

ACM-ICPC Template



GuessEver

Last Modify at May 29, 2015

Contents

1	Dynamic Programming	3
1.1	LCS - Longest Common Subsequence	3
1.2	LIS - Longest Increasing Subsequence	3
1.3	Maximum Continuous Subsequence Sum	4
1.4	RMQ - st	4
1.5	数位 dp	5
1.6	状压 dp	6
1.6.1	枚举子集	6
2	Math	6
2.1	GCD && LCM	6
2.1.1	GCD - Greatest Common Divisor	6
2.1.2	LCM - Least Common Multiple	6
2.1.3	E_GCD - Extended Greatest Common Divisor	6
2.2	Prime	6
2.2.1	Make Prime List	6
2.2.2	Prime Factor	7
2.3	Fast Power	7
2.4	约瑟夫环、丢手绢问题	7
2.5	康拓展开 Cantor	8
3	Datastructure	9
3.1	带权并查集	9
3.2	手写 Heap	10
3.3	Leftist Tree	11
3.4	Partition Tree	12
3.5	Treap	13
3.5.1	@ Array	13
3.5.2	@ Pointer	15
3.6	Size Balanced Tree	17
3.7	三维偏序 - CDQ 分治	18
4	Graph	20
4.1	Shortest path	20
4.1.1	Dijkstra	20
4.1.2	Spfa	21
4.1.3	Floyd	21
4.2	Minimum Spanning Tree	22
4.2.1	Prim	22
4.2.2	Kruskal	22
4.3	Tarjan - Strong Union	23
4.4	LCA	24
4.4.1	@ Tarjan	24
4.4.2	@ Doubling Algorithm	25
4.5	Bipartite Graph	27
4.5.1	Maximal Matching - The Hungarian algorithm	27
4.5.2	Optimal Matching - KM	28
4.6	Network Flow	28
4.6.1	Maximum Flow - isap	28
4.6.2	Minimum Cost Maximum Flow - spfa	28

5	Geometry	30
5.1	Convex Hull	30
5.2	All	31
6	String	36
6.1	Manacher	36
6.2	KMP	37
6.3	Suffix Array	38
6.4	Aho-Corasick Automaton	40
7	Tools	42
7.1	BigInteger - C++	42
7.2	C++ 读入优化	46
7.3	C char*	46
7.4	C++ std::string	46
7.5	Java	47
7.5.1	The overall framework	47
7.5.2	Input and Output	47
7.5.3	BigInteger	48
7.5.4	String	48
7.5.5	Hexadecimal Conversion	48
7.5.6	function	49
7.6	Batch test	49
7.6.1	@Linux	49
7.6.2	@Windows	50
7.7	Vimrc Config For Linux	50

1 Dynamic Programming

1.1 LCS - Longest Common Subsequence

```

1  int LCS() // O(N*N)
2  { // 字符串纠正到以 1 为下标
3      int f[N][N];
4      int res = 0;
5      for(int i = 1; i < lena; i++)
6          for(int j = 1; j < lenb; j++)
7              {
8                  if(a[i] == a[j]) f[i][j] = f[i-1][j-1] + 1;
9                  else f[i][j] = max(f[i-1][j], f[i][j-1]);
10                 res = max(res, f[i][j]);
11             }
12     return res;
13 }
14
15 int LCS() // O(NlogN)
16 { // 把 LCM 转化为 LIS 来做
17     // 1 2 5 9 3 --> 1 2 3 4 5
18     // 1 5 3 9 2 --> 1 3 5 4 2 --> 对这个序列跑 LIS()
19     //-----change-----
20     // 这里就要针对数据自己想尽办法转化了
21     for(int i = 1; i <= n; i++) h[a[i]] = i;
22     for(int i = 1; i <= n; i++) b[i] = h[b[i]];
23     //-----end-----
24     return LIS();
25 }

```

1.2 LIS - Longest Increasing Subsequence

```

1  int f[N];
2  int LIS() // O(N*N)
3  {
4      for(int i = 1; i <= n; i++)
5          for(int j = i-1; j >= 1; j--)
6              if(a[i] > a[j]) f[i] = max(f[i], f[j] + 1);
7      int res = 0;
8      for(int i = 1; i <= n; i++) res = max(res, f[i]);
9      return res;
10 }
11
12 int c[N], len = 0;
13 int LIS() // (NlogN)
14 {
15     for(int i = 1; i <= n; i++)
16     {
17         //-----find-----
18         int l = 1, r = len, mid;
19         while(l <= r)
20         {

```

```

21         mid = (l + r) / 2;
22         if(a[i] > c[mid]) l = mid + 1;
23         else r = mid - 1;
24     }
25     //-----end-----
26     c[l] = a[i];
27     len = max(len, l);
28 }
29 return len;
30 }

```

1.3 Maximum Continuous Subsequence Sum

```

1 int MaxSubSum()
2 {
3     int f[N], res;
4     for(int i = 1; i <= n; i++)
5     {
6         f[i] = max(a[i], f[i-1] + a[i]);
7         res = max(res, f[i]);
8     }
9     return res;
10 }
11
12 int MaxSubSum()
13 {
14     int res = 0, now = 0;
15     for(int i = 1; i <= n; i++)
16     {
17         now += a[i];
18         res = max(res, now);
19         if(now < 0) now = 0;
20     }
21     return res;
22 }

```

1.4 RMQ - st

```

1 int _rmq[N][30];
2 void init_RMQ(int *_orig) // [1, n]
3 {
4     for(int i = 1; i <= n; i++) _rmq[i][0] = _orig[i];
5     for(int j = 1; j <= log(1.0 * n) / log(2.0); j++)
6         for(int i = 1; i <= n + 1 - (1 << j); i++)
7             _rmq[i][j] = std::max(_rmq[i][j-1], _rmq[i+(1<<(j-1))][j-1]);
8 }
9 int query_RMQ(int l, int r) // max{x E [l, r]}
10 {
11     int k = log(r - l + 1.0) / log(2.0);
12     return std::max(_rmq[l][k], _rmq[r-(1<<k)+1][k]);

```

13 }

1.5 数位 dp

```

1  #include <cstdio>
2  #include <cstring>
3  #include <algorithm>
4  // calculate the number of numbers in [l, r] which not contain '4' or
   '62'
5  long long l, r;
6  int k;
7  int L[100], R[100];
8  long long f[100][2][2][10];
9
10 int predo(long long a, int *num)
11 {
12     int len = 0;
13     do num[++len] = a % 10; while(a /= 10);
14     return len;
15 }
16
17 long long calc(int pos, bool d, bool u, int pre)
18 {
19     if(pos == 0) return 1;
20     long long &res = f[pos][d][u][pre];
21     if(res != -1) return res;
22     res = 0;
23     int st = d ? L[pos] : 0;
24     int ed = u ? R[pos] : 9;
25     for(int i = st; i <= ed; i++)
26     {
27         if(i == 4 || (pre == 6 && i == 2)) continue;
28         res += calc(pos-1, d && i == L[pos], u && i == R[pos], i);
29     }
30     return res;
31 }
32
33 int main()
34 {
35     while(scanf("%lld%lld", &l, &r) == 2 && (l || r))
36     {
37         memset(f, -1, sizeof(f));
38         memset(L, 0, sizeof(L));
39         memset(R, 0, sizeof(R));
40         int len = std::max(predo(l, L), predo(r, R));
41         printf("%lld\n", calc(len, 1, 1, 0));
42     }
43     return 0;
44 }

```

1.6 状压 dp

1.6.1 枚举子集

```
1 | for(int st = S; st; st = (st - 1) & S) ;
```

2 Math

2.1 GCD & LCM

2.1.1 GCD - Greatest Common Divisor

```
1 | int gcd(int a, int b) { return b ? gcd(b, a % b) : a; }
```

2.1.2 LCM - Least Common Multiple

```
1 | inline int lcm(int a, int b) { return a / gcd(a, b) * b; }
```

2.1.3 E_GCD - Extended Greatest Common Divisor

```
1 | ax + by = 1
2 | bx1 + (a%b)y1 = 1    ==>    bx + (a-a/b*b)y = 1
3 | ==> ay1 + b(x1-a/b*y1) = 1
4 | 对应  ax  + by          = 1
5 |
6 | int egcd(int a, int b, int &x, int &y)
7 | {
8 |     if(b == 0)
9 |     {
10 |         x = 1; y = 0;
11 |         return a;
12 |     }
13 |     int x1, y1;
14 |     int e = egcd(b, a%b, x1, y1);
15 |     x = y1;
16 |     y = x1 - a / b * y1;
17 |     return e;
18 | }
```

2.2 Prime

2.2.1 Make Prime List

```
1 | void make_prime_list(int maxp) // O(2*N)
2 | {
3 |     for(int i = 2; i <= maxp; i++)
4 |     {
5 |         if(!h[i]) pri[l++] = i;
6 |         for(int j = 0; j < l && pri[j] <= maxp / i; j++)
```

```

7         {
8             h[i * pri[j]] = true;
9             if(i % pri[j] == 0) break;
10        }
11    }
12 }

```

2.2.2 Prime Factor

```

1 void factor()
2 {
3     make_prime_list();
4     for(int j = 0; j < Cnt && pri[j]*pri[j] <= n; j++)
5     {
6         if(n % pri[j] == 0)
7         {
8             printf("%d_", pri[j]);
9             while(n % pri[j] == 0) n /= pri[j];
10        }
11    }
12    if(n!=1) printf("%d",n);
13 }

```

2.3 Fast Power

```

1 //x^y % mod
2 int mul(int x, LL y, int mod) // 递归
3 {
4     if(y == 1) return x;
5     if(y & 1) return (mul((x * (LL)x) % mod, y / 2, mod) * (LL)x)%mod;
6     else return mul((x * (LL)x) % mod, y / 2, mod) % mod;
7 }
8 int mul(int x, int y, int mod) // 非递归
9 {
10    int s = 1;
11    int ss = x;
12    while(y)
13    {
14        if(y & 1) s = s * ss;
15        y /= 2;
16        ss *= ss;
17    }
18    return s;
19 }

```

2.4 约瑟夫环、丢手绢问题

```

1 #include <stdio>
2 //UVALive 4727
3 int n, m;

```



```

4
5 int Joseph(int totalPeople, int nextNumber, int startIndex, int lastIdx
6 )
7 { // All based on 0_Index , the Answer is the last `lastIdx` to leave
8   int now = (nextNumber - 1) % lastIdx + (startIndex - nextNumber);
9   for(int i = lastIdx + 1; i <= totalPeople; i++)
10     now = (now + nextNumber) % i;
11   return now;
12 }
13 int main()
14 {
15   int T; scanf("%d", &T);
16   while(T--)
17   {
18     scanf("%d%d", &n, &m);
19     printf("%d□%d□%d\n", Joseph(n, m, m, 3)+1, Joseph(n, m, m, 2)
20           +1, Joseph(n, m, m, 1)+1);
21   }
22   return 0;
23 }

```

2.5 康拓展开 Cantor

```

1 #include <cstdio>
2 #include <cstring>
3
4 int fac[10], a[10];
5
6 bool Read(int *p)
7 {
8   for(int i = 0; i < 9; i++)
9   {
10     char chtmp;
11     if(scanf("□%c", &chtmp) != 1) return 0;
12     p[i] = chtmp == 'x' ? 0 : chtmp - '0';
13   }
14   return 1;
15 }
16
17 int Cantor(int *p) // Eight puzzle status -> Integer
18 {
19   int res = 0;
20   for(int i = 0; i < 9; i++)
21   {
22     int cnt = 0;
23     for(int j = i + 1; j < 9; j++)
24       if(p[j] < p[i]) cnt++;
25     res += cnt * fac[9 - i - 1];
26   }
27   return res;
28 }

```

```

29
30 bool used[10] = {0};
31 int getRank(int r)
32 {
33     for(int i = 0, j = 0; i < 9; i++)
34     {
35         if(!used[i] && j == r) return i;
36         if(!used[i]) j++;
37     }
38 }
39 void getStatus(int cantor, int *p) // Integer -> Eight puzzle status
40 {
41     memset(used, 0, sizeof(used));
42     for(int i = 0; i < 9; i++)
43     {
44         p[i] = getRank(cantor / fac[9 - i - 1]);
45         used[p[i]] = 1;
46         cantor %= fac[9 - i - 1];
47     }
48 }
49
50 void PRINT(int *p)
51 {
52     int hash = Cantor(p);
53     printf("Cantor_value=%d\n", hash);
54     getStatus(hash, p);
55     printf("Cantor_Status=");
56     for(int i = 0; i < 9; i++) printf("%d", p[i]); puts("");
57 }
58
59 int main()
60 {
61     fac[0] = 1; for(int i = 1; i < 10; i++) fac[i] = fac[i-1] * i;
62     while(Read(a)) PRINT(a);
63     return 0;
64 }

```

3 Datastructure

3.1 带权并查集

```

1 #include <stdio>
2 #include <stdlib>
3
4 const int N = 100000 + 10;
5
6 int n, f[N], g[N];
7
8 int getroot(int x)
9 {
10     if(f[x] == x) return x;

```

```

11     int tmp = getroot(f[x]);
12     g[x] += g[f[x]]; // update the value
13     return f[x] = tmp;
14 }
15
16 void merge(int x, int y) // merge x's set and y's set
17 { // Guarantee that the x must be the root of its set, which means x ==
    getroot(x) is true, but it may not be same for y
18     int fy = getroot(y);
19     g[x] += g[y] + abs(x - y) % 1000; // update the value
20     f[x] = fy;
21 }
22
23 int main()
24 {
25     scanf("%d", &n);
26     for(int i = 1; i <= n; i++) f[i] = i;
27     char op; int x, y;
28     while(scanf("%c", &op) == 1 && op != '0')
29     {
30         if(op == 'I')
31         {
32             scanf("%d%d", &x, &y);
33             if(getroot(x) == getroot(y)) continue;
34             merge(x, y);
35         }
36         else{
37             scanf("%d", &x);
38             getroot(x); // !!! update the value of x before output
39             printf("%d\n", g[x]);
40         }
41         //for(int i = 1; i <= n; i++) printf("%d ", f[i]); puts("");
42     }
43     return 0;
44 }

```

3.2 手写 Heap

```

1  #include <cstdio>
2  #include <algorithm>
3
4  const int N = 250000;
5
6  int n, a[N], x, size = 0;
7
8  void update(int i)
9  {
10     while(i > 1 && a[i] > a[i/2])
11     {
12         std::swap(a[i], a[i/2]);
13         i /= 2;
14     }

```

```

15 }
16
17 void pop()
18 {
19     int i = 1; a[i] = 0;
20     while(i * 2 <= size && (a[i] < a[i*2] || a[i] < a[i*2+1]))
21     {
22         if(i * 2 == size || (i * 2 < size && a[i*2] >= a[i*2+1]))
23         {
24             a[i] = a[i*2];
25             a[i*2] = 0;
26             i = i * 2;
27         }
28         else {
29             a[i] = a[i*2+1];
30             a[i*2+1] = 0;
31             i = i * 2 + 1;
32         }
33     }
34     a[i] = a[size]; size--;
35     update(i);
36 }
37
38 int main()
39 {
40     scanf("%d", &n);
41     for(int i = 1; i <= n; i++)
42     {
43         scanf("%d", &x);
44         a[++size] = x;
45         update(size);
46     }
47     for(int i = 1; i <= n; i++)
48     {
49         printf("%d□", a[1]);
50         pop();
51     }
52     return 0;
53 }

```

3.3 Leftist Tree

```

1 //很多时候需要配合并查集一起使用
2 int getroot(int x){return f[x]==x ? x : f[x]=getroot(f[x]);}
3
4 //把x和y合并在一起，其实就是把y插入x
5 int merge(int x,int y)//返回合并后子树的根
6 {
7     if(!x || !y) return x|y;
8     if(A[x] < A[y]) swap(x,y);//大根堆，如果y比x大，与其让y插入x，
    不如让x插入y
9     R[x]=merge(R[x],y);//始终往右子树合并

```

```

10     f[R[x]] = x; //更新并查集
11     if(D[R[x]] > D[L[x]]) swap(L[x], R[x]); //保持左偏树性质
12     D[x] = D[R[x]] + 1;
13     若还有其他维护信息也需要更新;
14     return x; //返回根
15 }
16
17 int del(int x)
18 {
19     int t = merge(L[x], R[x]);
20     f[L[x]] = L[x]; f[R[x]] = R[x]; //更新并查集
21     L[x] = R[x] = D[x] = 0;
22     return t;
23 }

```

3.4 Partition Tree

```

1 struct Parti{int val, left;} val[30][N];
2 void build_tree(int d, int l, int r)
3 {
4     if(l == r) return;
5     int m = (l + r) >> 1, same = m - l + 1;
6     int lcnt = l, rcnt = m + 1;
7     for(int i = l; i <= r; i++)
8         if(val[d][i].val < sorted[m]) same--;
9     for(int i = l; i <= r; i++)
10    {
11        int flag = 0;
12        if((val[d][i].val < sorted[m]) || (val[d][i].val == sorted[m] &&
13            same))
14        {
15            flag = 1;
16            val[d + 1][lcnt++] = val[d][i];
17            if(val[d][i].val == sorted[m]) same--;
18        }
19        else val[d][rcnt++] = val[d][i];
20        val[d][i].left = val[d][i - 1].left + flag;
21    }
22    build_tree(d + 1, l, m);
23    build_tree(d + 1, m + 1, r);
24 }
25 int query(int d, int l, int r, int x, int y, int k)
26 {
27     if(l == r) return val[d][l].val;
28     int m = (l + r) >> 1;
29     int lx = val[d][x - 1].left - val[d][l - 1].left; //[l,x-1] to left
30     int ly = val[d][y].left - val[d][x - 1].left; //[x,y] to left
31     int rx = (x - 1 - l + 1) - lx; //[l,x-1] to right
32     int ry = (y - x + 1) - ly; //[x,y] to right
33     if(ly >= k) return query(d+1, l, m, l-1+lx+1, l-1+lx+ly, k);
34     else return query(d+1, m+1, r, m+1-1+rx+1, m+1-1+rx+ry, k-ly);
35 }

```

3.5 Treap

3.5.1 @ Array

```

1  #include <cstdio>
2  #include <cstdlib>
3  #include <ctime>
4
5  const int N = 100000 + 10;
6
7  int m, Limit;
8  int L[N], R[N], S[N], fix[N], key[N];
9  int root, total, leave;
10
11 void rotate_left(int &p)
12 {
13     int tmp = R[p];
14     R[p] = L[tmp];
15     int zsize = S[L[tmp]];
16     S[p] = S[p] - S[tmp] + zsize;
17     L[tmp] = p;
18     S[tmp] = S[tmp] - zsize + S[p];
19     p = tmp;
20 }
21 void rotate_right(int &p)
22 {
23     int tmp = L[p];
24     L[p] = R[tmp];
25     int zsize = S[R[tmp]];
26     S[p] = S[p] - S[tmp] + zsize;
27     R[tmp] = p;
28     S[tmp] = S[tmp] - zsize + S[p];
29     p = tmp;
30 }
31
32 void insert(int &p, int x)
33 {
34     if(!p)
35     {
36         p = ++total;
37         L[p] = R[p] = 0;
38         S[p] = 1;
39         fix[p] = rand();
40         key[p] = x;
41         return;
42     }
43     S[p]++;
44     if(x < key[p])
45     {
46         insert(L[p], x);
47         if(fix[L[p]] > fix[p]) rotate_right(p);
48     }
49     else {

```

```

50     insert(R[p], x);
51     if(fix[R[p]] > fix[p]) rotate_left(p);
52 }
53 }
54
55 void remove(int &p, int limit)
56 {
57     if(!p) return;
58     if(key[p] < limit)
59     {
60         leave += S[L[p]] + 1;
61         p = R[p];
62         remove(p, limit);
63     }
64     else{
65         remove(L[p], limit);
66         S[p] = S[L[p]] + S[R[p]] + 1;
67     }
68 }
69
70 int kth(int &p, int k)
71 {
72     if(k <= S[L[p]]) return kth(L[p], k);
73     else if(k == S[L[p]] + 1) return key[p];
74     else return kth(R[p], k - S[L[p]] - 1);
75 }
76
77 int main()
78 {
79     srand(time(0));
80     scanf("%d%d", &m, &Limit);
81     int delta = 0;
82     while(m--)
83     {
84         char op; int x;
85         scanf("%c%d", &op, &x);
86         if(op == 'I')
87         {
88             if(x < Limit) continue;
89             insert(root, x - delta);
90         }
91         else if(op == 'A') delta += x;
92         else if(op == 'S')
93         {
94             delta -= x;
95             remove(root, Limit - delta);
96         }
97         else {
98             x = S[root] - x + 1;
99             if(x <= 0) puts("-1");
100             else printf("%d\n", kth(root, x) + delta);
101         }
102     }

```

```

103     printf("%d\n", leave);
104     return 0;
105 }

```

3.5.2 @ Pointer

```

1  #include <stdio>
2  #include <stdlib>
3  #include <ctime>
4
5  int m, Limit;
6  struct Treap{
7      int fix, key, size;
8      Treap *left, *right;
9  }*root, *null;
10 int leave;
11
12 void rotate_left(Treap *&p)
13 {
14     Treap *tmp = p -> right;
15     p -> right = tmp -> left;
16     int zsize = tmp -> left -> size;
17     p -> size = p -> size - tmp -> size + zsize;
18     tmp -> left = p;
19     tmp -> size = tmp -> size - zsize + p -> size;
20     p = tmp;
21 }
22 void rotate_right(Treap *&p)
23 {
24     Treap *tmp = p -> left;
25     p -> left = tmp -> right;
26     int zsize = tmp -> right -> size;
27     p -> size = p -> size - tmp -> size + zsize;
28     tmp -> right = p;
29     tmp -> size = tmp -> size - zsize + p -> size;
30     p = tmp;
31 }
32
33 void insert(Treap *&p, int x)
34 {
35     if(p == null)
36     {
37         p = new Treap;
38         p -> fix = rand();
39         p -> key = x;
40         p -> size = 1;
41         p -> left = null;
42         p -> right = null;
43         return;
44     }
45     if(x < p -> key)
46     {

```



```

47     insert(p -> left, x);
48     p -> size++;
49     if(p -> left -> fix > p -> fix) rotate_right(p);
50 }
51 else {
52     insert(p -> right, x);
53     p -> size++;
54     if(p -> right -> fix > p -> fix) rotate_left(p);
55 }
56 }
57
58 void remove(Treap *&p, int L)
59 {
60     if(p == null) return;
61     if(p -> key < L)
62     {
63         leave += p -> left -> size + 1;
64         p = p -> right;
65         remove(p, L);
66     }
67     else {
68         remove(p -> left, L);
69         p -> size = p -> left -> size + p -> right -> size + 1;
70     }
71 }
72
73 int kth(Treap *&p, int k)
74 {
75     int Lsize = p -> left -> size;
76     if(k <= Lsize) return kth(p -> left, k);
77     else if(k == Lsize + 1) return p -> key;
78     else return kth(p -> right, k - Lsize - 1);
79 }
80
81 int main()
82 {
83     srand(time(0));
84     null = new Treap; root = null;
85     scanf("%d%d", &m, &Limit);
86     int delta = 0;
87     while(m--)
88     {
89         char op; int x;
90         scanf("%c%d", &op, &x);
91         if(op == 'I')
92         {
93             if(x < Limit) continue;
94             insert(root, x - delta);
95         }
96         else if(op == 'A') delta += x;
97         else if(op == 'S')
98         {
99             delta -= x;

```

```

100         remove(root, Limit - delta);
101     }
102     else {
103         x = root -> size - x + 1;
104         if(x <= 0) puts("-1");
105         else printf("%d\n", kth(root, x) + delta);
106     }
107 }
108 printf("%d\n", leave);
109 return 0;
110 }

```

3.6 Size Balanced Tree

```

1  int A[N], S[N], L[N], R[N], root, total;
2  void rotate_left(int &x)
3  {
4      int y = R[x];
5      R[x] = L[y];
6      L[y] = x;
7      S[y] = S[x];
8      S[x] = S[L[x]] + S[R[x]] + 1;
9      x = y;
10 }
11 void rotate_right(int &x)
12 {
13     int y = L[x];
14     L[x] = R[y];
15     R[y] = x;
16     S[y] = S[x];
17     S[x] = S[L[x]] + S[R[x]] + 1;
18     x = y;
19 }
20
21 void maintain(int &p, bool flag)
22 {
23     if(flag)//调整右边
24     {
25         if(S[R[R[p]]] > S[L[p]] rotate_left(p);
26         else if(S[R[L[p]]] > S[L[p]])
27         {
28             rotate_right(R[p]);
29             rotate_left(p);
30         }
31         else return;
32     }
33     else
34     {
35         if(S[L[L[p]]] > S[R[p]] rotate_right(p);
36         else if(S[L[R[p]]] > S[R[p]])
37         {
38             rotate_left(L[p]);

```

```

39         rotate_right(p);
40     }
41     else return;
42 }
43 maintain(L[p], 0);
44 maintain(R[p], 1);
45 maintain(p, 0);
46 maintain(p, 1);
47 }
48
49 void insert(int &p, int e)
50 {
51     if(!p)
52     {
53         p = ++total;
54         L[p] = R[p] = 0;
55         A[p] = e; S[p] = 1;
56         return;
57     }
58     S[p]++;
59     if(e < A[p]) insert(L[p], e);
60     else insert(R[p], e);
61     maintain(p, k >= A[p]);
62 }
63
64 int getmin()
65 {
66     for(int x = root; L[x]; x = L[x]);
67     return A[x];
68 }
69 int getmax()
70 {
71     for(int x = root; R[x]; x = R[x]);
72     return A[x];
73 }
74 int kth(int &p, int k)
75 {
76     int tmp = S[L[p]] + 1;
77     if(k == tmp) return A[p];
78     else if(k < tmp) return kth(L[p], k);
79     else return kth(R[p], k - tmp);
80 }

```

3.7 三维偏序 - CDQ 分治

```

1 #include <cstdio>
2 #include <cstring>
3 #include <algorithm>
4 #define lowbit(_X) ((_X)&(-(_X)))
5 // SPOJ LIS2
6 const int N = 100000 + 10;
7

```

```

8  int n, f[N], idx[N], hash[N];
9  struct Node{
10     int x, y, z;
11     void Read(int i)
12     {
13         scanf("%d%d", &y, &z);
14         x = i; f[i] = 1; idx[i] = i;
15     }
16 }a[N];
17 int maxp;
18 int c[N]; // tree Array
19
20 bool cmpx(int i, int j) { return a[i].x < a[j].x; }
21 bool cmpy(int i, int j) { return a[i].y < a[j].y; }
22 bool cmpz(int i, int j) { return a[i].z < a[j].z; }
23
24 void discrete()
25 {
26     std::sort(idx+1, idx+1+n, cmpy); maxp = 0;
27     for(int i = 1; i <= n; i++)
28     {
29         if(i == 1 || a[idx[i]].y != a[idx[i-1]].y) hash[idx[i]] = ++
            maxp;
30         else hash[idx[i]] = maxp;
31     }
32     for(int i = 1; i <= n; i++) a[idx[i]].y = hash[idx[i]];
33     std::sort(idx+1, idx+1+n, cmpz); maxp = 0;
34     for(int i = 1; i <= n; i++)
35     {
36         if(i == 1 || a[idx[i]].z != a[idx[i-1]].z) hash[idx[i]] = ++
            maxp;
37         else hash[idx[i]] = maxp;
38     }
39     for(int i = 1; i <= n; i++) a[idx[i]].z = hash[idx[i]];
40 }
41
42 void insert(int a, int x)
43 {
44     for( ; a <= maxp; a += lowbit(a)) c[a] = std::max(c[a], x);
45 }
46 int query(int a) // [1, a]
47 {
48     int res = 0;
49     for( ; a > 0; a -= lowbit(a)) res = std::max(res, c[a]);
50     return res;
51 }
52
53 void solve(int l, int mid, int r)
54 {
55     std::sort(&idx[l], &idx[mid]+1, cmpy);
56     std::sort(&idx[mid+1], &idx[r]+1, cmpy);
57     // [l, mid] .. calculated ok
58     // now calculating [mid+1, r]

```

```

59 // f[i] = max{f[j]} + 1;
60 int j = l;
61 for(int i = mid + 1; i <= r; i++)
62 {
63     for( ; j <= mid && a[idx[j]].y < a[idx[i]].y; j++)
64         insert(a[idx[j]].z, f[a[idx[j]].x]);
65     int tmp = query(a[idx[i]].z - 1);
66     if(tmp + 1 > f[a[idx[i]].x]) f[a[idx[i]].x] = tmp + 1;
67 }
68 //memset(c, 0, sizeof(c));
69 for(int i = l; i <= mid; i++)
70 {
71     int b = a[idx[i]].z;
72     for( ; b <= maxp; b += lowbit(b)) c[b] = 0;
73 }
74 std::sort(&idx[mid+1], &idx[r]+1, cmpx);
75 // CDQ(mid+1, r) next, so sort back it
76 }
77
78 void CDQ(int l, int r)
79 {
80     if(l == r) return;
81     int mid = l + (r - l) / 2;
82     CDQ(l, mid);
83     solve(l, mid, r);
84     CDQ(mid + 1, r);
85 }
86
87 int main()
88 {
89     scanf("%d", &n);
90     for(int i = 1; i <= n; i++) a[i].Read(i);
91     discrete();
92     std::sort(idx+1, idx+1+n, cmpx);
93     CDQ(1, n);
94     int res = 1;
95     //for(int i = 1; i <= n; i++) printf("%d ", f[i]); puts("");
96     for(int i = 1; i <= n; i++) if(f[i] > res) res = f[i];
97     printf("%d\n", res);
98     return 0;
99 }

```

4 Graph

4.1 Shortest path

4.1.1 Dijkstra

```

1 void dijkstra()
2 {
3     memset(dist, 0x3f, sizeof(dist));
4     dist[1] = 0; Q.push(make_pair(0, 1));

```

```

5   while(!Q.empty())
6   {
7       int x = Q.top().second; Q.pop();
8       if(done[x]) continue;
9       done[x] = 1;
10      for(Link p = head[x]; p; p = p->next)
11          if(dist[p->y] > dist[x] + p->z)
12          {
13              dist[p->y] = dist[x] + p->z;
14              Q.push(make_pair(-dist[p->y], p->y));
15          }
16      }
17  }

```

4.1.2 Spfa

```

1  void spfa()
2  {
3      memset(inQ, 0, sizeof(inQ));
4      memset(dist, 0x3f, sizeof(dist));
5      dist[S] = 0; Q.push(S); inQ[S] = 1; //S为源点
6      while(!Q.empty())
7      {
8          int x = Q.front(); Q.pop(); inQ[x] = 0;
9          for(Link p = head[x]; p; p = p->next)
10             if(dist[p->y] > dist[x] + p->z)
11             {
12                 dist[p->y] = dist[x] + p->z;
13                 if(!inQ[p->y])
14                 {
15                     Q.push(p->y);
16                     inQ[p->y] = 1;
17                 }
18             }
19      }
20  }

```

4.1.3 Floyd

```

1  void floyd()
2  {
3      for(int k = 1; k <= n; k++) // 这里可以看作是一个加边的过程
4          for(int i = 1; i <= n; i++)
5              for(int j = 1; j <= n; j++)
6                  map[i][j] = min(map[i][j], map[i][k] + map[k][j]);
7  }
8
9  // 最小环
10 void MinCircle()
11 {
12     cap[] = map[];

```

```

13     int circle = 0x3f3f3f3f;
14     for(int k = 1; k <= n; k++)
15     {
16         for(int i = 1; i < k; i++)
17             for(int j = i+1; j < k; j++)
18                 circle = min(circle, map[i][j] + cap[j][k]+cap[k][i]);
19         for(int i = 1; i <= n; i++)
20             for(int j = 1; j <= n; j++)
21                 map[i][j] = min(map[i][j], map[i][k] + map[k][j]);
22     }
23     return circle == 0x3f3f3f3f ? -1 : circle;
24 }
25
26 // floyd判圈法 (大白书 p44)
27 void Circle()
28 {
29     int ans = k;
30     int k1 = k, k2 = k;
31     do{
32         k1 = next(k1);
33         k2 = next(k2); ans = max(ans, k2);
34         k2 = next(k2); ans = max(ans, k2);
35     }while(k1 != k2);
36     return ans;
37 }

```

4.2 Minimum Spanning Tree

4.2.1 Prim

```

1 int prim()
2 {
3     memset(dist, 0x3f, sizeof(dist));
4     dist[1] = 0; Q.push(make_pair(0, 1));
5     int res = 0;
6     while(!Q.empty())
7     {
8         int x = Q.top().second; Q.pop();
9         if(done[x]) continue;
10        res += dist[x]; done[x] = 1;
11        for(Link p = head[x]; p; p = p->next)
12            if(dist[p->y] > p->z)
13            {
14                dist[p->y] = p->z;
15                Q.push(make_pair(-dist[p->y], p->y));
16            }
17    }
18    return res;
19 }

```

4.2.2 Kruskal

```

1 int kruskal()
2 {
3     sort(edge, edge+Cnt, cmp);
4     int res = 0;
5     for(int i = 0; i < Cnt; i++)
6     {
7         if(getroot(edge[i].x) == getroot(edge[i].y)) continue;
8         f[getroot(edge[i].x)] = getroot(edge[i].y);
9         res += edge[i].z;
10    }
11    return res;
12 }

```

4.3 Tarjan - Strong Union

```

1 void dfs(int x)
2 {
3     now[x] = low[x] = ++dfstime;
4     hash[x] = 1;
5     st.push(x); inst[x] = 1;
6     for(int i = 1; i <= n; i++)
7         if(map[x][i])
8         {
9             if(!hash[i])
10            {
11                dfs(i);
12                low[x] = min(low[x], low[i]);
13            }
14            else if(inst[i]) low[x] = min(low[x], now[i]);
15        }
16    if(low[x] == now[x])
17    {
18        while(!st.empty())
19        {
20            int u = st.top();
21            st.pop(); inst[u] = 0;
22            belong[u] = number;
23            if(u == x) break;
24        }
25        number++;
26    }
27 }
28 void tarjan()
29 {
30     for(int i = 1; i <= n; i++)
31         if(!hash[i]) dfs(i);
32     if(!st.empty()) // 这是一个未知 bug    栈中还会剩下一个强连通分量
33     {
34         while!st.empty()
35         {
36             int u = st.top();
37             st.pop();

```



```

38         belong[u] = number;
39     }
40     number++;
41 }
42 }

```

4.4 LCA

4.4.1 @ Tarjan

```

1 // poj 1330 (changed something)
2 // LCA tarjan
3 #include <cstdio>
4 #include <cstring>
5
6 const int N = 10000 + 10;
7
8 int n;
9 struct Link{int y, idx; Link *next;}*head[N], *ask[N];
10 int tx, ty;
11 bool in[N], vis[N];
12 int f[N];
13 int ans[N]; // Query Answer
14
15 void inLink(int x, int y)
16 {
17     Link *p = new Link;
18     p -> y = y;
19     p -> next = head[x];
20     head[x] = p;
21 }
22 void inAsk(int x, int y, int idx)
23 {
24     Link *p = new Link;
25     p -> y = y;
26     p -> idx = idx;
27     p -> next = ask[x];
28     ask[x] = p;
29 }
30
31 int getroot(int x)
32 {
33     return f[x] == x ? x : f[x] = getroot(f[x]);
34 }
35
36 void LCA(int x)
37 {
38     vis[x] = 1;
39     f[x] = x;
40     for(Link *p = ask[x]; p; p = p -> next)
41         if(vis[p->y]) ans[p->idx] = getroot(p->y);
42     for(Link *p = head[x]; p; p = p -> next)

```

```

43     if(!vis[p->y])
44     {
45         LCA(p->y);
46         f[p->y] = x;
47     }
48 }
49
50 int main()
51 {
52     int T; scanf("%d", &T);
53     while(T--)
54     {
55         memset(head, 0, sizeof(head));
56         memset(ask, 0, sizeof(ask));
57         memset(in, 0, sizeof(in));
58         memset(vis, 0, sizeof(vis));
59         scanf("%d", &n);
60         for(int i = 1; i <= n; i++) f[i] = i;
61         for(int i = 1; i < n; i++)
62         {
63             int x, y;
64             scanf("%d%d", &x, &y);
65             inLink(x, y);
66             in[y] = 1;
67         }
68         int q = 1; // the number of query
69         for(int i = 1; i <= q; i++)
70         {
71             int x, y; scanf("%d%d", &x, &y);
72             inAsk(x, y, i); inAsk(y, x, i);
73         }
74         int root = -1;
75         for(int i = 1; i <= n; i++)
76             if(!in[i]) {root = i; break;}
77         LCA(root);
78         for(int i = 1; i <= q; i++)
79             printf("%d\n", ans[i]);
80     }
81     return 0;
82 }

```

4.4.2 @ Doubling Algorithm

```

1 #include <cstdio>
2 #include <cstring>
3 #include <algorithm>
4 // POJ 1330 LCA_Doubling Algorithm
5 const int N = 10000 + 10;
6
7 const int UPDepth = 14;
8 int n;
9 struct Link{

```

```

10     int y;
11     Link *next;
12 }*head[N];
13 bool in[N];
14 int ancient[N][17];
15 int deep[N];
16
17 void inLink(int x, int y)
18 {
19     Link *p = new Link;
20     p -> y = y;
21     p -> next = head[x];
22     head[x] = p;
23 }
24
25 void dfs(int x, int depth, int father)
26 {
27     deep[x] = depth;
28     ancient[x][0] = father;
29     for(Link *p = head[x]; p; p = p -> next)
30         dfs(p -> y, depth + 1, x);
31 }
32
33 void getLCA()
34 {
35     for(int i = 1; i <= n; i++)
36         if(!in[i]) dfs(i, 1, 0);
37     for(int j = 1; j <= UPDepth; j++)
38         for(int i = 1; i <= n; i++)
39             ancient[i][j] = ancient[ancient[i][j-1]][j-1];
40 }
41
42 int LCA(int x, int y)
43 {
44     if(deep[x] > deep[y]) std::swap(x, y); // deep[x] <= deep[y]
45     for(int j = UPDepth; j >= 0; j--)
46         if(deep[x] <= deep[ancient[y][j]]) y = ancient[y][j];
47     if(x == y) return x;
48     for(int j = UPDepth; j >= 0; j--)
49         if(ancient[x][j] != ancient[y][j])
50         {
51             x = ancient[x][j];
52             y = ancient[y][j];
53         }
54     return ancient[y][0];
55 }
56
57 int main()
58 {
59     int T; scanf("%d", &T);
60     while(T--)
61     {
62         memset(head, 0, sizeof(head));

```

```

63     memset(ancient, 0, sizeof(ancient));
64     memset(in, 0, sizeof(in));
65     memset(deep, 0, sizeof(deep));
66     scanf("%d", &n);
67     for(int i = 1; i < n; i++)
68     {
69         int x, y; scanf("%d%d", &x, &y);
70         inLink(x, y); in[y] = 1;
71     }
72     getLCA();
73     int x, y; scanf("%d%d", &x, &y);
74     printf("%d\n", LCA(x, y));
75 }
76 return 0;
77 }

```

4.5 Bipartite Graph

4.5.1 Maximal Matching - The Hungarian algorithm

```

1  int timeStamp = 0;
2  int n, m, g[N][N];
3  int vis[N], pre[N];
4
5  bool search(int x)
6  {
7      for(int i = 1; i <= m; i++)
8          if(g[x][i] && vis[i] != timeStamp)
9              {
10                 vis[i] = timeStamp;
11                 if(pre[i] == -1 || search(pre[i]))
12                     {
13                         pre[i] = x;
14                         return 1;
15                     }
16             }
17      return 0;
18  }
19
20  int maxMatch()
21  {
22      int res = 0;
23      memset(pre, -1, sizeof(pre));
24      for(int i = 1; i <= n; i++)
25          {
26              ++timeStamp;
27              res += search(i);
28          }
29      return res;
30  }

```

4.5.2 Optimal Matching - KM

不会... 用费用流解决

4.6 Network Flow

4.6.1 Maximum Flow - isap

```

1  #include <cstdio>
2  #include <algorithm>
3
4  const int N = 200 + 10;
5
6  int n, m, g[N][N];
7  int v[N], h[N];
8  int S, T;
9
10 int sap(int x, int flow)
11 {
12     if(x == n) return flow;
13     int res = 0;
14     for(int i = S; i <= T; i++)
15         if(g[x][i] && h[x] == h[i] + 1)
16         {
17             int t = sap(i, std::min(g[x][i], flow - res));
18             res += t; g[x][i] -= t; g[i][x] += t;
19             if(res == flow) return res;
20             if(h[S] >= T) return res;
21         }
22     //if(h[S] >= T) return res;
23     if((--v[h[x]]) == 0) h[S] = T;
24     ++v[++h[x]];
25     return res;
26 }
27
28 int main()
29 {
30     scanf("%d%d", &m, &n); // m = number of edges, n = number of points
31     for(int i = 1; i <= m; i++)
32     {
33         int x, y, z;
34         scanf("%d%d%d", &x, &y, &z);
35         g[x][y] += z;
36     }
37     v[0] = T; S = 1; T = n;
38     int maxflow = 0;
39     while(h[S] < T) maxflow += sap(1, 0x3f3f3f3f);
40     printf("%d\n", maxflow);
41     return 0;
42 }

```

4.6.2 Minimum Cost Maximum Flow - spfa

```

1 struct EG{int from,to,flow,cost,next;}edge[M];
2
3 void add_edge(int a,int b,int c,int d)
4 {
5     edge[L]=(EG){a,b,c,+d,head[a]};
6     head[a]=L++;
7     edge[L]=(EG){b,a,0,-d,head[b]};
8     head[b]=L++;
9 }
10
11 bool spfa()
12 {
13     memset(inQ, 0, sizeof(inQ));
14     memset(dist, 0x3f, sizeof(dist));
15     dist[S] = 0;
16     q.push(S);
17     while(!q.empty())
18     {
19         int x = q.front();
20         q.pop();
21         inQ[x] = 0;
22         for(int i = head[x]; i != -1; i = edge[i].next)
23             if(edge[i].flow && dist[edge[i].to] > dist[x] + edge[i].
                cost)
24             {
25                 pre[edge[i].to] = i;
26                 dist[edge[i].to] = dist[x] + edge[i].cost;
27                 if(!inQ[edge[i].to])
28                 {
29                     inQ[edge[i].to] = 1;
30                     q.push(edge[i].to);
31                 }
32             }
33     }
34     return dist[T] != inf;
35 }
36 void MFMC()
37 {
38     memset(head, -1, sizeof(head));
39     建图调用 add_edge();
40
41     int mincost = 0, maxflow = 0;
42     while(spfa())
43     {
44         int res = inf;
45         for(int i = T; i != S; i = edge[pre[i]].from)
46         {
47             res = min(res, edge[pre[i]].flow);
48         }
49         for(int i = T; i != S; i = edge[pre[i]].from)
50         {
51             edge[pre[i]].flow -= res;
52             edge[pre[i] ^ 1].flow += res;

```

```

53     }
54     maxflow += res;
55     mincost += res * dist[T];
56 }
57 }

```

5 Geometry

5.1 Convex Hull

```

1 // 点集 list[0~n-1]
2 // 点集 stack[0~top-1]
3 Point list[Maxn];
4 int Stack[Maxn],top;
5 bool _cmp (Point p1,Point p2)
6 {
7     double tmp=(p1-list[0])^(p2-list[0]);
8     if (fuhao(tmp)>0) return true;
9     else if (fuhao(tmp)==0&&fuhao(dist(p1,list[0])-dist(p2,list[0]))
10         <=0)
11         return true;
12     else return false;
13 }
14 void Graham(int n)
15 {
16     Point p0;
17     int k=0;
18     p0=list[0];
19     for (int i=1;i<n;++i)
20     {
21         if ((p0.y>list[i].y)||((p0.y==list[i].y&&p0.x>list[i].x))
22         {
23             p0=list[i];
24             k=i;
25         }
26     }
27     swap(list[k],list[0]);
28     sort(list+1,list+n,_cmp);
29     if (n==1)
30     {
31         top=1;
32         stack[0]=0;
33         return;
34     }
35     if (n==2)
36     {
37         top=2;
38         stack[0]=0;
39         stack[1]=1;
40         return;
41     }

```

```

41     stack[0]=0;
42     stack[1]=1;
43     top=2;
44     for (int i=2;i<n;++i)
45     {
46         while (top>1 && fuhao((list[stack[top-1]]-list[stack[top-2]])^(
            list[i]-list[stack[top-2]]))<=0)
47             top--;
48         stack[top++]=i;
49     }
50 }

```

5.2 All

```

1  #include <cstdio>
2  #include <cstdlib>
3  #include <cstring>
4  #include <cmath>
5  #include <algorithm>
6  #include <utility>
7  using std::max;
8  using std::min;
9  using std::sort;
10 using std::swap;
11 using std::pair;
12 using std::make_pair;
13 const double eps = 1e-8, inf = 1e20;
14 const double pi = 4.0 * atan(1.0);
15 #define Degree(_rad) (180.0 / pi * (_rad))
16
17 int fuhao(double x)
18 {
19     if (fabs(x)<eps) return 0;
20     if (x<0) return -1;
21     else return 1;
22 }
23
24 ////////////////////////////////////////////////// Point && Vector
25 //////////////////////////////////////////////////
26 struct Point{
27     double x, y;
28     Point (){}
29     Point (double _x,double _y):x(_x),y(_y){}
30     void init(double a, double b) { x = a; y = b; }
31
32     // basic calc
33     bool operator == (const Point &b) const
34     {
35         return !fuhao(x - b.x) && !fuhao(y - b.y);
36     }
37     Point operator + (const Point &b) const
38     {

```



```

38         return Point(x + b.x, y + b.y);
39     }
40     Point operator - (const Point &b) const
41     {
42         return Point(x - b.x, y - b.y);
43     }
44     Point operator * (const double &b) const
45     {
46         return Point(x * b, y * b);
47     }
48
49     Point Rotate(Point p, double alpha) //  $\alpha \in [0, +\infty)$  逆时针
50     {
51         double x0 = p.x, y0 = p.y;
52         double tx = x - x0, ty = y - y0;
53         double nx = tx * cos(alpha) - ty * sin(alpha);
54         double ny = tx * sin(alpha) + ty * cos(alpha);
55         nx += x0; ny += y0;
56         return Point(nx, ny);
57     }
58
59     // Vector
60     double operator *(const Point &b) const
61     { // Dot
62         return x * b.x + y * b.y;
63     }
64     double operator ^ (const Point &b) const
65     { // Cross
66         return x * b.y - y * b.x;
67     }
68     double Abs() { return sqrt(x * x + y * y); }
69 };
70 double Dist(const Point &a, const Point &b) { return (a - b).Abs(); }
71 typedef Point Vector;
72
73 double Angle(Vector a, Vector b)
74 {
75     return acos(a * b / a.Abs() / b.Abs());
76 }
77 Vector Get_H(Vector A)
78 { // 求与向量垂直的单位向量 使用前确保不为 0 向量
79     //  $A \neq \text{Vector}(0.0, 0.0)$ ;
80     double L = A.Abs();
81     return Vector(-A.y / L, A.x / L);
82 }
83
84 ////////////////////////////////////// E - N - D
85     //////////////////////////////////////
86
87 ////////////////////////////////////// Line
88     //////////////////////////////////////
89 struct Line{

```

```

89     Point s,e;
90     Line() {}
91     Line(Point ss, Point ee)
92     {
93         s = ss; e = ee;
94     }
95
96     // 两直线的关系：重合0， 平行1， 相交2 并返回交点
97     pair<int,Point> operator &(const Line &b) const
98     {
99         Point ans = s;
100        if(fuhao((s-e)^(b.s-b.e))==0)
101        {
102            if (fuhao((s-b.e)^(b.s-b.e))==0)
103                return make_pair(0,ans); //重合
104            else return make_pair(1,ans); //平行
105        }
106        double t = ((s-b.s)^(b.s-b.e)) / ((s-e)^(b.s-b.e));
107        ans.x += (e.x-s.x) * t;
108        ans.y += (e.y-s.y) * t;
109        return make_pair(2,ans); //相交
110    }
111 };
112 ////////////////////////////////////// E - N - D
113 //////////////////////////////////////
114 //判断线段相交
115 bool inter(Line l1,Line l2)
116 {
117     return
118     max(l1.s.x,l1.e.x) >= min(l2.s.x,l2.e.x) &&
119     max(l1.s.y,l1.e.y) >= min(l2.s.y,l2.e.y) &&
120     max(l2.s.x,l2.e.x) >= min(l1.s.x,l1.e.x) &&
121     max(l2.s.y,l2.e.y) >= min(l1.s.y,l1.e.y) &&
122     fuhao((l2.s-l1.e)^(l1.s-l1.e)) * fuhao((l2.e-l1.e)^(l1.s-l1.e)) <=0
123     &&
124     fuhao((l1.s-l2.e)^(l2.s-l2.e)) * fuhao((l1.e-l2.e)^(l2.s-l2.e)) <=0;
125 }
126 //判断直线与线段相交
127 bool Seg_inter_line(Line l1,Line l2)//l1为直线 l2为线段
128 {
129     return fuhao((l2.s-l1.e)^(l1.s-l1.e))*fuhao((l2.e-l1.e)^(l1.s-l1.e))
130     <=0;
131 }
132 //点到直线距离
133 //返回点到直线最近的点
134 Point PointToLine(Point P,Line L)
135 {
136     Point ans;
137     double t=((P-L.s)*(L.e-L.s))/((L.e-L.s)*(L.e-L.s));
138     ans.x=L.s.x+(L.e.x-L.s.x)*t;
139     ans.y=L.s.y+(L.e.y-L.s.y)*t;
140     return ans;

```

```

139 }
140 //点到线段距离
141 //返回点到线段最近的点
142 Point NearestPointToLineSeg(Point P,Line L)
143 {
144     Point ans;
145     double t = ((P-L.s)*(L.e-L.s)) / ((L.e-L.s)*(L.e-L.s));
146     if (t>=0&&t<=1)
147     {
148         ans.x = L.s.x + (L.e.x-L.s.x)*t;
149         ans.y = L.s.y + (L.e.y-L.s.y)*t;
150     }
151     else {
152         if (Dist(P,L.s)<Dist(P,L.e))
153             ans = L.s;
154         else ans = L.e;
155     }
156     return ans;
157 }
158 //多边形面积
159 double CalcArea(Point p[],int n)
160 {
161     double ans=0;
162     for (int i=0;i<n;++i)
163         ans+=(p[i]^p[(i+1)%n])/2;
164     return fabs(ans);
165 }
166 //判断点在线段上
167 bool OnSeg(Point P,Line L)
168 {
169     return
170         fuhao((L.s-P)^(L.e-P))==0 &&
171         fuhao((P.x-L.s.x)*(P.x-L.e.x))<=0 &&
172         fuhao((P.y-L.s.y)*(P.y-L.e.y))<=0;
173 }
174 //三点求圆心坐标
175 Point waixin(Point a,Point b,Point c)
176 {
177     double a1=b.x-a.x,b1=b.y-a.y,c1=(a1*a1+b1*b1)/2;
178     double a2=c.x-a.x,b2=c.y-a.y,c2=(a2*a2+b2*b2)/2;
179     double d=a1*b2-a2*b1;
180     return Point(a.x+(c1*b2-c2*b1)/d,a.y+(a1*c2-a2*c1)/d);
181 }
182
183
184 ///////////////////////////////////////////////////          Graham
185 ///////////////////////////////////////////////////
186 //求凸包 点list[0~n-1]
187 //凸包结果Stack[0~top-1]
188 const int Maxn = 100;////////////////////////////////////here!!
189 Point list[Maxn]; ///////////////////////////////////////////////////?!?!?!?! 补全Maxn
190 //!?!?!?!?!?!?!?!?!?!?!
191 int Stack[Maxn],top;

```

```

190 bool _cmp (Point p1,Point p2)
191 {
192     double tmp=(p1-list[0])^(p2-list[0]);
193     if (fuhao(tmp)>0) return true;
194     else if (fuhao(tmp)==0&&fuhao(Dist(p1,list[0])-Dist(p2,list[0]))
195             <=0)
196         return true;
197     else return false;
198 }
199 void Graham(int n)
200 {
201     Point p0;
202     int k=0;
203     p0=list[0];
204     for (int i=1;i<n;++i)
205     {
206         if ((p0.y>list[i].y)||((p0.y==list[i].y&&p0.x>list[i].x))
207         {
208             p0=list[i];
209             k=i;
210         }
211     }
212     swap(list[k],list[0]);
213     sort(list+1,list+n,_cmp);
214     if (n==1)
215     {
216         top=1;
217         Stack[0]=0;
218         return;
219     }
220     if (n==2)
221     {
222         top=2;
223         Stack[0]=0;
224         Stack[1]=1;
225         return;
226     }
227     Stack[0]=0;
228     Stack[1]=1;
229     top=2;
230     for (int i=2;i<n;++i)
231     {
232         while (top>1 && fuhao((list[Stack[top-1]]-list[Stack[top-2]])^(
233             list[i]-list[Stack[top-2]]))<=0)
234             top--;
235         Stack[top++]=i;
236     }
237 }
238 ////////////////////////////////////// E - N - D
239 //////////////////////////////////////

```

```

239 /////////////////////////////////////////////////// Area
    ///////////////////////////////////////////////////
240 double PolygonArea(Point *pp, int nn) // pp[0, n-1]
241 {
242     double ans_area = 0.0;
243     for(int i = 1; i < nn-1; i++)
244     {
245         ans_area += (pp[i] - pp[0]) ^ (pp[i+1] - pp[0]);
246     }
247     return fabs(ans_area / 2);
248 }
249 /////////////////////////////////////////////////// E - N - D
    ///////////////////////////////////////////////////
250
251 /////////////////////////////////////////////////// 点在多边形内
    ///////////////////////////////////////////////////
252 int isPointInPolygon(Point p, Point *poly, int nn)
253 {
254     int w = 0;
255     for(int i = 0; i < n; i++)
256     {
257         if(OnSeg(p, Line(poly[i], poly[(i+1)%n]))) return -1; // 边界上
258         int k = fuhao((poly[(i+1)%n] - poly[i]) ^ (p - poly[i]));
259         int d1 = fuhao(poly[i].y - p.y);
260         int d2 = fuhao(poly[(i+1)%n].y - p.y);
261         if(k > 0 && d1 <= 0 && d2 > 0) wn++;
262         if(k < 0 && d1 > 0 && d2 <= 0) wn--;
263     }
264     if(wn != 0) return 1; //内部
265     return 0; // 外部
266 }
267 /////////////////////////////////////////////////// E - N - D
    ///////////////////////////////////////////////////
268
269
270 int main()
271 {
272 }

```

6 String

6.1 Manacher

```

1 #include <stdio>
2 #include <algorithm>
3 // HDU 3068
4 const int N = 110000 + 10;
5
6 char t[N], s[2*N];
7 int n, p[2*N];
8

```

```

9 void pre(char *origin, char *str, int &_len)
10 {
11     _len = 0;
12     str[_len++] = '$';
13     for(int i = 0; origin[i]; i++)
14     {
15         str[_len++] = '#';
16         str[_len++] = origin[i];
17     }
18     str[_len++] = '#';
19     str[_len] = 0;
20     //puts(str);
21 }
22
23 void getPi(char *str, int _len, int *_P)
24 {
25     int mx = 0, id;
26     for(int i = 1; i < _len; i++)
27     {
28         if(mx > i) _P[i] = std::min(_P[2*id-i], mx-i);
29         else _P[i] = 1;
30         for(; str[i+_P[i]] == str[i-_P[i]]; _P[i]++);
31         if(_P[i] + i > mx)
32         {
33             mx = _P[i] + i;
34             id = i;
35         }
36     }
37 }
38
39 int main()
40 {
41     while(scanf("%s", t) == 1)
42     {
43         pre(t, s, n);
44         getPi(s, n, p);
45         int res = 1;
46         for(int i = 1; i < n; i++)
47             res = std::max(res, p[i]-1);
48         printf("%d\n", res);
49     }
50     return 0;
51 }

```

6.2 KMP

```

1 #include <cstdio>
2 #include <cstring>
3 // POJ 3461 : Count the number of t occurrences in s
4 char s[1000000+10], t[1000000+10];
5 int next[1000000+10];
6

```

```

7 void getNext(char *t, int len, int *Next)
8 {
9     memset(Next, 0, sizeof(Next)); Next[0] = -1;
10    for(int j = 0, k = -1; j < len; )
11    {
12        if(k == -1 || t[j] == t[k]) Next[++j] = ++k;
13        else k = Next[k];
14    }
15 }
16 int kmp(char *s, int lens, char *t, int lent)
17 {
18     int res = 0;
19     getNext(t, lent, next);
20     for(int i = 0, j = 0; i < lens; )
21     {
22         if(j == -1 || s[i] == t[j]) { i++; j++; }
23         else j = next[j];
24         if(j == lent) res++; // Bingo! [pos = j - lent]
25     }
26     return res;
27 }
28
29 int main()
30 {
31     int T; scanf("%d", &T);
32     while(T--)
33     {
34         scanf("%s%s", t, s);
35         printf("%d\n", kmp(s, strlen(s), t, strlen(t)));
36     }
37     return 0;
38 }

```

6.3 Suffix Array

```

1 #include <cstdio>
2 #include <algorithm>
3 #include <map>
4 using std::map;
5 // POJ 3261 找重复了K次的最长子串
6 const int N = 20000 + 10;
7 /*
8     sa[rank[i]] = i
9     sa[i] = j      : rank i is s[j, n)
10    rank[j] = i      : s[j, n) is rank i
11    height[i] = j    : the longest common prefix of string rank _i and
                       _i-1
12 */
13
14 int sa[N], rank[N];
15 int c[N], tmp[N];
16 int height[N];

```

```

17
18 bool cmp(int *r, int a, int b, int l)
19 {
20     return r[a] == r[b] && r[a+l] == r[b+l];
21 }
22
23 void DA(int *s, int n, int m) // s[0...n-1] E [1, m)
24 {
25     int i, j, p, *x = rank, *y = tmp;
26     for(i = 0; i < m; i++) c[i] = 0;
27     for(i = 0; i < n; i++) c[x[i] = s[i]]++;
28     for(i = 1; i < m; i++) c[i] += c[i-1];
29     for(i = n-1; i >= 0; i--) sa[--c[x[i]]] = i;
30     for(j = 1, p = 0; p < n; j *= 2, m = p)
31     {
32         for(p = 0, i = n-j; i < n; i++) y[p++] = i;
33         for(i = 0; i < n; i++) if(sa[i] >= j) y[p++] = sa[i] - j;
34         for(i = 0; i < m; i++) c[i] = 0;
35         for(i = 0; i < n; i++) c[x[y[i]]]++;
36         for(i = 1; i < m; i++) c[i] += c[i-1];
37         for(i = n-1; i >= 0; i--) sa[--c[x[y[i]]]] = y[i];
38         for(std::swap(x, y), p = 1, x[sa[0]] = 0, i = 1; i < n; i++)
39             x[sa[i]] = cmp(y, sa[i], sa[i-1], j) ? p - 1 : p++;
40     }
41     for(i = 0; i < n; i++) rank[sa[i]] = i;
42
43     int k = 0; height[0] = 0;
44     for(i = 0; i < n; height[rank[i++]] = k) if(rank[i])
45         for(k ? k-- : 0, j = sa[rank[i]-1]; s[j+k] == s[i+k]; k++);
46 }
47
48 int n, K, a[N];
49 map<int, int> hash;
50
51 bool check(int len)
52 {
53     int cnt = 0;
54     for(int i = 1; i < n; i++)
55     {
56         if(height[i] >= len) cnt++;
57         else cnt = 0;
58         if(cnt >= K - 1) return 1;
59     }
60     return 0;
61 }
62
63 int Solve()
64 {
65     int low = 0, high = n, ans = 0;
66     while(low <= high)
67     {
68         int mid = low + (high - low) / 2;
69         if(check(mid)) { low = mid + 1; ans = mid; }

```



```

70     else high = mid - 1;
71 }
72 return ans;
73 }
74
75 int main()
76 {
77     //-----Read-----
78     scanf("%d%d", &n, &K);
79     for(int i = 0; i < n; i++)
80     {
81         scanf("%d", &a[i]);
82         tmp[i] = a[i];
83     }
84     std::sort(tmp, tmp+n);
85     int cnt = 0;
86     for(int i = 0; i < n; i++)
87         if(i == 0 || tmp[i] != tmp[i-1]) hash[tmp[i]] = ++cnt;
88     for(int i = 0; i < n; i++) a[i] = hash[a[i]];
89     a[n++] = 0; ////////////
90     DA(a, n, cnt+1);
91     /* for(int i = 0; i < n; i++)
92     {
93         printf("rank = %d -> [%d, %d) [%d] :", i, sa[i], n, height[i]);
94         for(int j = sa[i]; j < n; j++) printf(" %d", a[j]);
95         puts("");
96     } */
97     printf("%d\n", Solve());
98     return 0;
99 }

```

6.4 Aho-Corasick Automaton

```

1  #include <cstdio>
2  #include <cstring>
3  #include <queue>
4  using std::queue;
5  // HDU 2222 查询 n 个模式串中有几个在原串 str 中出现了
6  struct ACG{
7      int count;
8      ACG *fail, *next[26];
9      ACG()
10     {
11         fail = 0;
12         count = 0;
13         for(int i = 0; i < 26; i++) next[i] = 0;
14     }
15 }*root;
16 queue<ACG*> Q;
17
18 void insert(char *str, ACG *p)
19 {

```

```

20     int len = strlen(str);
21     for(int i = 0; i < len; i++)
22     {
23         int x = str[i] - 'a';
24         if(!p -> next[x]) p -> next[x] = new ACG;
25         p = p -> next[x];
26     }
27     p -> count ++;
28 }
29
30 void build_acg()
31 {
32     while(!Q.empty()) Q.pop();
33     Q.push(root);
34     while(!Q.empty())
35     {
36         ACG *p = Q.front(); Q.pop();
37         for(int i = 0; i < 26; i++)
38         {
39             if(p -> next[i])
40             {
41                 if(p == root) p -> next[i] -> fail = root;
42                 else{
43                     ACG *temp = p -> fail;
44                     while(temp)
45                     {
46                         if(temp -> next[i])
47                         {
48                             p -> next[i] -> fail = temp -> next[i];
49                             break;
50                         }
51                         temp = temp -> fail;
52                     }
53                     if(!temp) p -> next[i] -> fail = root;
54                 }
55                 Q.push(p -> next[i]);
56             }
57         }
58     }
59 }
60
61 int query(char *str, ACG *p)
62 {
63     int len = strlen(str), res = 0;
64     for(int i = 0; i < len; i++)
65     {
66         int x = str[i] - 'a';
67         while(!p -> next[x] && p != root) p = p -> fail;
68         p = p -> next[x];
69         if(!p) p = root;
70         ACG *temp = p;
71         while(temp != root && temp -> count != -1)
72         {

```

```

73         res += temp -> count;
74         temp -> count = -1;
75         temp = temp -> fail;
76     }
77 }
78     return res;
79 }
80
81 int n;
82 char tmp[1000000+10];
83
84 int main()
85 {
86     int T; scanf("%d", &T);
87     while(T--)
88     {
89         root = new ACG;
90         scanf("%d", &n);
91         for(int i = 1; i <= n; i++)
92         {
93             scanf("%s", tmp);
94             insert(tmp, root);
95         }
96         build_acg();
97         scanf("%s", tmp);
98         printf("%d\n", query(tmp, root));
99     }
100     return 0;
101 }

```

7 Tools

7.1 BigInteger - C++

```

1 // 程序中全部为正整数之间的操作
2 #include <cstdio>
3 #include <cstring>
4 #include <algorithm>
5 using std::max;
6
7 const int base = 10000; // 压4位
8
9 struct BigInt{
10     int c[1000], len, sign;
11     BigInt() { memset(c, 0, sizeof(c)); len = 1; sign = 0; }
12     void Zero()
13     {
14         while(len > 1 && c[len] == 0) len--;
15         if(len == 1 && c[len] == 0) sign = 0;
16     }
17     void writein(char *s)

```

```

18     {
19         int k = 1, L = strlen(s);
20         for(int i = L-1; i >= 0; i--)
21         {
22             c[len] += (s[i]-'0') * k;
23             k *= 10;
24             if(k == base)
25             {
26                 k = 1;
27                 len++;
28             }
29         }
30     }
31 void Read()
32 {
33     char s[5000] = {0};
34     scanf("%s", s);
35     writein(s);
36 }
37 void Print()
38 {
39     if(sign) printf("-");
40     printf("%d", c[len]);
41     for(int i = len-1; i >= 1; i--) printf("%04d", c[i]);
42     printf("\n");
43 }
44 BigInt operator = (int a)
45 {
46     char s[100] = {0};
47     sprintf(s, "%d", a);
48     writein(s);
49     return *this;
50 }
51 bool operator > (const BigInt &b)
52 {
53     if(len != b.len) return len > b.len;
54     for(int i = len; i >= 1; i--)
55     {
56         if(c[i] != b.c[i]) return c[i] > b.c[i];
57     }
58     return 0;
59 }
60 bool operator < (const BigInt &b)
61 {
62     if(len != b.len) return len < b.len;
63     for(int i = len; i >= 1; i--)
64     {
65         if(c[i] != b.c[i]) return c[i] < b.c[i];
66     }
67     return 0;
68 }
69 bool operator == (const BigInt &b)
70 {

```

```

71         if(len != b.len) return 0;
72         for(int i = 1; i <= len; i++)
73             if(c[i] != b.c[i]) return 0;
74         return 1;
75     }
76     bool operator == (const int &a)
77     {
78         BigInt b; b = a;
79         return *this == b;
80     }
81     BigInt operator + (const BigInt &b)
82     {
83         BigInt r; r.len = max(len, b.len) + 1;
84         for(int i = 1; i <= r.len; i++)
85         {
86             r.c[i] += c[i] + b.c[i];
87             r.c[i+1] += r.c[i] / base;
88             r.c[i] %= base;
89         }
90         r.Zero();
91         return r;
92     }
93     BigInt operator + (const int &a)
94     {
95         BigInt b; b = a;
96         return *this + b;
97     }
98     BigInt operator - (const BigInt &b)
99     {
100         BigInt a, c; // a - c
101         a = *this; c = b;
102         if(a < c)
103         {
104             std::swap(a, c);
105             a.sign = 1;
106         }
107         for(int i = 1; i <= len; i++)
108         {
109             a.c[i] -= c.c[i];
110             if(a.c[i] < 0)
111             {
112                 a.c[i] += base;
113                 a.c[i+1]--;
114             }
115         }
116         a.Zero();
117         return a;
118     }
119     BigInt operator - (const int &a)
120     {
121         BigInt b; b = a;
122         return *this - b;
123     }

```

```

124     BigInt operator * (const BigInt &b)
125     {
126         BigInt r; r.len = len + b.len + 2;
127         for(int i = 1; i <= len; i++)
128         {
129             for(int j = 1; j <= b.len; j++)
130             {
131                 r.c[j+i-1] += c[i] * b.c[j];
132             }
133         }
134         for(int i = 1; i <= r.len; i++)
135         {
136             r.c[i+1] += r.c[i] / base;
137             r.c[i] %= base;
138         }
139         r.Zero();
140         return r;
141     }
142     BigInt operator * (const int &a)
143     {
144         BigInt b; b = a;
145         return *this * b;
146     }
147     BigInt operator / (BigInt b)//整除
148     {
149         BigInt t, r;
150         if(b == 0) return r;
151         r.len = len;
152         for(int i = len; i >= 1; i--)
153         {
154             t = t * base + c[i];
155             int div;
156             //-----try-----
157             int up = 10000, down = 0;
158             while(up >= down)
159             {
160                 int mid = (up + down) / 2;
161                 BigInt ccc ; ccc = b * mid;
162                 if(ccc > t) up = mid - 1;
163                 else {
164                     down = mid + 1;
165                     div = mid;
166                 }
167             }
168             //-----end-----
169             r.c[i] = div;
170             t = t - b * div;
171         }
172         //最后的t为余数，要用的自己想办法传出去
173         r.Zero();
174         return r;
175     }
176     BigInt operator / (const int &a)

```

```

177     {
178         BigInt b; b = a;
179         return *this / b;
180     }
181     BigInt operator % (const BigInt &b)
182     { // 其实可以复制上面除法的，这里换一种写法
183         return *this - *this / b * b;
184     }
185     BigInt operator % (const int &a)
186     {
187         BigInt b; b = a;
188         return *this % b;
189     }
190 };
191
192 int main()
193 {
194     return 0;
195 }

```

7.2 C++ 读入优化

```

1 inline int nextInt()
2 {
3     char ch = getchar(); int res = 0; bool sign = 0;
4     while(!isdigit(ch) && ch != '-') ch = getchar();
5     if(ch == '-') { sign = 1; ch = getchar(); }
6     do res = (res << 1) + (res << 3) + ch - '0';
7     while(isdigit(ch = getchar()));
8     return sign ? -res : res;
9 }

```

7.3 C char*

```

1 头文件 cstring
2 strlen(s); // 获取长度  $O(N)$ 
3 strcpy(a+2, b+1) // 从 b+1 开始全部赋值给 a+2 开始的字符串
4 strncpy(a+2, b+1, 2) // 从 b+1 开始赋值 2 个给 a+2 开始的字符串
5 strcmp(a, b) // 比较 a 和 b 的大小，相等返回 0，a > b 返回正整数
6 strcat(a, b) // 相当于 string 类的 a += b;
7 strstr(a, b) - a; // 返回 b 在 a 中第一次出现的位置，不存在返回 NULL (即 0)，由于 -a
    , 所以最后应该是 -a

```

7.4 C++ std::string

```

1 //====初始化====
2 头文件 string 并加上 std::
3 string s(str); // 相当于 string s=str;
4 string s(cstr); // 把 char 数组类型的字符串 cstr 作为 s 的初值
5 s.clear(); // 清空，相当于 s="";

```

```

6
7 //==== 长度 ====
8 s.length();//获取s的长度, O(1)
9 s.size();//一样
10
11 //==== 插入删除 ====
12 s.insert(2, "a"); //在s的位置2插入string类字符串"a"
13 s.erase(2, 3); //从s的位置2开始删除3个字符
14
15 //==== 查找 ====
16 s.find("abc");//查找字符串"abc"在s中第一次出现的位置 ( 据说是KMP实现的 )
17 //s="aabcc"; printf("%d %d\n", (int)s.find("abc"), (int)s.find("aabb"));
18 //上一行程序应输出 1 -1 ( 若没找到必须强行转换为int才为 -1 )

```

7.5 Java

7.5.1 The overall framework

```

1 import java.io.*;
2 import java.util.*;
3 import java.math.*;
4 public class Main{
5     public static void main(String args[])
6     {
7     }
8 }

```

7.5.2 Input and Output

```

1 Scanner cin = new Scanner(System.in);//一定记住最后 cin.close();
2 Scanner cin = new Scanner(new BufferedInputStream(System.in));
3
4 //一般直接用 System.out.println();
5 PrintWriter cout = new PrintWriter(System.out);//一定记住最后 cout.
    close();
6 PrintWriter cout = new PrintWriter(new BufferedOutputStream(System.out)
    );
7
8 int n = cin.nextInt();
9 String s = cin.next();
10 double m = cin.nextDouble();
11 String line = cin.nextLine(); // 读一整行
12 BigInteger c = cin.nextBigInteger();
13 while(cin.hasNext()) {};
14
15 //PrintWriter 用 cout.println(...);
16 System.out.println(n + "—>" + s "—>" + m);
17
18 //使用format控制格式, 与C/C++一样, double用%f,
19 System.out.format("%03d", c).println();
20 System.out.format("%.3f", c).println();

```



```

21
22 //变量声明
23 int a, b[] = new int[100];
24 double a, b[] = new double[100];
25 int a[][] = new int[100][100];
26 String ...
27 BigInteger/BigDecimal ...

```

7.5.3 BigInteger

```

1 BigInteger a = BigInteger.valueOf(100);
2 BigInteger b = BigInteger.valueOf(50);
3 BigInteger ONE = BigInteger.ONE;
4 BigInteger TWO = BigInteger.valueOf(2);
5 a = a.add(ONE).subtract(b);
6 a = a.multiply(TWO).divide(TWO);
7 a = a.mod(TWO);
8 a.compareTo(ONE); // 大于1, 小于-1, 等于0
9 //BigDecimal 为高精小数

```

7.5.4 String

```

1 String s = "abcdefg"; // 注意0下标!
2 char c = s.charAt(2); // 相当于 `char c = s[2]` (C++)(c = 'c')
3 char ch[];
4 ch = s.toCharArray(); // 字符串转换为字符数组
5 for(int i = 0; i < ch.length; i++) ch[i] += 2;
6 System.out.println(ch); // 输出cdefghi
7 String tmp1 = s.substring(1); // bcdefg
8 String tmp2 = s.substring(2, 4); // cd

```

7.5.5 Hexadecimal Conversion

```

1 import java.io.*;
2 import java.util.*;
3 import java.math.*;
4 // Binary, Octal, Decimal(Integer/BigInteger), Hexadecimal
5 public class Main{
6     public static void main(String args[])
7     {
8         //Decimal(123) to Others
9         String a1 = Integer.toBinaryString(123);
10        String a2 = Integer.toOctalString(123);
11        String a3 = Integer.toHexString(123);
12        //Others to Decimal(123)
13        int b1 = Integer.valueOf("1111011", 2);
14        int b2 = Integer.valueOf("173", 8);
15        int b3 = Integer.valueOf("7b", 16);
16        // Others to BigInteger(Decimal(123))
17        BigInteger c1 = new BigInteger("1111011", 2);

```

```

18         BigInteger c2 = new BigInteger("173", 8);
19         BigInteger c3 = new BigInteger("7B", 16);
20     }
21 }

```

7.5.6 function

```

1 Arrays.fill(a, x); // for(int i = 0; i < N; i++) a[i] = x;
2 Arrays.fill(a, l, r, x); // for(int i = l; i < r; i++) a[i] = x;
3 Arrays.sort(a); // 给a的所有元素排序 升序
4 Arrays.sort(a, l, r); // 给a的[l, r)元素排序 升序
5 Arrays.sort(a, l, r, new cmp());
6
7 import java.io.*;
8 import java.util.*;
9 import java.math.*;
10 class INT{
11     int s;
12     public INT(int x) { s = x; } // 构造函数 INT a = new INT(3);
13 }
14 class cmp implements Comparator<INT>{
15     public int compare(INT a, INT b)
16     {
17         return a.s - b.s;
18     }
19 }
20 public class Main{
21     public static void main(String args[])
22     {
23         Scanner cin = new Scanner(System.in);
24         int n;
25         INT a[] = new INT[100];
26         for(int i = 1; i <= 10; i++) a[i] = new INT(11 - i);
27         Arrays.sort(a, 1, 11, new cmp());
28     }
29 }
30 //a[i].s排序前 10 9 8 7 6 5 4 3 2 1
31 //a[i].s排序后 1 2 3 4 5 6 7 8 9 10
32
33 String s = Integer.toString(n, B); // 把十进制数n转换成B进制数
34 int b = Integer.parseInt(s, B); // 把B进制数s转换成10进制数

```

7.6 Batch test

7.6.1 @Linux

```

1 mkdata=mk
2 filea=a
3 fileb=b
4
5 g++ $mkdata.cpp -o $mkdata

```

```

6  g++ $filea.cpp -o $filea
7  g++ $fileb.cpp -o $fileb
8  cas=0
9  while true; do
10     ./$mkdata > $filea.in
11     ./$filea < $filea.in > $filea.out
12     ./$fileb < $filea.in > $fileb.out
13     if ! diff $filea.out $fileb.out
14     then
15         echo "␣Wrong␣Answer"
16         break
17     fi
18     echo $((cas=cas+1)) "␣Accepted"
19 done

```

7.6.2 @Windows

```

1  :loop
2      mk > A.in
3      A < A.in > A.out
4      p < A.in > p.out
5      fc A.out p.out
6      if errorlevel 1 goto end
7      goto loop
8  :end
9      pause

```

7.7 Vimrc Config For Linux

```

1  filetype on
2  filetype indent on
3  set nobackup
4  set nu
5  set st=4
6  set ts=4
7  set sw=4
8
9  map <F7> <Esc>:w<CR>:!javac %:r.java<CR>:!java %:r<CR>
10 imap <F7> <Esc>:w<CR>:!javac %:r.java<CR>:!java %:r<CR>
11 map <F8> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!gdb %:r<CR>
12 imap <F8> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!gdb %:r<CR>
13 map <F9> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!./%:r<CR>
14 imap <F9> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!./%:r<CR>
15 map <c-a> <Esc>gg"+yG
16 imap␣<c-a>␣<Esc>gg"+yG

```