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Problem	Tags	28	// Algorithm
01 A			// Algorithm
02 B			// Algorithm // Circle - Circle
03 C			// Algorithm
		33	// Algorithm
04 D			// Algorithm
05 E			// Algorithm // Algorithm
06 F			// Line - Point
		1	// Algorithm
07 G			// Algorithm
08 H			// Algorithm // Algorithm
09 I			// Algorithm
10 J			// Segment - Point
			// Algorithm
11 K			// Algorithm
12 L			// Algorithm // Algorithm
13 M			// Algorithm
		J	

#### 1.3 Circle Generation

```
Time
        Meeting Description
                                              Chk
                                                    1 // From 3 Points
030
        All Problems Read. Write Tags.
                                                    2 // Algorithm
                                                    3 // Algorithm
060
        Ace Decided. Choose Coder.
                                                    4 // Algorithm
090
        Decide & Order Solveable Problems
120
        Status Check
150
        Status Check
180
        Status Check
210
        Status Check
240
        Status Check
270
        Status Check
```

#### 2D Geometry

## 1.1 Primitives

```
typedef complex<double> point;
   struct circle {
     point c; double r;
      \texttt{circle}\,(\texttt{point}\ \texttt{c},\ \textcolor{red}{\texttt{double}}\ \texttt{r})\,:\!\texttt{c(c)}\,,\!\texttt{r(r)}\,\{\,\}
      circle(){}
   double cross(const point &a, const point &b) {
     return imag(conj(a)*b);
double dot(const point &a, const point &b) {
      return real(conj(a)*b);
```

## 1.2 Intersections

27 // Algorithm

```
1 // Line - Line
   // Algorithm
3 // Algorithm
4 // Algorithm
                                                                                    4
                                                                                         area += (conj(ai)*ib).imag();
5 // Algorithm
6 // Algorithm
                                                                                       1.6 Point In Polygon
7 // Line - Segment
8 // Algorithm
                                                                                    1 // Algorithm
9 // Algorithm
                                                                                    2 // Algorithm
                                                                                   3 // Algorithm
4 // Algorithm
5 // Algorithm
6 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Segment - Segment
14 // Algorithm
15 // Algorithm
                                                                                    7 // Algorithm
8 // Algorithm
16 // Algorithm
17 // Algorithm
                                                                                   9 // Algorithm
10 // Algorithm
                                                                                   11 // Algorithm
12 // Algorithm
18 // Algorithm
19 // Circle - Line
                                                                                   13 // Algorithm
14 // Algorithm
20 // Algorithm
21 // Algorithm
                                                                                   15 // Algorithm
16 // Algorithm
22 // Algorithm
23 // Algorithm
24 // Algorithm
                                                                                   17 // Algorithm
                                                                                   18 // Algorithm
25 // Circle - Segment
26 // Algorithm
                                                                                   19 // Algorithm
```

```
5 // Algorithm
6 // Algorithm
7 // From 1 Line 2 Points
8 // Algorithm
9 // Algorithm
10 // Algorithm
11 // Algorithm
```

12 // Algorithm 13 // From 2 Lines 1 Point 14 // Algorithm 15 // Algorithm 16 // Algorithm 17 // Algorithm 18 // Algorithm

20 // Algorithm 21 // Algorithm 22 // Algorithm 23 // Algorithm 24 // Algorithm

19 // From 3 Lines

# 1.4 Heron Triangle Area

```
1 // Formula
2 // Formula
3 // Formula
```

## 1.5 Polygon Centroid

```
1 for(int i = 1; i < n-1; i++) {
2  pt ai = pts[i] - pts[i-1],
3  ib = pts[i+1] - pts[i];</pre>
```

20 // Algorithm

```
1.7
        Convex Hull
                                                                      9 // Algorithm
                                                                     10 // Algorithm
                                                                     11 // Algorithm
12 // Algorithm
 1 // Algorithm
   // Algorithm
 3 // Algorithm
                                                                     13 // Algorithm
14 // Algorithm
 4 // Algorithm
 5 // Algorithm
                                                                     15 // Algorithm
 6 // Algorithm
                                                                     16 // Algorithm
 7 // Algorithm
                                                                     17 // Algorithm
 8 // Algorithm
                                                                     18 // Algorithm
9 // Algorithm
10 // Algorithm
                                                                     19 // Algorithm
                                                                     20 // Algorithm
// Algorithm
Algorithm
                                                                        2 3D Geometry
13 // Algorithm
14 // Algorithm
                                                                        2.1 Primitives
15 // Algorithm
16 // Algorithm
                                                                      1 // Code
                                                                        // Code
17 // Algorithm
                                                                      3 // Code
18 // Algorithm
                                                                      4 // Code
19 // Algorithm
                                                                      5 // Code
20 // Algorithm
                                                                      6 // Code
                                                                      7 // Code
   1.8 Line Segment Set Intersection
                                                                      8 // Code
                                                                     9 // Code
10 // Code
 1 // Algorithm
 2 // Algorithm
                                                                     11 // Code
 3 // Algorithm
                                                                     12 // Code
13 // Code
14 // Code
 4 // Algorithm
 5 // Algorithm
 6 // Algorithm
                                                                     15 // Code
 7 // Algorithm
 8 // Algorithm
                                                                        2.2 Convex Hull
 9 // Algorithm
10 // Algorithm
11 // Algorithm
                                                                      1 // Algorithm
12 // Algorithm
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13 // Algorithm
                                                                      3 // Algorithm
14 // Algorithm
                                                                      4 // Algorithm
15 // Algorithm
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16 // Algorithm
                                                                      6 // Algorithm
17 // Algorithm
                                                                        // Algorithm
18 // Algorithm
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19 // Algorithm
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                                                                     10 // Algorithm
20 // Algorithm
21 // Algorithm
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22 // Algorithm
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23 // Algorithm
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24 // Algorithm
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25 // Algorithm
26 // Algorithm
                                                                     16 // Algorithm
27 // Algorithm
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                                                                     18 // Algorithm
28 // Algorithm
29 // Algorithm
                                                                     19 // Algorithm
30 // Algorithm
                                                                     20 // Algorithm
31 // Algorithm
32 // Algorithm
                                                                        2.3 Great Circle Distance
33 // Algorithm
34 // Algorithm
                                                                      1 // Code
35 // Algorithm
                                                                      2 // Code
3 // Code
36 // Algorithm
37 // Algorithm
                                                                      4 // Code
5 // Code
38 // Algorithm
39 // Algorithm
40 // Algorithm
                                                                      6 // Code
7 // Code
41 // Algorithm
42 // Algorithm
                                                                        // Code
// Code
43 // Algorithm
44 // Algorithm
45 // Algorithm
                                                                     10 // Code
                                                                        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
                                                                      6 }
                                                                        // derangements
 3 // Algorithm
 4 // Algorithm
                                                                      8
                                                                        long long D(int n) {
                                                                          return n*D(n-1) + pow(-1, n);
return (n-1)*(D(n-1) + D(n-2));
 5 // Algorithm
 6 // Algorithm
                                                                     10
   // Algorithm
 8 // Algorithm
                                                                        // iterate over all subsets with < m elements
```

```
13 for (int i = 0; i < (1<<n); i=Integer.bitCount(i) < m ? i 1 // Code
                                                                      2 // Code
3 // Code
4 // Code
        +1 : (i|(i-1))+1)
14 // iterate over all the subsets
15 for (int i=0; i < (1<<n); i++)
     // iterate over all the subsets of the i-th subset
                                                                   5 // Code
6 // Code
    for(int i2 = i; i2 > 0; i2 = (i2-1) & i)
                                                                       7 // Code
                                                                       8 // Code
   4 Data Structures
                                                                      9 // Code
10 // Code
   4.1 Palindromic Tree
                                                                      11 // Code
12 // Code
 1 // Algorithm
   // Algorithm
                                                                      13 // Code
14 // Code
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16 // Code
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18 // Code
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10 // Algorithm
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12 // Algorithm
13 // Algorithm
                                                                         4.5 BIT + Search
14 // Algorithm
15 // Algorithm
                                                                       1 // Algorithm
16 // Algorithm
                                                                         // Algorithm
17 // Algorithm
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18 // Algorithm
                                                                         // Algorithm
19 // Algorithm
                                                                         // Algorithm
20 // Algorithm
                                                                       6 // Algorithm
                                                                       7 // Algorithm
                                                                       8 // Algorithm
9 // Algorithm
   4.2 Treap
1 // Algorithm
                                                                      10 // Algorithm
                                                                      11 // Algorithm
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                                                                      13 // Algorithm
5 // Algorithm
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6 // Algorithm 7 // Algorithm
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                                                                      17 // Algorithm
8 // Algorithm
9 // Algorithm
                                                                      18 // Algorithm
                                                                      19 // Algorithm
10 // Algorithm
                                                                      20 // Algorithm
11 // Algorithm
12 // Algorithm
                                                                         4.6 Segment Tree + Lazy Propagation
13 // Algorithm
14 // Algorithm
                                                                       1 // Algorithm
15 // Algorithm
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16 // Algorithm
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17 // Algorithm
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18 // Algorithm
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22 // Algorithm
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23 // Algorithm
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26 // Algorithm
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   // Algorithm
                                                                      14 // Algorithm
15 // Algorithm
28 // Algorithm
   // Algorithm
                                                                      16 // Algorithm
17 // Algorithm
30 // Algorithm
                                                                      18 // Algorithm
19 // Algorithm
   4.3 Sparse Array
                                                                      20 // Algorithm
21 // Algorithm
1 // Code
2 // Code
                                                                      22 // Algorithm
23 // Algorithm
3 // Code
4 // Code
                                                                      24 // Algorithm
5 // Code
                                                                      25 // Algorithm
 6 // Code
                                                                      26 // Algorithm
27 // Algorithm
7 // Code
8 // Code
9 // Code
                                                                      28 // Algorithm
                                                                      29 // Algorithm
10 // Code
                                                                      30 // Algorithm
11 // Code
12 // Code
                                                                         4.7 Weighted Union Disjoint Sets
13 // Code
14 // Code
                                                                         // Algorithm
15 // Code
                                                                        // Algorithm
                                                                         // Algorithm
   4.4 Skip Lists
                                                                       4 // Algorithm
```

```
5 // Algorithm
                                                                     1 double* GaussianElimination(int N, double **mat) {
6 // Algorithm
7 // Algorithm
                                                                         int i, j, k, L; double t;
for (i = 0; i < N - 1; i++) {</pre>
                                                                     2
                                                                     3
8 // Algorithm
                                                                     4
                                                                           L = i;
                                                                           for (j = i + 1; j < N; j++)
  if (fabs(mat[j][i]) > fabs(mat[L][i]))
9 // Algorithm
10 // Algorithm
                                                                     6
                                                                                L = j;
11 // Algorithm
                                                                            for (k = i; k <= N; k++)
12 // Algorithm
                                                                     8
13 // Algorithm
                                                                     9
                                                                            swap(mat[i][k], mat[L][k]);
                                                                            for (j = i + 1; j < N; j++)
for (k = N; k >= i; k--)
14 // Algorithm
                                                                    10
15 // Algorithm
                                                                    11
                                                                    12
                                                                                mat[j][k] = (mat[i][k] * mat[j][i]) / mat[i][i];
   5 Game Theory
                                                                    13
                                                                    14
                                                                          double *res = new double[N];
   5.1 Nim Game
                                                                         for (j = N - 1; j \ge 0; j--) {
for (t = 0.0, k = j + 1; k < N; k++)
                                                                    15
                                                                    16
1 // Algorithm
                                                                            t += mat[j][k] * res[k];
                                                                    17
2 // Algorithm
3 // Algorithm
                                                                            res[j] = (mat[j][N] - t) / mat[j][j];
                                                                    18
                                                                    19
4 // Algorithm
5 // Algorithm
                                                                    20
                                                                         return res;
 6 // Algorithm
7 // Algorithm
                                                                       6.4 Fast Fourier-Transform
 8 // Algorithm
9 // Algorithm
                                                                     1 // Algorithm
10 // Algorithm
                                                                       // Algorithm
                                                                     3 // Algorithm
   5.2 Grundy Numbers
                                                                     4 // Algorithm
                                                                     5 // Algorithm
 1 // Algorithm
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3 // Algorithm
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4 // Algorithm
                                                                     9 // Algorithm
5 // Algorithm
                                                                    10 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                       6.5 Misc. Formulas
 8 // Algorithm
9 // Algorithm
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10 // Algorithm
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11 // Algorithm
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12 // Algorithm
                                                                     4 // Algorithm
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19 // Algorithm
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12 // Algorithm
20 // Algorithm
                                                                    13 // Algorithm
14 // Algorithm
   5.3 General Josephus Problem
   6 General Mathematics
                                                                    15 // Algorithm
16 // Algorithm
   6.1 Inclusion-Exclusion Patterns
                                                                    17 // Algorithm
                                                                    18 // Algorithm
 1 // Algorithm
                                                                    19 // Algorithm
2 // Algorithm
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3 // Algorithm
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8 // Algorithm
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9 // Algorithm
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10 // Algorithm
                                                                    28 // Algorithm
                                                                    29 // Algorithm
   6.2 Determinant
                                                                    30 // Algorithm
 1 // Algorithm
                                                                       7 Graph Theory
 2 // Algorithm
3 // Algorithm
                                                                       7.1 Primitives
4 // Algorithm
5 // Algorithm
                                                                     1 // Algorithm
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14 // Algorithm
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11 // Algorithm
15 // Algorithm
                                                                    12 // Algorithm
   6.3 Gaussian Elimination
                                                                    13 // Algorithm
```

```
14 // Algorithm
                                                                        11 // Algorithm
                                                                        12 // Algorithm
15 // Algorithm
                                                                        13 // Algorithm
14 // Algorithm
   7.2 Articulation Points & Bridges
                                                                        15 // Algorithm
16 // Algorithm
 1 // Algorithm
                                                                        17 // Algorithm
18 // Algorithm
   // Algorithm
3 // Algorithm
4 // Algorithm
                                                                        19 // Algorithm
                                                                        20 // Algorithm
5 // Algorithm
6 // Algorithm
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                                                                           7.6 Dinic's Max Flow
8 // Algorithm
9 // Algorithm
                                                                         1 // Algorithm
10 // Algorithm
                                                                         2 // Algorithm
11 // Algorithm
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                                                                         3 // Algorithm
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17 // Algorithm
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12 // Algorithm
19 // Algorithm
20 // Algorithm
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14 // Algorithm
   7.3 SCC
                                                                        15 // Algorithm
                                                                        16 // Algorithm
 1 // Algorithm
                                                                        17 // Algorithm
18 // Algorithm
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5 // Algorithm
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7 // Algorithm
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9 // Algorithm
                                                                                 Min-Cost Max Flow
                                                                         1 // Algorithm
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18 // Algorithm
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                                                                        11 // Algorithm
12 // Algorithm
19 // Algorithm
20 // Algorithm
                                                                        13 // Algorithm
                                                                        14 // Algorithm
   7.4 2-SAT
                                                                        15 // Algorithm
                                                                        16 // Algorithm
 1 // Algorithm
                                                                        17 // Algorithm
2 // Algorithm
                                                                        18 // Algorithm
3 // Algorithm
                                                                        19 // Algorithm
4 // Algorithm
                                                                        20 // Algorithm
5 // Algorithm
6 // Algorithm
                                                                           7.8 Euler Cycles
7 // Algorithm
8 // Algorithm
                                                                         1 // Algorithm
9 // Algorithm
10 // Algorithm
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11 // Algorithm
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12 // Algorithm
                                                                         4 // Algorithm
                                                                         5 // Algorithm
6 // Algorithm
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8 // Algorithm
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16 // Algorithm
17 // Algorithm
                                                                         9 // Algorithm
18 // Algorithm
                                                                        10 // Algorithm
                                                                        11 // Algorithm
12 // Algorithm
19 // Algorithm
20 // Algorithm
                                                                        13 // Algorithm
14 // Algorithm
   7.5 Edmonds-Karp Max Flow
                                                                        15 // Algorithm
                                                                        16 // Algorithm
 1 // Algorithm
                                                                        17 // Algorithm
2 // Algorithm
                                                                        18 // Algorithm
3 // Algorithm
                                                                        19 // Algorithm
4 // Algorithm
                                                                        20 // Algorithm
5 // Algorithm
6 // Algorithm
                                                                            7.9 Maximum Matching
7 // Algorithm
 8 // Algorithm
 9 // Algorithm
                                                                         1 // Algorithm
10 // Algorithm
                                                                           // Algorithm
```

```
3 // Algorithm
                                                                           7.14 Stable Marriage
4 // Algorithm
5 // Algorithm
                                                                         1 // Algorithm
6 // Algorithm
                                                                           // Algorithm
7 // Algorithm
                                                                           // Algorithm
8 // Algorithm
                                                                         4 // Algorithm
9 // Algorithm
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11 // Algorithm
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17 // Algorithm
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18 // Algorithm
                                                                        14 // Algorithm
19 // Algorithm
                                                                        15 // Algorithm
20 // Algorithm
                                                                            7.15 Maximum Assignment
   7.10 HL Decomposition
                                                                         1 // Algorithm
 1 // Algorithm
                                                                           // Algorithm
// Algorithm
   // Algorithm
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   // Algorithm
                                                                         4 // Algorithm
5 // Algorithm
   // Algorithm
                                                                         6 // Algorithm
7 // Algorithm
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14 // Algorithm
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15 // Algorithm
16 // Algorithm
                                                                           8 Linear Programming
17 // Algorithm
18 // Algorithm
                                                                           8.1 Simplex
19 // Algorithm
20 // Algorithm
                                                                           // Algorithm
                                                                            // Algorithm
   7.11 Modelling Inequalities
                                                                           // Algorithm
                                                                           // Algorithm
// Algorithm
1 // Algorithm
                                                                         6 // Algorithm
7 // Algorithm
   // Algorithm
   // Algorithm
                                                                           // Algorithm
// Algorithm
4 // Algorithm
5 // Algorithm
                                                                        10 // Algorithm
11 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                        12 // Algorithm
13 // Algorithm
8 // Algorithm
   // Algorithm
                                                                        14 // Algorithm
15 // Algorithm
10 // Algorithm
   7.12 Max Flow Tricks
                                                                        16 // Algorithm
17 // Algorithm
 1 // Algorithm
                                                                        18 // Algorithm
19 // Algorithm
   // Algorithm
3 // Algorithm
                                                                        20 // Algorithm
21 // Algorithm
4 // Algorithm
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10 // Algorithm
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                                                                        28 // Algorithm
29 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
                                                                               Algorithm
                                                                        31 // Algorithm
14 // Algorithm
15 // Algorithm
                                                                           9 Number Theory
   7.13 Bellman Ford
                                                                           9.1 Extended GCD
 1 // Algorithm
                                                                         1 long long gcd( long long a, long long b )
   // Algorithm
3 // Algorithm
                                                                           { return( b == 0 ? a : gcd( b, a % b ) ); }
4 // Algorithm
                                                                         3
                                                                           //USED BY: egcd, msolve, inverse, ldioph
5 // Algorithm
                                                                           template < class Int > struct Triple {
                                                                             Int d, x, y;
6 // Algorithm
7 // Algorithm
                                                                              \label{eq:triple} \texttt{Triple}(\texttt{Int}\ q,\ \texttt{Int}\ w,\ \texttt{Int}\ e): \texttt{d}(q)\,,\ \texttt{x}(w)\,,\ \texttt{y}(e)\,\{\,\}
 8 // Algorithm
   // Algorithm
                                                                            //USED BY: msolve, inverse, ldioph
10 // Algorithm
                                                                           template < class Int > Triple < Int > egcd( Int a, Int b ) {
```

```
if( !b ) return Triple< Int >( a, Int( 1 ), Int( 0 ) ); 1 // Algorithm
                                                               2 // Algorithm
3 // Algorithm
4 // Algorithm
11
    Triple< Int > q = egcd(b, a % b);
    return Triple< Int >( q.d, q.y, q.x - a / b * q.y );
12
13 }
                                                                5 // Algorithm
6 // Algorithm
  9.2 Modular Inverse
                                                                7 // Algorithm
                                                                8 // Algorithm
1 //solves ax = 1 (mod n).
                                                                9 // Algorithm
  template < class Int > Int inverse( Int a, Int n ) {
                                                               10 // Algorithm
       Triple< Int > t = egcd( a, n );
       if( t.d > Int( 1 ) ) return Int( 0 );
4
                                                                  9.9 Chinese Remainder
       Int r = t.x % n;
5
       return( r < Int( 0 ) ? r + n : r );</pre>
6
                                                                1 // Algorithm
7
                                                                  // Algorithm
                                                                  // Algorithm
                                                                3
  9.3 Modular Linear Equation
                                                                4 // Algorithm
                                                                  // Algorithm
1 // Algorithm
                                                                6 // Algorithm
   // Algorithm
                                                                7 // Algorithm
  // Algorithm
                                                                8 // Algorithm
4 // Algorithm
                                                                  // Algorithm
5 // Algorithm
                                                               10 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                  9.10 Discerete Logarithm
8 // Algorithm
  // Algorithm
                                                                1 // Algorithm
10 // Algorithm
                                                                2 // Algorithm
                                                                3 // Algorithm
   9.4 Linear Diophantine Equation
                                                                4 // Algorithm
                                                                5 // Algorithm
                                                                6 // Algorithm
1 // Algorithm
                                                                7 // Algorithm
2 // Algorithm
                                                                8 // Algorithm
3 // Algorithm
                                                                9 // Algorithm
4 // Algorithm
                                                               10 // Algorithm
5 // Algorithm
6 // Algorithm
                                                                  9.11 Tortoise & Hare
7 // Algorithm
  // Algorithm
9 // Algorithm
                                                                  // mu = start of cycle, lambda = cycle length
10 // Algorithm
                                                                   ii floyd(int x0) {
                                                                    int tortoise = f(x0), hare = f(f(x0));
                                                                    while(tortoise != hare)
  9.5 Modular Powers
                                                                      tortoise = f(tortoise), hare = f(f(hare));
                                                                    int mu = 0; hare = x0;
1 // Algorithm
                                                                    while(tortoise != hare)
2 // Algorithm
                                                                      tortoise = f(tortoise), hare = f(hare), mu++;
3 // Algorithm
                                                                    int lambda = 1; hare = f(tortoise);
4 // Algorithm
                                                                    while(tortoise != hare)
                                                               10
5 // Algorithm
                                                                      hare = f(hare), lambda++;
6 // Algorithm
                                                                    return ii(mu, lambda);
                                                               12
7 // Algorithm
8 // Algorithm
9 // Algorithm
                                                                  9.12 Pollard Rho
10 // Algorithm
                                                                  10 Search
  9.6 Sieve of Eratosthenes
                                                                  10.1 Binary Search
1 // Algorithm
2 // Algorithm
                                                                1 // Algorithm
                                                                2 // Algorithm
3 // Algorithm
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                                                                4 // Algorithm
                                                                5 // Algorithm
6 // Algorithm
                                                                  // Algorithm
7 // Algorithm
                                                                  // Algorithm
8 // Algorithm
                                                                  // Algorithm
9 // Algorithm
                                                                  // Algorithm
10 // Algorithm
                                                               10 // Algorithm
11 // Algorithm
                                                               12 // Algorithm
  9.7 Primality Testing & Factoring
                                                               13 // Algorithm
                                                               14 // Algorithm
1 // Algorithm
                                                               15 // Algorithm
2 // Algorithm
3 // Algorithm
                                                                  10.2 Ternary Search
4 // Algorithm
5 // Algorithm
                                                                1 long double min() {
2     long double lo = -1e6, hi = 1e6, res = 3e6;
6 // Algorithm
7 // Algorithm
                                                                      while(fabs(lo-hi) > EPS) {
8 // Algorithm
9 // Algorithm
                                                                4
                                                                          long double left = (hi-lo)/3 + lo, right = (2*(hi-
                                                                               10))/3 + 10;
10 // Algorithm
                                                                5
                                                                          long double resL = F(left), resR = F(right);
                                                                          if(resL < resR)</pre>
   9.8 Euler Phi
                                                                               hi = right;
```

```
1 // Algorithm
                                                                          2 // Algorithm
3 // Algorithm
4 // Algorithm
                 lo = left;
9
             res = min(res, min(resL, resR));
10
11
12
        return res;
                                                                          5 // Algorithm
6 // Algorithm
13
                                                                            // Algorithm
                                                                            // Algorithm
   11 Strings
                                                                         9 // Algorithm
10 // Algorithm
   11.1 Aho Corasick
                                                                         11 // Algorithm
12 // Algorithm
   // Algorithm
                                                                         13 // Algorithm
14 // Algorithm
   // Algorithm
   // Algorithm
                                                                         15 // Algorithm
16 // Algorithm
4 // Algorithm
 5 // Algorithm
                                                                         17 // Algorithm
18 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                         19 // Algorithm
 8 // Algorithm
                                                                         20 // Algorithm
 9 // Algorithm
                                                                         21 // Algorithm
10 // Algorithm
11 // Algorithm
                                                                            11.6 Suffix Array
12 // Algorithm
13 // Algorithm
                                                                          1 // Algorithm
14 // Algorithm
                                                                            // Algorithm
15 // Algorithm
                                                                            // Algorithm
                                                                            // Algorithm
   11.2 Hashing
                                                                            // Algorithm
                                                                            // Algorithm
 1 // Algorithm
                                                                            // Algorithm
                                                                          8 // Algorithm
9 // Algorithm
   // Algorithm
3 // Algorithm
                                                                        10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
 4 // Algorithm
5 // Algorithm
6 // Algorithm
7 // Algorithm
 8 // Algorithm
                                                                         14 // Algorithm
15 // Algorithm
9 // Algorithm
10 // Algorithm
                                                                         16 // Algorithm
17 // Algorithm
11 // Algorithm
12 // Algorithm
                                                                         18 // Algorithm
19 // Algorithm
13 // Algorithm
14 // Algorithm
                                                                         20 // Algorithm
21 // Algorithm
15 // Algorithm
                                                                         22 // Algorithm
23 // Algorithm
   11.3 Z-Algorithm
                                                                         24 // Algorithm
25 // Algorithm
 1 // Algorithm
                                                                         26 // Algorithm
27 // Algorithm
   // Algorithm
3 // Algorithm
                                                                         28 // Algorithm
 4 // Algorithm
                                                                         29 // Algorithm
5 // Algorithm
                                                                         30 // Algorithm
6 // Algorithm
7 // Algorithm
                                                                            12 Misc
8 // Algorithm
9 // Algorithm
10 // Algorithm
11 // Algorithm
12 // Algorithm
13 // Algorithm
14 // Algorithm
15 // Algorithm
   11.4 \quad KMP + Periods
 1 // Algorithm
   // Algorithm
   // 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
```

### 11.5 Manacher