ACM-ICPC Template

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Contents

1 Dynamic Programming

1.1 LCS - Longest Common Subsequence

```
int LCS() // O(N*N)
{//字符串纠正到以 1 为下标
    int f[N][N];
    int res = 0;
    for(int i = 1; i < lena; i++)
        for(int j = 1; j < lenb; j++)
        {
            if(a[i] == a[j]) f[i][j] = f[i-1][j-1] + 1;
            else f[i][j] = max(f[i-1][j], f[i][j-1]);
            res = max(res, f[i][j]);
        }
    return res;
}

int LCS() // O(NlogN)
{//把 LCM 转化为 LIS 来做
// 1 2 5 9 3 -->> 1 2 3 4 5
// 1 5 3 9 2 -->> 1 3 5 4 2 -->> 对这个序列跑LIS()
    //------change------
        //这里就要针对数据自己想尽办法转化了
        for(int i = 1; i <= n; i++) h[a[i]] = i;
        for(int i = 1; i <= n; i++) b[i] = h[b[i]];
    //------end------
    return LIS();
}
```

1.2 LIS - Longest Increasing Subsequence

```
int f[N];
int LIS()//O(N*N)
{
    for(int i = 1; i <= n; i++)
        for(int j = i-1; j >= 1; j--)
            if(a[i] > a[j]) f[i] = max(f[i], f[j] + 1);
    int res = 0;
    for(int i = 1; i <= n; i++) res = max(res, f[i]);
    return res;
}

int c[N], len = 0;
int LIS()//(NlogN)
{
    for(int i = 1; i <= n; i++)
    {
        //------find------
            int l = 1, r = len, mid;
            while(l <= r)
            {
```

```
                mid = (l + r) / 2;
                if(a[i] > c[mid]) l = mid + 1;
                else r = mid - 1;
            }
        //------end------
        c[l] = a[i];
        len = max(len, l);
    }
    return len;
}
```

1.3 Maximum Continuous Subsequence Sum

```
int MaxSubSum()
{
    int f[N], res;
    for(int i = 1; i <= n; i++)
    {
        f[i] = max(a[i], f[i-1] + a[i]);
        res = max(res, f[i]);
    }
    return res;
}

int MaxSubSum()
{
    int res = 0, now = 0;
    for(int i = 1; i <= n; i++)
    {
        now += a[i];
        res = max(res, now);
        if(now < 0) now = 0;
    }
    return res;
}
```

1.4 RMQ - st

```
int _rmq[N][30];
void init_RMQ(int *_orig) // [1, n]
{
    for(int i = 1; i <= n; i++) _rmq[i][0] = _orig[i];
    for(int j = 1; j <= log(1.0 * n) / log(2.0); j++)
        for(int i = 1; i <= n + 1 - (1 << j); i++)
            _rmq[i][j] = std::max(_rmq[i][j-1], _rmq[i+(1<<(j-1))][j
               -1]);
}
int query_RMQ(int l, int r) // max{x E [l, r]}
{
    int k = log(r - l + 1.0) / log(2.0);
    return std::max(_rmq[l][k], _rmq[r-(1<<k)+1][k]);
```

```
}
```

1.5 数位 dp

```
#include <cstdio>
#include <cstring>
#include <algorithm>
// calculate the number of numbers in [l, r] which not contain '4' or '62'
long long l, r;
int k;
int L[100], R[100];
long long f[100][2][2][10];

int predo(long long a, int *num)
{
    int len = 0;
    do num[++len] = a % 10; while(a /= 10);
    return len;
}

long long calc(int pos, bool d, bool u, int pre)
{
    if(pos == 0) return 1;
    long long &res = f[pos][d][u][pre];
    if(res != -1) return res;
    res = 0;
    int st = d ? L[pos] : 0;
    int ed = u ? R[pos] : 9;
    for(int i = st; i <= ed; i++)
    {
        if(i == 4 || (pre == 6 && i == 2)) continue;
        res += calc(pos-1, d && i == L[pos], u && i == R[pos], i);
    }
    return res;
}

int main()
{
    while(scanf("%lld%lld", &l, &r) == 2 && (l || r))
    {
        memset(f, -1, sizeof(f));
        memset(L, 0, sizeof(L));
        memset(R, 0, sizeof(R));
        int len = std::max(predo(l, L), predo(r, R));
        printf("%lld\n", calc(len, 1, 1, 0));
    }
    return 0;
}
```

1.6 状压 dp

1.6.1 枚举子集

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

2 Math

2.1 GCD && LCM

2.1.1 GCD - Greatest Common Divisor

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

2.1.2 LCM - Least Common Multiple

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

2.1.3 E_GCD - Extended Greatest Common Divisor

```
ax + by = 1
bx1 + (a%b)y1 = 1    ==>   bx + (a-a/b*b)y = 1
  ==> ay1 + b(x1-a/b*y1) = 1
对应  ax  + by          = 1

int egcd(int a, int b, int &x, int &y)
{
    if(b == 0)
    {
        x = 1; y = 0;
        return a;
    }
    int x1, y1;
    int e = egcd(b, a%b, x1, y1);
    x = y1;
    y = x1 - a / b * y1;
    return e;
}
```

2.2 Prime

2.2.1 Make Prime List

```
namespace prime{
    const int N = 10000000 + 10;
    int pri[N], h[N], Cnt;
    void make(int maxp) // O(2*N)
    {
        for(int i = 2; i <= maxp; i++)
```

```
        {
            if(!h[i]) pri[Cnt++] = i;
            for(int j = 0; j < Cnt && pri[j] <= maxp / i; j++)
            {
                h[i * pri[j]] = true;
                if(i % pri[j] == 0) break;
            }
        }
    }
}
```

2.2.2 Prime Factor

```
void factor()
{
    make_prime_list();
    for(int j = 0; j < Cnt && pri[j]*pri[j] <= n; j++)
    {
        if(n % pri[j] == 0)
        {
            printf("%d␣", pri[j]);
            while(n % pri[j] == 0) n /= pri[j];
        }
    }
    if(n!=1) printf("%d",n);
}
```

2.3 Fast Power

```
//x^y  % mod
int mul(int x, LL y, int mod) // 递归
{
    if(y == 1) return x;
    if(y & 1) return (mul((x * (LL)x) % mod, y / 2, mod) * (LL)x)%mod;
    else return mul((x * (LL)x) % mod, y / 2, mod) % mod;
}
int mul(int x, int y, int mod) // 非递归
{
    int s = 1;
    int ss = x;
    while(y)
    {
        if(y & 1) s = s * ss;
        y /= 2;
        ss *= ss;
    }
    return s;
}
```

2.4 约瑟夫环、丢手绢问题

```cpp
#include <cstdio>
//UVALive 4727
int n, m;

int Joseph(int totalPeople, int nextNumber, int startIndex, int lastIdx)
{ // All based on 0_Index , the Answer is the last `lastIdx` to leave
    int now = (nextNumber - 1) % lastIdx + (startIndex - nextNumber);
    for(int i = lastIdx + 1; i <= totalPeople; i++)
        now = (now + nextNumber) % i;
    return now;
}

int main()
{
    int T; scanf("%d", &T);
    while(T--)
    {
        scanf("%d%d", &n, &m);
        printf("%d␣%d␣%d\n", Joseph(n, m, m, 3)+1, Joseph(n, m, m, 2)+1, Joseph(n, m, m, 1)+1);
    }
    return 0;
}
```

2.5 康拓展开 Cantor

```cpp
#include <cstdio>
#include <cstring>

int fac[10], a[10];

bool Read(int *p)
{
    for(int i = 0; i < 9; i++)
    {
        char chtmp;
        if(scanf("␣%c", &chtmp) != 1) return 0;
        p[i] = chtmp == 'x' ? 0 : chtmp - '0';
    }
    return 1;
}

int Cantor(int *p) // Eight puzzle status -> Integer
{
    int res = 0;
    for(int i = 0; i < 9; i++)
    {
        int cnt = 0;
        for(int j = i + 1; j < 9; j++)
```

```
            if(p[j] < p[i]) cnt++;
        res += cnt * fac[9 - i - 1];
    }
    return res;
}

bool used[10] = {0};
int getRank(int r)
{
    for(int i = 0, j = 0; i < 9; i++)
    {
        if(!used[i] && j == r) return i;
        if(!used[i]) j++;
    }
}
void getStatus(int cantor, int *p) // Integer -> Eight puzzle status
{
    memset(used, 0, sizeof(used));
    for(int i = 0; i < 9; i++)
    {
        p[i] = getRank(cantor / fac[9 - i - 1]);
        used[p[i]] = 1;
        cantor %= fac[9 - i - 1];
    }
}

void PRINT(int *p)
{
    int hash = Cantor(p);
    printf("Cantor value = %d\n", hash);
    getStatus(hash, p);
    printf("Cantor Status = ");
    for(int i = 0; i < 9; i++) printf("%d", p[i]); puts("");
}

int main()
{
    fac[0] = 1; for(int i = 1; i < 10; i++) fac[i] = fac[i-1] * i;
    while(Read(a)) PRINT(a);
    return 0;
}
```

3 Datastructure

3.1 带权并查集

```
#include <cstdio>
#include <cstdlib>

const int N = 100000 + 10;

```

```
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 != 'O')
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
```

```
{
    if(!x || !y) return x|y;
    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
    R[x]=merge(R[x],y);//始终往右子树合并
    f[R[x]] = x;//更新并查集
    if(D[R[x]] > D[L[x]]) swap(L[x],R[x]);//保持左偏树性质
    D[x] = D[R[x]] + 1;
    若还有其他维护信息也需要更新;
    return x;//返回根
}

int del(int x)
{
    int t = merge(L[x],R[x]);
    f[L[x]] = L[x]; f[R[x]] = R[x];//更新并查集
    L[x] = R[x] = D[x] = 0;
    return t;
}
```

3.4 Partition Tree

```
struct Parti{int val, left;} val[30][N];
void build_tree(int d, int l, int r)
{
    if(l == r) return;
    int m = (l + r) >> 1, same = m - l + 1;
    int lcnt = l, rcnt = m + 1;
    for(int i = l; i <= r; i++)
        if(val[d][i].val < sorted[m]) same--;
    for(int i = l; i <= r; i++)
    {
        int flag = 0;
        if((val[d][i].val < soted[m]) || (val[d][i].val == sorted[m] && same))
        {
            flag = 1;
            val[d + 1][lcnt++] = val[d][i];
            if(val[d][i].val == sorted[m]) same--;
        }
        else val[d][rcnt++] = val[d][i];
        val[d][i].left = val[d][i - 1].left + flag;
    }
    build_tree(d + 1, l, m);
    build_tree(d + 1, m + 1, r);
}
int query(int d, int l, int r, int x, int y, int k)
{
    if(l == r) return val[d][l].val;
    int m = (l + r) >> 1;
    int lx = val[d][x - 1].left - val[d][l - 1].left; //[l,x-1] to left
    int ly = val[d][y].left - val[d][x - 1].left; //[x,y] to left
```

```
30      int rx = (x - 1 - l + 1) - lx; //[l,x-1] to right
31      int ry = (y - x + 1) - ly; //[x,y] to right
32      if(ly >= k) return query(d+1, l, m, l-1+lx+1, l-1+lx+ly, k);
33      else return query(d+1, m+1, r, m+1-1+rx+1, m+1-1+rx+ry, k-ly);
34  }
```

3.5 Treap

3.5.1 @ Array

```
1   struct treap {
2       const int N = 100000 + 10;
3       int L[N*20], R[N*20], S[N*20], fix[N*20], A[N*20];
4       int root, total;
5       void rotate_left(int &p)
6       {
7           int tmp = R[p];
8           R[p] = L[tmp];
9           int zsize = S[L[tmp]];
10          S[p] = S[p] - S[tmp] + zsize;
11          L[tmp] = p;
12          S[tmp] = S[tmp] - zsize + S[p];
13          p = tmp;
14      }
15      void rotate_right(int &p)
16      {
17          int tmp = L[p];
18          L[p] = R[tmp];
19          int zsize = S[R[tmp]];
20          S[p] = S[p] - S[tmp] + zsize;
21          R[tmp] = p;
22          S[tmp] = S[tmp] - zsize + S[p];
23          p = tmp;
24      }
25      void Insert(int &p, int x)
26      {
27          if(!p)
28          {
29              p = ++total;
30              L[p] = R[p] = 0;
31              S[p] = 1;
32              fix[p] = rand();
33              A[p] = x;
34              return;
35          }
36          S[p]++;
37          if(x < A[p])
38          {
39              Insert(L[p], x);
40              if(fix[L[p]] > fix[p]) rotate_right(p);
41          }
42          else {
```

```
            Insert(R[p], x);
            if(fix[R[p]] > fix[p]) rotate_left(p);
        }
    }
    int Delete_min(int &p)
    {
        S[p]--;
        if(!L[p])
        {
            int value = A[p];
            p = R[p];
            return value;
        }
        else return Delete_min(L[p]);
    }
    void Delete(int &p, int x)
    {
        if(!p) return;
        S[p]--;
        if(x < A[p]) Delete(L[p], x);
        else if(x > A[p]) Delete(R[p], x);
        else {
            if(!L[p] && !R[p]) p = 0;
            else if(!L[p] || !R[p])
            {
                if(!L[p]) p = R[p];
                else p = L[p];
            }
            else A[p] = Delete_min(R[p]);
        }
    }
    int Count_leq(int &p, int x)
    {
        if(!p) return 0;
        if(A[p] <= x) return S[L[p]] + 1 + Count_leq(R[p], x);
        else return Count_leq(L[p], x);
    }
    int Count_geq(int &p, int x)
    {
        if(!p) return 0;
        if(A[p] >= x) return S[R[p]] + 1 + Count_geq(L[p], x);
        else return Count_geq(R[p], x);
    }
    int Find_kth(int &p, int k)
    {
        if(k == S[L[p]] + 1) return A[p];
        if(k <= S[L[p]]) return Find_kth(L[p], k);
        else return Find_kth(R[p], k - S[L[p]] - 1);
    }
};
```

3.5.2 @ Pointer

```
struct treap {
    struct Treap{
        int fix, key, size;
        Treap *left, *right;
        Treap() { fix = key = size = left = right = 0; }
    }*root, *null;

    void init()
    {
        null = new Treap;
        root = null;
    }
    void rotate_left(Treap *&p)
    {
        Treap *tmp = p -> right;
        p -> right = tmp -> left;
        int zsize = tmp -> left -> size;
        p -> size = p -> size - tmp -> size + zsize;
        tmp -> left = p;
        tmp -> size = tmp -> size - zsize + p -> size;
        p = tmp;
    }
    void rotate_right(Treap *&p)
    {
        Treap *tmp = p -> left;
        p -> left = tmp -> right;
        int zsize = tmp -> right -> size;
        p -> size = p -> size - tmp -> size + zsize;
        tmp -> right = p;
        tmp -> size = tmp -> size - zsize + p -> size;
        p = tmp;
    }

    void Insert(Treap *&p, int x)
    {
        if(p == null)
        {
            p = new Treap;
            p -> fix = rand();
            p -> key = x;
            p -> size = 1;
            p -> left = null;
            p -> right = null;
            return;
        }
        if(x < p -> key)
        {
            Insert(p -> left, x);
            p -> size++;
            if(p -> left -> fix > p -> fix) rotate_right(p);
        }
```

```
52          else {
53              Insert(p -> right, x);
54              p -> size++;
55              if(p -> right -> fix > p -> fix) rotate_left(p);
56          }
57      }
58      int Delete_min(Treap *&p)
59      {
60          p -> size--;
61          if(p -> left == null)
62          {
63              int value = p -> key;
64              p = p -> right;
65              return value;
66          }
67          else return Delete_min(p -> left);
68      }
69      void Delete(Treap *&p, int x) // Make sure that `x` is existed
70      {
71          if(p == null) return;
72          p -> size--;
73          if(x < p -> key) Delete(p -> left, x);
74          else if(x > p -> key) Delete(p -> right, x);
75          else { // delete *p
76              if(p -> left == null && p -> right == null)
77              {
78                  p = null;
79              }
80              else if(p -> left == null || p -> right == null)
81              {
82                  if(p -> left == null)
83                  {
84                      p = p -> right;
85                  }
86                  else { // p -> right == null
87                      p = p -> left;
88                  }
89              }
90              else { // p -> left != null && p -> right != null
91                  p -> key = Delete_min(p -> right);
92              }
93          }
94      }
95      int Count_leq(Treap *&p, int x)
96      {
97          if(p == null) return 0;
98          if(p -> key <= x) return p -> left -> size + 1 + Count_leq(p ->
                right, x);
99          else return Count_leq(p -> left, x);
100     }
101     int Count_geq(Treap *&p, int x)
102     {
103         if(p == null) return 0;
```

```
104         if(p -> key >= x) return p -> right -> size + 1 + Count_geq(p
                -> left, x);
105         else return Count_geq(p -> right, x);
106     }
107     int Find_kth(Treap *&p, int x)
108     {
109         if(k == p -> left -> size + 1) return p -> key;
110         if(k <= p -> left -> size) return Find_kth(p -> left, k);
111         else return Find_kth(p -> right, k - p -> left -> size - 1);
112     }
113 };
```

3.6 Size Balanced Tree

```
 1 struct SBT {
 2     const int N = 100000 + 10;
 3     int A[N*20], S[N*20], L[N*20], R[N*20];
 4     int root, total;
 5     void rotate_left(int &x)
 6     {
 7         int y = R[x];
 8         R[x] = L[y];
 9         L[y] = x;
10         S[y] = S[x];
11         S[x] = S[L[x]] + S[R[x]] + 1;
12         x = y;
13     }
14     void rotate_right(int &x)
15     {
16         int y = L[x];
17         L[x] = R[y];
18         R[y] = x;
19         S[y] = S[x];
20         S[x] = S[L[x]] + S[R[x]] + 1;
21         x = y;
22     }
23     void maintain(int &p, bool flag)
24     {
25         if(flag)
26         {
27             if(S[R[R[p]]] > S[L[p]]) rotate_left(p);
28             else if(S[R[L[p]]] > S[L[p]])
29             {
30                 rotate_right(R[p]);
31                 rotate_left(p);
32             }
33             else return;
34         }
35         else
36         {
37             if(S[L[L[p]]] > S[R[p]]) rotate_right(p);
38             else if(S[L[R[p]]] > S[R[p]])
```

```
            {
                rotate_left(L[p]);
                rotate_right(p);
            }
            else return;
        }
        maintain(L[p], 0);
        maintain(R[p], 1);
        maintain(p, 0);
        maintain(p, 1);
    }
    void Insert(int &p, int x)
    {
        if(!p)
        {
            p = ++total;
            L[p] = R[p] = 0;
            A[p] = x; S[p] = 1;
            return;
        }
        S[p]++;
        if(x < A[p]) Insert(L[p], x);
        else Insert(R[p], x);
        maintain(p, x >= A[p]);
    }
    int Delete_min(int &p)
    {
        S[p]--;
        if(!L[p])
        {
            int value = A[p];
            p = R[p];
            return value;
        }
        else return Delete_min(L[p]);
    }
    void Delete(int &p, int x)
    {
        if(!p) return;
        S[p]--;
        if(x < A[p]) Delete(L[p], x);
        else if(x > A[p]) Delete(R[p], x);
        else {
            if(!L[p] && !R[p]) p = 0;
            else if(!L[p] || !R[p])
            {
                if(!L[p]) p = R[p];
                else p = L[p];
            }
            else A[p] = Delete_min(R[p]);
        }
    }
    int Count_leq(int &p, int x)
```

```
92      {
93          if(!p) return 0;
94          if(A[p] <= x) return S[L[p]] + 1 + Count_leq(R[p], x);
95          else return Count_leq(L[p], x);
96      }
97      int Count_geq(int &p, int x)
98      {
99          if(!p) return 0;
100         if(A[p] >= x) return S[R[p]] + 1 + Count_geq(L[p], x);
101         else return Count_geq(R[p], x);
102     }
103     int Find_kth(int &p, int k)
104     {
105         if(k == S[L[p]] + 1) return A[p];
106         if(k <= S[L[p]]) return Find_kth(L[p], k);
107         else return Find_kth(R[p], k - S[L[p]] - 1);
108     }
109 };
```

3.7 树链剖分 Heavy-Light Decomposition

```
1  // Solution: www.guessbug.com/problem/HDU/3966
2  #pragma comment(linker, "/STACK:1024000000,1024000000")
3  #include <cstdio>
4  #include <cstring>
5  #include <vector>
6  using std::vector;
7  // HDU 3966 : Increase or decrease a value on path [x - y] on a tree.
8  //            Query a value of a certain point
9  const int N = 50000 + 10;
10
11 int n, m, q, a[N];
12 vector<int> path[N];
13
14 // Heavy-Light Decomposition
15 int size[N], father[N], deep[N], heavy_son[N];
16 int top[N], segid[N], time_stamp;
17 void dfs1(int x, int fa, int deepth)
18 {
19     size[x] = 1; father[x] = fa; deep[x] = deepth;
20     for(vector<int>::iterator it = path[x].begin(); it != path[x].end()
       ; it++)
21     {
22         if(*it == father[x]) continue;
23         dfs1(*it, x, deepth + 1);
24         size[x] += size[*it];
25         if(size[*it] > size[heavy_son[x]]) heavy_son[x] = *it;
26     }
27 }
28 void dfs2(int x, int topx)
29 {
30     top[x] = topx;
```

```
31      segid[x] = ++time_stamp;
32      if(heavy_son[x]) dfs2(heavy_son[x], topx); // not leaf
33      for(vector<int>::iterator it = path[x].begin(); it != path[x].end()
           ; it++)
34          if(*it != father[x] && *it != heavy_son[x])
35              dfs2(*it, *it);
36  }
37  // Heavy-Light Decomposition ----- END
38
39  int add[N*4];
40  void pushDown(int p)
41  {
42      add[p*2] += add[p];
43      add[p*2+1] += add[p];
44      add[p] = 0;
45  }
46  void modify(int p, int l, int r, int a, int b, int c)
47  {
48      if(a <= l && b >= r)
49      {
50          add[p] += c;
51          return;
52      }
53      int mid = l + (r - l) / 2;
54      pushDown(p);
55      if(a <= mid) modify(p*2, l, mid, a, b, c);
56      if(b > mid) modify(p*2+1, mid+1, r, a, b, c);
57  }
58  int query(int p, int l, int r, int a)
59  {
60      if(l == r && l == a) return add[p];
61      int mid = l + (r - l) / 2;
62      pushDown(p);
63      if(a <= mid) return query(p*2, l, mid, a);
64      else return query(p*2+1, mid+1, r, a);
65  }
66
67  void change(int a, int b, int c)
68  {
69      while(top[a] != top[b])
70      {
71          if(deep[top[a]] < deep[top[b]]) std::swap(a, b);
72          modify(1, 1, n, segid[top[a]], segid[a], c);
73          a = father[top[a]];
74      }
75      if(deep[a] > deep[b]) std::swap(a, b);
76      modify(1, 1, n, segid[a], segid[b], c);
77  }
78
79  int main()
80  {
81      while(scanf("%d%d%d", &n, &m, &q) == 3)
82      {
```

```
        time_stamp = 0;
        for(int i = 1; i <= n; i++)
        {
            size[i] = father[i] = heavy_son[i] = 0;
            deep[i] = top[i] = segid[i] = 0;
            path[i].clear();
        }
        for(int i = 1; i <= n; i++) scanf("%d", &a[i]);
        for(int i = 1; i <= m; i++)
        {
            int x, y; scanf("%d%d", &x, &y);
            path[x].push_back(y);
            path[y].push_back(x);
        }
        dfs1(1, 0, 1);
        dfs2(1, 1);
        memset(add, 0, sizeof(add));
        for(int i = 1; i <= n; i++) change(i, i, a[i]);
        while(q--)
        {
            char op; scanf("␣%c", &op);
            if(op == 'I' || op == 'D')
            {
                int a, b, c; scanf("%d%d%d", &a, &b, &c);
                if(op == 'I') change(a, b, c);
                else change(a, b, -c);
            }
            else {
                int x; scanf("%d", &x);
                printf("%d\n", query(1, 1, n, segid[x]));
            }
        }
    }
    return 0;
}
```

3.8 三维偏序 - CDQ 分治

```
#include <cstdio>
#include <cstring>
#include <algorithm>
#define lowbit(_X) ((_X)&(-(_X)))
// SPOJ LIS2
const int N = 100000 + 10;

int n, f[N], idx[N], hash[N];
struct Node{
    int x, y, z;
    void Read(int i)
    {
        scanf("%d%d", &y, &z);
        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)
```

```
            {
                dist[p->y] = dist[x] + p->z;
                Q.push(make_pair(-dist[p->y], p->y));
            }
    }
}
```

4.1.2 Spfa

```
void spfa()
{
    memset(inQ, 0, sizeof(inQ));
    memset(dist, 0x3f, sizeof(dist));
    dist[S] = 0; Q.push(S); inQ[S] = 1; //S为源点
    while(!Q.empty())
    {
        int x = Q.front(); Q.pop(); inQ[x] = 0;
        for(Link p = head[x]; p; p = p->next)
            if(dist[p->y] > dist[x] + p->z)
            {
                dist[p->y] = dist[x] + p->z;
                if(!inQ[p->y])
                {
                    Q.push(p->y);
                    inQ[p->y] = 1;
                }
            }
    }
}
```

4.1.3 Floyd

```
void floyd()
{
    for(int k = 1; k <= n; k++) // 这里可以看作是一个加边的过程
        for(int i = 1; i <= n; i++)
            for(int j = 1; j <= n; j++)
                map[i][j] = min(map[i][j], map[i][k] + map[k][j]);
}

// 最小环
void MinCircle()
{
    cap[] = map[];
    int circle = 0x3f3f3f3f;
    for(int k = 1; k <= n; k++)
    {
        for(int i = 1; i < k; i++)
            for(int j = i+1; j < k; j++)
                circle = min(circle, map[i][j] + cap[j][k]+cap[k][i]);
        for(int i = 1; i <= n; i++)
```

```
            for(int j = 1; j <= n; j++)
                map[i][j] = min(map[i][j], map[i][k] + map[k][j]);
    }
    return circle == 0x3f3f3f3f ? -1 : circle;
}

// floyd判圈法 （大白书 p44）
void Circle()
{
    int ans = k;
    int k1 = k, k2 = k;
    do{
        k1 = next(k1);
        k2 = next(k2); ans = max(ans, k2);
        k2 = next(k2); ans = max(ans, k2);
    }while(k1 != k2);
    return ans;
}
```

4.2 Minimum Spanning Tree

4.2.1 Prim

```
int prim()
{
    memset(dist, 0x3f, sizeof(dist));
    dist[1] = 0; Q.push(make_pair(0, 1));
    int res = 0;
    while(!Q.empty())
    {
        int x = Q.top().second; Q.pop();
        if(done[x]) continue;
        res += dist[x]; done[x] = 1;
        for(Link p = head[x]; p; p = p->next)
            if(dist[p->y] > p->z)
            {
                dist[p->y] = p->z;
                Q.push(make_pair(-dist[p->y], p->y));
            }
    }
    return res;
}
```

4.2.2 Kruskal

```
int kruskal()
{
    sort(edge, edge+Cnt, cmp);
    int res = 0;
    for(int i = 0; i < Cnt; i++)
    {
```

```
        if(getroot(edge[i].x) == getroot(edge[i].y)) continue;
        f[getroot(edge[i].x)] = getroot(edge[i].y);
        res += edge[i].z;
    }
    return res;
}
```

4.3 Tarjan - Strong Union

```
void dfs(int x)
{
    now[x] = low[x] = ++dfstime;
    hash[x] = 1;
    st.push(x); inst[x] = 1;
    for(int i = 1; i <= n; i++)
        if(map[x][i])
        {
            if(!hash[i])
            {
                dfs(i);
                low[x] = min(low[x], low[i]);
            }
            else if(inst[i]) low[x] = min(low[x], now[i]);
        }
    if(low[x] == now[x])
    {
        while(!st.empty())
        {
            int u = st.top();
            st.pop(); inst[u] = 0;
            belong[u] = number;
            if(u == x) break;
        }
        numer++;
    }
}
void tarjan()
{
    for(int i = 1; i <= n; i++)
        if(!hash[i]) dfs(i);
    if(!st.empty()) // 这是一个未知bug   栈中还会剩下一个强连通分量
    {
        while!st.empty())
        {
            int u = st.top();
            st.pop();
            belong[u] = number;
        }
        number++;
    }
}
```

4.4 LCA

4.4.1 @ Tarjan

```
// poj 1330 (changed something)
// LCA tarjan
#include <cstdio>
#include <cstring>

const int N = 10000 + 10;

int n;
struct Link{int y, idx; Link *next;}*head[N], *ask[N];
int tx, ty;
bool in[N], vis[N];
int f[N];
int ans[N]; // Query Answer

void inLink(int x, int y)
{
    Link *p = new Link;
    p -> y = y;
    p -> next = head[x];
    head[x] = p;
}
void inAsk(int x, int y, int idx)
{
    Link *p = new Link;
    p -> y = y;
    p -> idx = idx;
    p -> next = ask[x];
    ask[x] = p;
}

int getroot(int x)
{
    return f[x] == x ? x : f[x] = getroot(f[x]);
}

void LCA(int x)
{
    vis[x] = 1;
    f[x] = x;
    for(Link *p = ask[x]; p; p = p -> next)
        if(vis[p->y]) ans[p->idx] = getroot(p->y);
    for(Link *p = head[x]; p; p = p -> next)
        if(!vis[p->y])
        {
            LCA(p->y);
            f[p->y] = x;
        }
}

```

```
int main()
{
    int T; scanf("%d", &T);
    while(T--)
    {
        memset(head, 0, sizeof(head));
        memset(ask, 0, sizeof(ask));
        memset(in, 0, sizeof(in));
        memset(vis, 0, sizeof(vis));
        scanf("%d", &n);
        for(int i = 1; i <= n; i++) f[i] = i;
        for(int i = 1; i < n; i++)
        {
            int x, y;
            scanf("%d%d", &x, &y);
            inLink(x, y);
            in[y] = 1;
        }
        int q = 1;// the number of query
        for(int i = 1; i <= q; i++)
        {
            int x, y; scanf("%d%d", &x, &y);
            inAsk(x, y, i); inAsk(y, x, i);
        }
        int root = -1;
        for(int i = 1; i <= n; i++)
            if(!in[i]) {root = i; break;}
        LCA(root);
        for(int i = 1; i <= q; i++)
            printf("%d\n", ans[i]);
    }
    return 0;
}
```

4.4.2 @ Doubling Algorithm

```
#include <cstdio>
#include <cstring>
#include <algorithm>
// POJ 1330   LCA_Doubling Algorithm
const int N = 10000 + 10;

const int UPDeepth = 14;
int n;
struct Link{
    int y;
    Link *next;
}*head[N];
bool in[N];
int ancient[N][UPDeepth+1];
int deep[N];

```

```
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 deepth, int father)
26 {
27     deep[x] = deepth;
28     ancient[x][0] = father;
29     for(Link *p = head[x]; p; p = p -> next)
30         dfs(p -> y, deepth + 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 <= UPDeepth; 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 = UPDeepth; 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 = UPDeepth; 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);
```

```
            inLink(x, y); in[y] = 1;
        }
        getLCA();
        int x, y; scanf("%d%d", &x, &y);
        printf("%d\n", LCA(x, y));
    }
    return 0;
}
```

4.5 Bipartite Graph

4.5.1 Maximal Matching - The Hungarian algorithm

```
int timeStamp = 0;
int n, m, g[N][N];
int vis[N], pre[N];

bool search(int x)
{
    for(int i = 1; i <= m; i++)
        if(g[x][i] && vis[i] != timeStamp)
        {
            vis[i] = timeStamp;
            if(pre[i] == -1 || search(pre[i]))
            {
                pre[i] = x;
                return 1;
            }
        }
    return 0;
}

int maxMatch()
{
    int res = 0;
    memset(pre, -1, sizeof(pre));
    for(int i = 1; i <= n; i++)
    {
        ++timeStamp;
        res += search(i);
    }
    return res;
}
```

4.5.2 Optimal Matching - KM

不会... 用费用流解决

4.6 Network Flow

4.6.1 Maximum Flow - isap

```cpp
#include <cstdio>
#include <algorithm>

const int N = 200 + 10;

int n, m, g[N][N];
int v[N], h[N];
int S, T;

int sap(int x, int flow)
{
    if(x == T) return flow;
    int res = 0;
    for(int i = S; i <= T; i++)
        if(g[x][i] && h[x] == h[i] + 1)
        {
            int t = sap(i, std::min(g[x][i], flow - res));
            res += t; g[x][i] -= t; g[i][x] += t;
            if(res == flow) return res;
            if(h[S] >= T) return res;
        }
    //if(h[S] >= T) return res;
    if((--v[h[x]]) == 0) h[S] = T;
    ++v[++h[x]];
    return res;
}

int main()
{
    scanf("%d%d", &m, &n); // m = number of edges, n = number of points
    for(int i = 1; i <= m; i++)
    {
        int x, y, z;
        scanf("%d%d%d", &x, &y, &z);
        g[x][y] += z;
    }
    v[0] = T; S = 1; T = n; // all idx started from `1`
    int maxflow = 0;
    while(h[S] < T) maxflow += sap(1, 0x3f3f3f3f);
    printf("%d\n", maxflow);
    return 0;
}
```

4.6.2 Minimum Cost Maximum Flow - spfa

```cpp
struct EG{int from,to,flow,cost,next;}edge[M];

void add_edge(int a,int b,int c,int d)
{
    edge[L]=(EG){a,b,c,+d,head[a]};
    head[a]=L++;
    edge[L]=(EG){b,a,0,-d,head[b]};
```

```
    head[b]=L++;
}

bool spfa()
{
    memset(inQ, 0, sizeof(inQ));
    memset(dist, 0x3f, sizeof(dist));
    dist[S] = 0;
    q.push(S);
    while(!q.empty())
    {
        int x = q.front();
        q.pop();
        inQ[x] = 0;
        for(int i = head[x]; i != -1; i = edge[i].next)
            if(edge[i].flow && dist[edge[i].to] > dist[x] + edge[i].
               cost)
            {
                pre[edge[i].to] = i;
                dist[edge[i].to] = dist[x] + edge[i].cost;
                if(!inQ[edge[i].to])
                {
                    inQ[edge[i].to] = 1;
                    q.push(edge[i].to);
                }
            }
    }
    return dist[T] != inf;
}
void MFMC()
{
    memset(head, -1, sizeof(head));
    建图调用 add_edge();

    int mincost = 0, maxflow = 0;
    while(spfa())
    {
        int res = inf;
        for(int i = T; i != S; i = edge[pre[i]].from)
        {
            res = min(res, edge[pre[i]].flow);
        }
        for(int i = T; i != S; i = edge[pre[i]].from)
        {
            edge[pre[i]].flow -= res;
            edge[pre[i] ^ 1].flow += res;
        }
        maxflow += res;
        mincost += res * dist[T];
    }
}
```

5 Geometry

5.1 Convex Hull

```
1  //◆◆□°◆ μ◆list[0~n-1]
2  //□°◆½◆◆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]))
           <=0)
10         return true;
11     else    return false;
12 }
13 void Graham(int n)
14 {
15     Point p0;
16     int k=0;
17     p0=list[0];
18     for (int i=1;i<n;++i)
19     {
20         if ((p0.y>list[i].y)||(p0.y==list[i].y&&p0.x>list[i].x))
21         {
22             p0=list[i];
23             k=i;
24         }
25     }
26     swap(list[k],list[0]);
27     sort(list+1,list+n,_cmp);
28     if (n==1)
29     {
30         top=1;
31         stack[0]=0;
32         return;
33     }
34     if (n==2)
35     {
36         top=2;
37         stack[0]=0;
38         stack[1]=1;
39         return;
40     }
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  struct Point{
26      double x, y;
27      Point (){}
28      Point (double _x,double _y):x(_x),y(_y){}
29      void init(double a, double b) { x = a; y = b; }
30
31      // basic calc
32          bool operator == (const Point &b) const
33          {
34              return !fuhao(x - b.x) && !fuhao(y - b.y);
35          }
36          Point operator + (const Point &b) const
37          {
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 E [0, +oo) 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 != 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  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     fuhao((l1.s-l2.e)^(l2.s-l2.e)) * fuhao((l1.e-l2.e)^(l2.s-l2.e))<=0;
124 }
125 //判断直线与线段相交
126 bool Seg_inter_line(Line l1,Line l2)//l1为直线 l2为线段
127 {
128     return fuhao((l2.s-l1.e)^(l1.s-l1.e))*fuhao((l2.e-l1.e)^(l1.s-l1.e)
          )<=0;
129 }
130 //点到直线距离
131 //返回点到直线最近的点
132 Point PointToLine(Point P,Line L)
133 {
134     Point ans;
135     double t=((P-L.s)*(L.e-L.s))/((L.e-L.s)*(L.e-L.s));
136     ans.x=L.s.x+(L.e.x-L.s.x)*t;
137     ans.y=L.s.y+(L.e.y-L.s.y)*t;
138     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 //求凸包 点list[0~n-1]
186 //凸包结果Stack[0~top-1]
187 const int Maxn = 100;////////////////here!!
188 Point list[Maxn]; //////////?!?!?!?!补全Maxn
    !?!?!?!?!?!?!?!?!?!?!
189 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]))
        <=0)
195         return true;
196     else    return false;
```

```
}
void Graham(int n)
{
    Point p0;
    int k=0;
    p0=list[0];
    for (int i=1;i<n;++i)
    {
        if ((p0.y>list[i].y)||(p0.y==list[i].y&&p0.x>list[i].x))
        {
            p0=list[i];
            k=i;
        }
    }
    swap(list[k],list[0]);
    sort(list+1,list+n,_cmp);
    if (n==1)
    {
        top=1;
        Stack[0]=0;
        return;
    }
    if (n==2)
    {
        top=2;
        Stack[0]=0;
        Stack[1]=1;
        return;
    }
    Stack[0]=0;
    Stack[1]=1;
    top=2;
    for (int i=2;i<n;++i)
    {
        while (top>1 && fuhao((list[Stack[top-1]]-list[Stack[top-2]])^(
           list[i]-list[Stack[top-2]]))<=0)
            top--;
        Stack[top++]=i;
    }
}
//////////////////////////      E - N - D
   //////////////////////////


//////////////////////////          Area
   //////////////////////////
double PolygonArea(Point *pp, int nn) // pp[0, n-1]
{
    double ans_area = 0.0;
    for(int i = 1; i < nn-1; i++)
    {
        ans_area += (pp[i] - pp[0]) ^ (pp[i+1] - pp[0]);
    }
```

```
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 HASH

P = 102929; mod1 = 1000000000 + 7; mod2 = 1000000000 + 9;

6.2 Minimum Representation - 最小表示法

```
1  namespace MinimumRepresentation{
2      int get(int *s, int l)
3      {
4          int i = 0, j = 1, k = 0, t;
5          while(i < l && j < l && k < l) {
6              t = s[(i + k) >= l ? i + k - l : i + k] - s[(j + k) >= l ?
                   j + k - l : j + k];
7              if(!t) k++;
8              else{
9                  if(t > 0) i = i + k + 1;
10                 else j = j + k + 1;
11                 if(i == j) ++ j;
12                 k = 0;
```

```
            }
        }
        return (i < j ? i : j);
    }
}
```

6.3 Manacher

```
#include <cstdio>
#include <algorithm>
// HDU 3068
const int N = 110000 + 10;

char t[N], s[2*N];
int n, p[2*N];

void pre(char *origin, char *str, int &_len)
{
    _len = 0;
    str[_len++] = '$';
    for(int i = 0; origin[i]; i++)
    {
        str[_len++] = '#';
        str[_len++] = origin[i];
    }
    str[_len++] = '#';
    str[_len] = 0;
    //puts(str);
}

void getPi(char *str, int _len, int *_P)
{
    int mx = 0, id;
    for(int i = 1; i < _len; i++)
    {
        if(mx > i) _P[i] = std::min(_P[2*id-i], mx-i);
        else _P[i] = 1;
        for(; str[i+_P[i]] == str[i-_P[i]]; _P[i]++) ;
        if(_P[i] + i > mx)
        {
            mx = _P[i] + i;
            id = i;
        }
    }
}

int main()
{
    while(scanf("%s", t) == 1)
    {
        pre(t, s, n);
        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  }
```

6.4 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  }
```

6.5 Suffix Array

```cpp
#include <cstdio>
#include <algorithm>
#include <map>
using std::map;
// POJ 3261 找重复了K次的最长子串
const int N = 20000 + 10;
/*
    sa[rank[i]] = i
    sa[i] = j       : rank i is s[j, n)
    rank[j] = i     : s[j, n) is rank i
    height[i] = j   : the longest common prefix of string rank _i and
       _i-1
*/

int sa[N], rank[N];
int c[N], tmp[N];
int height[N];

bool cmp(int *r, int a, int b, int l)
{
    return r[a] == r[b] && r[a+l] == r[b+l];
}

void DA(int *s, int n, int m) // s[0...n-1] E [1, m)
{
    int i, j, p, *x = rank, *y = tmp;
    for(i = 0; i < m; i++) c[i] = 0;
    for(i = 0; i < n; i++) c[x[i] = s[i]]++;
    for(i = 1; i < m; i++) c[i] += c[i-1];
    for(i = n-1; i >= 0; i--) sa[--c[x[i]]] = i;
    for(j = 1, p = 0; p < n; j *= 2, m = p)
    {
        for(p = 0, i = n-j; i < n; i++) y[p++] = i;
        for(i = 0; i < n; i++) if(sa[i] >= j) y[p++] = sa[i] - j;
        for(i = 0; i < m; i++) c[i] = 0;
        for(i = 0; i < n; i++) c[x[y[i]]]++;
        for(i = 1; i < m; i++) c[i] += c[i-1];
        for(i = n-1; i >= 0; i--) sa[--c[x[y[i]]]] = y[i];
        for(std::swap(x, y), p = 1, x[sa[0]] = 0, i = 1; i < n; i++)
            x[sa[i]] = cmp(y, sa[i], sa[i-1], j) ? p - 1 : p++;
    }
    for(i = 0; i < n; i++) rank[sa[i]] = i;

    int k = 0; height[0] = 0;
    for(i = 0; i < n; height[rank[i++]] = k) if(rank[i])
        for(k ? k-- : 0, j = sa[rank[i]-1]; s[j+k] == s[i+k]; k++);
}

int n, K, a[N];
map<int, int> hash;

bool check(int len)
{
```

```
    int cnt = 0;
    for(int i = 1; i < n; i++)
    {
        if(height[i] >= len) cnt++;
        else cnt = 0;
        if(cnt >= K - 1) return 1;
    }
    return 0;
}

int Solve()
{
    int low = 0, high = n, ans = 0;
    while(low <= high)
    {
        int mid = low + (high - low) / 2;
        if(check(mid)) { low = mid + 1; ans = mid; }
        else high = mid - 1;
    }
    return ans;
}

int main()
{
    //------Read-------
    scanf("%d%d", &n, &K);
    for(int i = 0; i < n; i++)
    {
        scanf("%d", &a[i]);
        tmp[i] = a[i];
    }
    std::sort(tmp, tmp+n);
    int cnt = 0;
    for(int i = 0; i < n; i++)
        if(i == 0 || tmp[i] != tmp[i-1]) hash[tmp[i]] = ++cnt;
    for(int i = 0; i < n; i++) a[i] = hash[a[i]];
    a[n++] = 0; ////////////
    DA(a, n, cnt+1);
/*  for(int i = 0; i < n; i++)
    {
        printf("rank = %d -> [%d, %d) [%d] :", i, sa[i], n, height[i]);
        for(int j = sa[i]; j < n; j++) printf(" %d", a[j]);
        puts("");
    }   */
    printf("%d\n", Solve());
    return 0;
}
```

6.6 Aho-Corasick Automaton

```
#include <cstdio>
#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]);
```

```
            }
        }
    }
}

int query(char *str, ACG *p)
{
    int len = strlen(str), res = 0;
    for(int i = 0; i < len; i++)
    {
        int x = str[i] - 'a';
        while(!p -> next[x] && p != root) p = p -> fail;
        p = p -> next[x];
        if(!p) p = root;
        ACG *temp = p;
        while(temp != root && temp -> count != -1)
        {
            res += temp -> count;
            temp -> count = -1;
            temp = temp -> fail;
        }
    }
    return res;
}

int n;
char tmp[1000000+10];

int main()
{
    int T; scanf("%d", &T);
    while(T--)
    {
        root = new ACG;
        scanf("%d", &n);
        for(int i = 1; i <= n; i++)
        {
            scanf("%s", tmp);
            insert(tmp, root);
        }
        build_acg();
        scanf("%s", tmp);
        printf("%d\n", query(tmp, root));
    }
    return 0;
}
```

7 Tools

7.1 BigInteger - C++

```
//程序中全部为正整数之间的操作
#include <cstdio>
#include <cstring>
#include <algorithm>
using std::max;

const int base = 10000; // 压4位

struct BigInt{
    int c[1000], len, sign;
    BigInt() { memset(c, 0, sizeof(c)); len = 1; sign = 0; }
    void Zero()
    {
        while(len > 1 && c[len] == 0) len--;
        if(len == 1 && c[len] == 0) sign = 0;
    }
    void writein(char *s)
    {
        int k = 1, L = strlen(s);
        for(int i = L-1; i >= 0; i--)
        {
            c[len] += (s[i]-'0') * k;
            k *= 10;
            if(k == base)
            {
                k = 1;
                len++;
            }
        }
    }
    void Read()
    {
        char s[5000] = {0};
        scanf("%s", s);
        writein(s);
    }
    void Print()
    {
        if(sign) printf("-");
        printf("%d", c[len]);
        for(int i = len-1; i >= 1; i--) printf("%04d", c[i]);
        printf("\n");
    }
    BigInt operator = (int a)
    {
        char s[100] = {0};
        sprintf(s, "%d", a);
        writein(s);
        return *this;
    }
    bool operator > (const BigInt &b)
    {
        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                 {
```

```
                    int mid = (up + down) / 2;
                    BigInt ccc ; ccc = b * mid;
                    if(ccc > t) up = mid - 1;
                    else {
                        down = mid + 1;
                        div = mid;
                    }
                }
            //------end------
            r.c[i] = div;
            t = t - b * div;
        }
        //最后的t为余数，要用的自己想办法传出去
        r.Zero();
        return r;
    }
    BigInt operator / (const int &a)
    {
        BigInt b; b = a;
        return *this / b;
    }
    BigInt operator % (const BigInt &b)
    {//其实可以复制上面除法的，这里换一种写法
        return *this - *this / b * b;
    }
    BigInt operator % (const int &a)
    {
        BigInt b; b = a;
        return *this % b;
    }
};

int main()
{
    return 0;
}
```

7.2 C++ 读入优化

```
inline int nextInt()
{
    char ch = getchar(); int res = 0; bool sign = 0;
    while(!isdigit(ch) && ch != '-') ch = getchar();
    if(ch == '-') { sign = 1; ch = getchar(); }
    do res = (res << 1) + (res << 3) + ch - '0';
    while(isdigit(ch = getchar()));
    return sign ? -res : res;
}
```

7.3 C char*

```
头文件cstring
strlen(s);//获取长度  O(N)
strcpy(a+2,b+1)//从b+1开始全部赋值给a+2开始的字符串
strncpy(a+2,b+1,2)//从b+1开始赋值2个给a+2开始的字符串
strcmp(a,b)//比较a和b的大小，相等返回0，a>b返回正整数
strcat(a,b)//相当于string类的 a += b;
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

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

//====长度====
s.length();//获取s的长度，O(1)
s.size();//一样

//====插入删除====
s.insert(2, "a"); //在s的位置2插入string类字符串"a"
s.erase(2, 3); //从s的位置2开始删除3个字符

//====查找====
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）
//s="aabcc"; printf("%d %d\n",(int)s.find("abc"),(int)s.find("aabb"));
//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

```
import java.io.*;
import java.util.*;
import java.math.*;
public class Main{
    public static void main(String args[])
    {
    }
}
```

7.5.2 Input and Output

```
Scanner cin = new Scanner(System.in);
Scanner cin = new Scanner(new BufferedInputStream(System.in));
Scanner cin = new Scanner(new File("data.in"));

PrintWriter cout = new PrintWriter(System.out);
```

```
6  PrintWriter cout = new PrintWriter(new BufferedOutputStream(System.out)
       );
7  PrintWriter cout = new PrintWriter(new File("data.out"));
8
9  int n = cin.nextInt();
10 String s = cin.next();
11 double m = cin.nextDouble();
12 String line = cin.nextLine(); // 读一整行
13 BigInteger c = cin.nextBigInteger();
14 while(cin.hasNext()) {};
15
16 //PrintWriter 用 cout.println(...);
17 System.out.println(n + "-->" + s "-->" + m);
18
19 //使用format控制格式,与C/C++一样,double用%f,
20 System.out.format("%03d", c).println();
21 System.out.format("%.3f", c).println();
22
23 //变量声明
24 int a, b[] = new int[100];
25 double a, b[] = new double[100];
26 int a[][] = new int[100][100];
27 String ...
28 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

```java
import java.io.*;
import java.util.*;
import java.math.*;
// Binary, Octal, Decimal(Integer/BigInteger), Hexadecimal
public class Main{
    public static void main(String args[])
    {
        //Decimal(123) to Others
        String a1 = Integer.toBinaryString(123);
        String a2 = Integer.toOctalString(123);
        String a3 = Integer.toHexString(123);
        //Others to Decimal(123)
        int b1 = Integer.valueOf("1111011", 2);
        int b2 = Integer.valueOf("173", 8);
        int b3 = Integer.valueOf("7b", 16);
        // Others to BigInteger(Decimal(123))
        BigInteger c1 = new BigInteger("1111011", 2);
        BigInteger c2 = new BigInteger("173", 8);
        BigInteger c3 = new BigInteger("7B", 16);
    }
}
```

7.5.6 function

```java
Arrays.fill(a, x); // for(int i = 0; i < N; i++) a[i] = x;
Arrays.fill(a, l, r, x); // for(int i = l; i < r; i++) a[i] = x;
Arrays.sort(a); // 给a的所有元素排序 升序
Arrays.sort(a, l, r); // 给a的[l, r)元素排序 升序
Arrays.sort(a, l, r, new cmp());

import java.io.*;
import java.util.*;
import java.math.*;
class INT{
    int s;
    public INT(int x) { s = x; }// 构造函数 INT a = new INT(3);
}
class cmp implements Comparator<INT>{
    public int compare(INT a, INT b)
    {
        return a.s - b.s;
    }
}
public class Main{
    public static void main(String args[])
    {
        Scanner cin = new Scanner(System.in);
        int n;
        INT a[] = new INT[100];
        for(int i = 1; i <= 10; i++) a[i] = new INT(11 - i);
        Arrays.sort(a, 1, 11, new cmp());
    }
```

```
}
//a[i].s排序前 10 9 8 7 6 5 4 3 2 1
//a[i].s排序后 1 2 3 4 5 6 7 8 9 10

String s = Integer.toString(n, B); // 把十进制数n转换成B进制数
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

```
mkdata=mk
filea=a
fileb=b

g++ $mkdata.cpp -o $mkdata
g++ $filea.cpp -o $filea
g++ $fileb.cpp -o $fileb
cas=0
while true; do
    ./$mkdata > $filea.in
    ./$filea < $filea.in > $filea.out
    ./$fileb < $filea.in > $fileb.out
    if ! diff $filea.out $fileb.out
    then
        echo "␣Wrong␣Answer"
        break
    fi
    echo $((cas=cas+1)) "␣Accepted"
done
```

7.6.2 @Windows

```
:loop
    mk > A.in
    A < A.in > A.out
    p < A.in > p.out
    fc A.out p.out
    if errorlevel 1 goto end
    goto loop
:end
    pause
```

7.7 Vimrc Config For Linux

```
filetype on
filetype indent on
set nobackup
set nu
set st=4
```

```
set ts=4
set sw=4

map <F7> <Esc>:w<CR>:!javac %:r.java<CR>:!java %:r<CR>
imap <F7> <Esc>:w<CR>:!javac %:r.java<CR>:!java %:r<CR>
map <F8> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!gdb %:r<CR>
imap <F8> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!gdb %:r<CR>
map <F9> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!./%:r<CR>
imap <F9> <Esc>:w<CR>:!g++ -g %:r.cpp -o %:r<CR>:!./%:r<CR>
map <c-a> <Esc>gg"+yG
imap␣<c-a>␣<Esc>gg"+yG
```