // Algorithm
                                                                      //USED BY: msolve, inverse, ldioph
10 // Algorithm
                                                                   9 template< class Int > Triple< Int > egcd( Int a, Int b ) {
                                                                       if( !b ) return Triple< Int >( a, Int( 1 ), Int( 0 ) );
                                                                   10
   7.14 Stable Marriage
                                                                   11
                                                                        Triple< Int > q = egcd( b, a % b );
                                                                   12
                                                                        return Triple< Int >( q.d, q.y, q.x - a / b * q.y );
1 // Algorithm
                                                                   13 }
2 // Algorithm
                                                                      9.2 Modular Inverse
3 // Algorithm
4 // Algorithm
5 // Algorithm
                                                                   1 //solves ax = 1 (mod n).
6 // Algorithm
                                                                      template< class Int > Int inverse( Int a, Int n ) {
                                                                          Triple< Int > t = egcd( a, n );
7 // Algorithm
                                                                   3
8 // Algorithm
                                                                          if( t.d > Int( 1 ) ) return Int( 0 );
                                                                   4
9 // Algorithm
                                                                          Int r = t.x % n:
10 // Algorithm
                                                                          return( r < Int( 0 ) ? r + n : r );</pre>
11 // Algorithm
12 // Algorithm
13 // Algorithm
                                                                      9.3 Modular Linear Equation
14 // Algorithm
15 // Algorithm
                                                                     // Algorithm
   7.15 Maximum Assignment
                                                                      // Algorithm
                                                                    4 // Algorithm
                                                                   5 // Algorithm
1 // Algorithm
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                                                                   7 // Algorithm
                                                                   8 // Algorithm
4 // Algorithm
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                                                                   10 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                      9.4 Linear Diophantine Equation
8 // Algorithm
9 // Algorithm
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                                                                   1 // Algorithm
                                                                   2 // Algorithm
11 // Algorithm
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                                                                     // Algorithm
13 // Algorithm
                                                                   4 // Algorithm
14 // Algorithm
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15 // Algorithm
                                                                   6 // Algorithm
```

```
7 // Algorithm
                                                                   // mu = start of cycle, lambda = cycle length
8 // Algorithm
9 // Algorithm
                                                                2
                                                                   ii floyd(int x0) {
                                                                    int tortoise = f(x0), hare = f(f(x0));
                                                                3
                                                                    while(tortoise != hare)
10 // Algorithm
                                                                    tortoise = f(tortoise), hare = f(f(hare));
int mu = 0; hare = x0;
  9.5 Modular Powers
                                                                6
                                                                    while(tortoise != hare)
1 // Algorithm
                                                                     tortoise = f(tortoise), hare = f(hare), mu++;
                                                                    int lambda = 1; hare = f(tortoise);
  // Algorithm
                                                                9
                                                                    while (tortoise != hare)
3 // Algorithm
                                                               10
4 // Algorithm
                                                               11
                                                                     hare = f(hare), lambda++;
5 // Algorithm
                                                               12
                                                                    return ii(mu, lambda);
6 // Algorithm
7 // Algorithm
                                                                  9.12 Pollard Rho
8 // Algorithm
9 // Algorithm
                                                                  10 Search
10 // Algorithm
                                                                        Binary Search
  9.6 Sieve of Eratosthenes
                                                                1 // Algorithm
                                                                2 // Algorithm
3 // Algorithm
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8 // Algorithm
                                                                9 // Algorithm
                                                               10 // Algorithm
9 // Algorithm
                                                               11 // Algorithm
10 // Algorithm
                                                               12 // Algorithm
                                                               13 // Algorithm
  9.7 Primality Testing & Factoring
                                                               14 // Algorithm
                                                               15 // Algorithm
  // Algorithm
2 // Algorithm
                                                                  10.2 Ternary Search
3 // Algorithm
4 // Algorithm
                                                                1 long double min() {
5 // Algorithm
                                                                      long double lo = -1e6, hi = 1e6, res = 3e6;
6 // Algorithm
                                                                2
                                                                      while(fabs(lo-hi) > EPS) {
7 // Algorithm
8 // Algorithm
                                                                4
                                                                          long double left = (hi-lo)/3 + lo, right = (2*(hi-long))
  // Algorithm
                                                                               10))/3 + 10;
10 // Algorithm
                                                                          long double resL = F(left), resR = F(right);
                                                                          if(resL < resR)</pre>
  9.8 Euler Phi
                                                                7
                                                                              hi = right;
1 // Algorithm
                                                                9
                                                                              lo = left;
                                                                          res = min(res, min(resL, resR));
2 // Algorithm
                                                               10
3 // Algorithm
4 // Algorithm
                                                               12
                                                                      return res;
5 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                  11 Strings
8 // Algorithm
                                                                  11.1 Aho Corasick
9 // Algorithm
10 // Algorithm
                                                                 // Algorithm
                                                                  // Algorithm
  9.9 Chinese Remainder
                                                                3 // Algorithm
                                                                4 // Algorithm
1 // Algorithm
                                                                5 // Algorithm
2 // Algorithm
                                                                6 // Algorithm
3 // Algorithm
                                                                7 // Algorithm
4 // Algorithm
                                                                8 // Algorithm
5 // Algorithm
                                                                9 // Algorithm
6 // Algorithm
                                                               10 // Algorithm
7 // Algorithm
                                                               11 // Algorithm
8 // Algorithm
                                                               12 // Algorithm
9 // Algorithm
                                                               13 // Algorithm
14 // Algorithm
10 // Algorithm
                                                               15 // Algorithm
  9.10 Discerete Logarithm
                                                                  11.2 Hashing
1 // Algorithm
2 // Algorithm
                                                                1 // Algorithm
3 // Algorithm
                                                               2 // Algorithm
3 // Algorithm
4 // Algorithm
5 // Algorithm
                                                                4 // Algorithm
5 // Algorithm
6 // Algorithm
7 // Algorithm
                                                               6 // Algorithm
7 // Algorithm
8 // Algorithm
  // Algorithm
                                                                  // Algorithm
10 // Algorithm
                                                                9 // Algorithm
                                                               10 // Algorithm
  9.11 Tortoise & Hare
                                                               11 // Algorithm
```

```
18 // Algorithm
19 // Algorithm
20 // Algorithm
21 // Algorithm
12 // Algorithm
13 // Algorithm
14 // Algorithm
 15 // Algorithm
                                                                                                                              22 // Algorithm
23 // Algorithm
       11.3 Z-Algorithm
                                                                                                                              24 // Algorithm
25 // Algorithm
  1 // Algorithm
                                                                                                                             26 // Algorithm
27 // Algorithm
28 // Algorithm
29 // Algorithm
     // Algorithm
// Algorithm
  4 // Algorithm
  5 // Algorithm
                                                                                                                              30 // Algorithm
  6 // Algorithm
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7 // Algorithm
8 // Algorithm
9 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
14 // Algorithm
15 // Algorithm
                                                                                                                                    12 Misc
 15 // Algorithm
      11.4 \text{ KMP} + \text{Periods}
  // Algorithm
// Algorithm
 3 // Algorithm
4 // Algorithm
4 // Algorithm
5 // Algorithm
6 // Algorithm
7 // Algorithm
9 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
14 // Algorithm
14 // Algorithm
15 // Algorithm
       11.5 Manacher
  1 // Algorithm
  2 // Algorithm
3 // Algorithm
  4 // Algorithm
  5 // Algorithm
6 // Algorithm
6 // Algorithm
7 // Algorithm
8 // Algorithm
9 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
14 // Algorithm
15 // Algorithm
16 // Algorithm
17 // Algorithm
18 // Algorithm
19 // Algorithm
20 // Algorithm
21 // Algorithm
      11.6 Suffix Array
  1 // Algorithm
 2 // Algorithm
3 // Algorithm
  4 // Algorithm
5 // Algorithm
  6 // Algorithm 7 // Algorithm
 8 // Algorithm
9 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
 14 // Algorithm
 15 // Algorithm
 16 // Algorithm
 17 // Algorithm
```

13 Last Page Cut this paper out. Use it wisely!

Problem	Tags
01 A	
02 B	
03 C	
04 D	
05 E	
06 F	
07 G	
08 H	
09 I	
10 J	
11 K	
12 L	
13 M	

Time	Meeting Description	Chk
030	All Problems Read. Write Tags.	
060	Ace Decided. Choose Coder.	
090	Decide & Order Solveable Problems	
120	Status Check	
150	Status Check	
180	Status Check	
210	Status Check	
240	Status Check	
270	Status Check	