

ACM-ICPC Template



GuessEver

Last Modify at October 17, 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	8
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	树链剖分 Heavy-Light Decomposition	19
3.8	三维偏序 - CDQ 分治	21
4	Graph	23
4.1	Shortest path	23
4.1.1	Dijkstra	23
4.1.2	Spfa	24
4.1.3	Floyd	24
4.2	Minimum Spanning Tree	25
4.2.1	Prim	25
4.2.2	Kruskal	25
4.3	Tarjan - Strong Union	26
4.4	LCA	27
4.4.1	@ Tarjan	27
4.4.2	@ Doubling Algorithm	28
4.5	Bipartite Graph	30
4.5.1	Maximal Matching - The Hungarian algorithm	30
4.5.2	Optimal Matching - KM	30
4.6	Network Flow	30
4.6.1	Maximum Flow - isap	30
4.6.2	Minimum Cost Maximum Flow - spfa	31

5	Geometry	33
5.1	Convex Hull	33
5.2	All	34
6	String	39
6.1	HASH	39
6.2	Minimum Representation - 最小表示法	39
6.3	Manacher	40
6.4	KMP	41
6.5	Suffix Array	41
6.6	Aho-Corasick Automaton	43
7	Tools	45
7.1	BigInteger - C++	45
7.2	C++ 读入优化	49
7.3	C char*	49
7.4	C++ std::string	50
7.5	Java	50
7.5.1	The overall framework	50
7.5.2	Input and Output	50
7.5.3	BigInteger	51
7.5.4	String	51
7.5.5	Hexadecimal Conversion	51
7.5.6	function	52
7.6	Batch test	53
7.6.1	@Linux	53
7.6.2	@Windows	53
7.7	Vimrc Config For Linux	53
8	WHAT THE FUCK!!!	54
8.1	不用递归的 DFS - dfsWithoutDfs.cpp	54
8.2	时间结构体	54

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() //  $O(N\log N)$ 
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() //  $(N\log N)$ 
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], Log[你想开多大就开多大];
2 for(int i = 2; i < 随便; i++) Log2[i] = Log2[i>>1] + 1;
3 void init_RMQ(int *_orig) // [1, n]
4 {
5     for(int i = 1; i <= n; i++) _rmq[i][0] = _orig[i];
6     for(int j = 1; j <= Log2[n]; j++)
7         for(int i = 1; i <= n + 1 - (1 << j); i++)
8             _rmq[i][j] = std::max(_rmq[i][j-1], _rmq[i+(1<<(j-1))][j-1]);
9 }
10 int query_RMQ(int l, int r) // max{x E [l, r]}
11 {
12     int k = Log2[r - l + 1];

```

```

13     return std::max(_rmq[l][k], _rmq[r-(1<<k)+1][k]);
14 }

```

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 | namespace prime{
2 |     const int N = 100000000 + 10;
3 |     int pri[N], h[N], Cnt;
4 |     void make(int maxp) // O(2*N)
5 |     {
6 |         for(int i = 2; i <= maxp; i++)
```

```

7      {
8          if(!h[i]) pri[Cnt++] = i;
9          for(int j = 0; j < Cnt && pri[j] <= maxp / i; j++)
10         {
11             h[i * pri[j]] = true;
12             if(i % pri[j] == 0) break;
13         }
14     }
15 }
16 }

```

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
14 int main()
15 {
16   int T; scanf("%d", &T);
17   while(T--)
18   {
19     scanf("%d%d", &n, &m);
20     printf("%d□%d□%d\n", Joseph(n, m, m, 3)+1, Joseph(n, m, m, 2)
21       +1, Joseph(n, m, m, 1)+1);
22   }
23   return 0;
24 }

```

2.5 康拓展开 Cantor

```

1 #include <stdio>
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 <cstdio>
2 #include <cstdlib>
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] &&
            same))
13        {
14            flag = 1;
15            val[d + 1][lcnt++] = val[d][i];
16            if(val[d][i].val == sorted[m]) same--;
17        }
18        else val[d][rcnt++] = val[d][i];
19        val[d][i].left = val[d][i - 1].left + flag;
20    }
21    build_tree(d + 1, l, m);
22    build_tree(d + 1, m + 1, r);
23 }
24 int query(int d, int l, int r, int x, int y, int k)
25 {
26     if(l == r) return val[d][l].val;
27     int m = (l + r) >> 1;
28     int lx = val[d][x - 1].left - val[d][l - 1].left; //[l,x-1] to left
29     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 {

```

```

43         Insert(R[p], x);
44         if(fix[R[p]] > fix[p]) rotate_left(p);
45     }
46 }
47 int Delete_min(int &p)
48 {
49     S[p]--;
50     if(!L[p])
51     {
52         int value = A[p];
53         p = R[p];
54         return value;
55     }
56     else return Delete_min(L[p]);
57 }
58 void Delete(int &p, int x)
59 {
60     if(!p) return;
61     S[p]--;
62     if(x < A[p]) Delete(L[p], x);
63     else if(x > A[p]) Delete(R[p], x);
64     else {
65         if(!L[p] && !R[p]) p = 0;
66         else if(!L[p] || !R[p])
67         {
68             if(!L[p]) p = R[p];
69             else p = L[p];
70         }
71         else A[p] = Delete_min(R[p]);
72     }
73 }
74 int Count_leq(int &p, int x)
75 {
76     if(!p) return 0;
77     if(A[p] <= x) return S[L[p]] + 1 + Count_leq(R[p], x);
78     else return Count_leq(L[p], x);
79 }
80 int Count_geq(int &p, int x)
81 {
82     if(!p) return 0;
83     if(A[p] >= x) return S[R[p]] + 1 + Count_geq(L[p], x);
84     else return Count_geq(R[p], x);
85 }
86 int Find_kth(int &p, int k)
87 {
88     if(k == S[L[p]] + 1) return A[p];
89     if(k <= S[L[p]]) return Find_kth(L[p], k);
90     else return Find_kth(R[p], k - S[L[p]] - 1);
91 }
92 };

```

3.5.2 @ Pointer

```

1 struct treap {
2     struct Treap{
3         int fix, key, size;
4         Treap *left, *right;
5         Treap() { fix = key = size = left = right = 0; }
6     }*root, *null;
7
8     void init()
9     {
10         null = new Treap;
11         root = null;
12     }
13     void rotate_left(Treap *&p)
14     {
15         Treap *tmp = p -> right;
16         p -> right = tmp -> left;
17         int zsize = tmp -> left -> size;
18         p -> size = p -> size - tmp -> size + zsize;
19         tmp -> left = p;
20         tmp -> size = tmp -> size - zsize + p -> size;
21         p = tmp;
22     }
23     void rotate_right(Treap *&p)
24     {
25         Treap *tmp = p -> left;
26         p -> left = tmp -> right;
27         int zsize = tmp -> right -> size;
28         p -> size = p -> size - tmp -> size + zsize;
29         tmp -> right = p;
30         tmp -> size = tmp -> size - zsize + p -> size;
31         p = tmp;
32     }
33
34     void Insert(Treap *&p, int x)
35     {
36         if(p == null)
37         {
38             p = new Treap;
39             p -> fix = rand();
40             p -> key = x;
41             p -> size = 1;
42             p -> left = null;
43             p -> right = null;
44             return;
45         }
46         if(x < p -> key)
47         {
48             Insert(p -> left, x);
49             p -> size++;
50             if(p -> left -> fix > p -> fix) rotate_right(p);
51         }

```



```

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 ->
99         right, x);
100     else return Count_leq(p -> left, x);
101 }
102 int Count_geq(Treap *&p, int x)
103 {
104     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]])

```

```

39         {
40             rotate_left(L[p]);
41             rotate_right(p);
42         }
43         else return;
44     }
45     maintain(L[p], 0);
46     maintain(R[p], 1);
47     maintain(p, 0);
48     maintain(p, 1);
49 }
50 void Insert(int &p, int x)
51 {
52     if(!p)
53     {
54         p = ++total;
55         L[p] = R[p] = 0;
56         A[p] = x; S[p] = 1;
57         return;
58     }
59     S[p]++;
60     if(x < A[p]) Insert(L[p], x);
61     else Insert(R[p], x);
62     maintain(p, x >= A[p]);
63 }
64 int Delete_min(int &p)
65 {
66     S[p]--;
67     if(!L[p])
68     {
69         int value = A[p];
70         p = R[p];
71         return value;
72     }
73     else return Delete_min(L[p]);
74 }
75 void Delete(int &p, int x)
76 {
77     if(!p) return;
78     S[p]--;
79     if(x < A[p]) Delete(L[p], x);
80     else if(x > A[p]) Delete(R[p], x);
81     else {
82         if(!L[p] && !R[p]) p = 0;
83         else if(!L[p] || !R[p])
84         {
85             if(!L[p]) p = R[p];
86             else p = L[p];
87         }
88         else A[p] = Delete_min(R[p]);
89     }
90 }
91 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 depth)
18 {
19     size[x] = 1; father[x] = fa; deep[x] = depth;
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, depth + 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     {

```

```

83     time_stamp = 0;
84     for(int i = 1; i <= n; i++)
85     {
86         size[i] = father[i] = heavy_son[i] = 0;
87         deep[i] = top[i] = segid[i] = 0;
88         path[i].clear();
89     }
90     for(int i = 1; i <= n; i++) scanf("%d", &a[i]);
91     for(int i = 1; i <= m; i++)
92     {
93         int x, y; scanf("%d%d", &x, &y);
94         path[x].push_back(y);
95         path[y].push_back(x);
96     }
97     dfs1(1, 0, 1);
98     dfs2(1, 1);
99     memset(add, 0, sizeof(add));
100    for(int i = 1; i <= n; i++) change(i, i, a[i]);
101    while(q--)
102    {
103        char op; scanf("%c", &op);
104        if(op == 'I' || op == 'D')
105        {
106            int a, b, c; scanf("%d%d%d", &a, &b, &c);
107            if(op == 'I') change(a, b, c);
108            else change(a, b, -c);
109        }
110        else {
111            int x; scanf("%d", &x);
112            printf("%d\n", query(1, 1, n, segid[x]));
113        }
114    }
115 }
116 return 0;
117 }

```

3.8 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(idcx+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(idcx+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 <stdio>
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][UPDepth+1];
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 <stdio>
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 == T) 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; // all idx started from `1`
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μlist[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     }
42     stack[0]=0;
43     stack[1]=1;
44     top=2;
45     for (int i=2;i<n;++i)
46     {
47         while (top>1 && fuhao((list[stack[top-1]]-list[stack[top-2]])^(
            list[i]-list[stack[top-2]]))<=0)
            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     {
39         return Point(x + b.x, y + b.y);
40     }
41     Point operator - (const Point &b) const
42     {
43         return Point(x - b.x, y - b.y);
44     }
45     Point operator * (const double &b) const
46     {

```

```

46         return Point(x * b, y * b);
47     }
48
49     Point Rotate(Point p, double alpha) // alpha ∈ [0, +∞) 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     //////////////////////////////////////
89 struct Line{
90     Point s,e;
91     Line() {}
92     Line(Point ss, Point ee)
93     {
94         s = ss; e = ee;
95     }
96
97     // 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
115bool 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
127bool 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
134Point 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;
141}
142//点到线段距离
143//返回点到线段最近的点
144Point NearestPointToLineSeg(Point P,Line L)
145{
146    Point ans;
147    double t = ((P-L.s)*(L.e-L.s)) / ((L.e-L.s)*(L.e-L.s));
148    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;
192 bool _cmp (Point p1,Point p2)
193 {
194     double tmp=(p1-list[0])^(p2-list[0]);
195     if (fuhao(tmp)>0) return true;
196     else if (fuhao(tmp)==0&&fuhao(Dist(p1,list[0])-Dist(p2,list[0]))
197         <=0)
198         return true;
199     else return false;

```

```

197 }
198 void Graham(int n)
199 {
200     Point p0;
201     int k=0;
202     p0=list[0];
203     for (int i=1;i<n;++i)
204     {
205         if ((p0.y>list[i].y)||((p0.y==list[i].y&& p0.x>list[i].x))
206         {
207             p0=list[i];
208             k=i;
209         }
210     }
211     swap(list[k],list[0]);
212     sort(list+1,list+n,_cmp);
213     if (n==1)
214     {
215         top=1;
216         Stack[0]=0;
217         return;
218     }
219     if (n==2)
220     {
221         top=2;
222         Stack[0]=0;
223         Stack[1]=1;
224         return;
225     }
226     Stack[0]=0;
227     Stack[1]=1;
228     top=2;
229     for (int i=2;i<n;++i)
230     {
231         while (top>1 && fuhao((list[Stack[top-1]]-list[Stack[top-2]])^(
232             list[i]-list[Stack[top-2]]))<=0)
233             top--;
234         Stack[top++]=i;
235     }
236     ////////////////////////////////////////      E - N - D
237     ////////////////////////////////////////
238
239     ////////////////////////////////////////      Area
240     ////////////////////////////////////////
241     double PolygonArea(Point *pp, int nn) // pp[0, n-1]
242     {
243         double ans_area = 0.0;
244         for(int i = 1; i < nn-1; i++)
245         {
246             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

$P = 102929$; $\text{mod1} = 10000000000 + 7$; $\text{mod2} = 10000000000 + 9$;

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;

```



```

13         }
14     }
15     return (i < j ? i : j);
16 }
17 }

```

6.3 Manacher

```

1 #include <cstdio>
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 }

```

6.4 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

```

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 }

```

6.6 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);
2 Scanner cin = new Scanner(new BufferedInputStream(System.in));
3 Scanner cin = new Scanner(new File("data.in"));
4
5 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

```

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

```

8 WHAT THE FUCK!!!

8.1 不用递归的 DFS - dfsWithoutDfs.cpp

```

1 void dfs()
2 {
3     st.clear();
4     DFS.push(std::make_pair(root, 0));
5     int END = 3;
6     while(!DFS.empty())
7     {
8         pair<int, int> &now = DFS.top();
9         if(now.second != END)
10         {
11             ++now.second;
12             DFS.push(std::make_pair(SON[now.first], 0));
13         }
14         else DFS.pop();
15     }
16 }

```

8.2 时间结构体

```

1 const char mon[][5] = {"", "Jan", "Feb", "Mar", "Apr", "May", "Jun", "
    Jul", "Aug", "Sep", "Oct", "Nov", "Dec"};
2 const int days[] = {0, 31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31};
3 struct Date{
4     int year, month, day, hour;
5     bool check(int y)
6     {
7         return (y % 4 == 0 && y % 100 != 0) || y % 400 == 0;
8     }
9     int getHours() // to 2000.01.01 0 o'clock
10    {
11        int hours = 1;
12        for(int i = 2000; i < year; i++) hours += 24 * (365 + check(i))
13        ;
14        for(int i = 1; i < month; i++)

```

```
14 |             hours += 24 * (days[i] + (i == 2 && check(year)));
15 |         return hours += 24 * (day - 1) + hour;
16 |     }
17 | };
```