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## 数据结构：

### push\_down完全版\_Splay

一定是要注意push\_down使用的位置

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| **/\***  **写这题感触较深的就是，只要访问儿子，就一定要先push\_down！**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <vector>  **#include** <climits>  **#include** <map>  **using** **namespace** std;  **#define** pb push\_back  **#define** ALL(x) x.begin(),x.end()  **#define** PII pair<**int**,**int**>  **#define** MP(x,y) make\_pair((x),(y))  **#define** ll **long** **long**  **#define** ull **unsigned** ll  **#define** Max(a,b) a=max(a,b)  **#define** Min(a,b) a=min(a,b)  **#define** fuck(x) cout<<#x<<" "<<x<<endl  **const** **int** INF = 0x3f3f3f3f;  **const** **int** N = 200010;  PII val[N], a[N];  **int** pre[N], ch[N][2], flip[N], sz[N], mi[N];  **int** tot, root;  **struct** Splay  {  **void** init()  {  val[0] = PII(INF, INF);  tot = root = 0;  }  **int** newnode(**int** fa, PII v)  {  **int** k = ++tot;  ch[k][0] = ch[k][1] = 0;  pre[k] = fa;  val[k] = v;  mi[k] = k;  flip[k] = 0;  sz[k] = 1;  **return** k;  }  **void** P(**int** x)  {  **if**(flip[x])  {  flip[x] = 0;  swap(ch[x][0], ch[x][1]);  **if**(ch[x][0] != 0) flip[ch[x][0]] ^= 1;  **if**(ch[x][1] != 0) flip[ch[x][1]] ^= 1;  }  }  **void** push\_up(**int** x)  {  sz[x] = sz[ch[x][0]] + sz[ch[x][1]] + 1;  mi[x] = x;  **if**(val[mi[x]] > val[mi[ch[x][0]]])  {  mi[x] = mi[ch[x][0]];  }  **if**(val[mi[x]] > val[mi[ch[x][1]]])  {  mi[x] = mi[ch[x][1]];  }  **//val[x] = min(val[x], min(val[ch[x][0]], val[ch[x][1]]));**  }  **void** rotate(**int** x)  {  **int** y = pre[x], d = (ch[y][1] == x);  P(y); P(x);  ch[y][d] = ch[x][!d];  **if**(ch[x][!d]) pre[ch[x][!d]] = y;  ch[x][!d] = y;  pre[x] = pre[y];  pre[y] = x;  **if**(pre[x]) ch[pre[x]][ch[pre[x]][1] == y] = x;  push\_up(y);  push\_up(x);  }  **void** splay(**int** x, **int** goal)  {  **while**(pre[x] != goal)  {  **int** f = pre[x], ff = pre[f];  P(ff); P(f);  **if**(ff == goal) rotate(x);  **else** **if**((ch[ff][1] == f) == (ch[f][1] == x))  rotate(f), rotate(x);  **else**  rotate(x), rotate(x);  }  push\_up(x);  **if**(goal == 0) root = x;  }  **int** build(**int** l, **int** r, **int** fa)  {  **if**(l > r) **return** 0;  **int** mid = l + r >> 1;  **int** k = newnode(fa, a[mid]);  **if**(fa == 0) root = k;  ch[k][0] = build(l, mid-1, k);  ch[k][1] = build(mid+1, r, k);  push\_up(k);  **return** k;  }  **int** kth(**int** k)  {  **int** x = root;  **while**(x)  {  P(x);  **if**(sz[ch[x][0]] >= k) x = ch[x][0];  **else** {  k -= sz[ch[x][0]] + 1;  **if**(k == 0) **return** x;  x = ch[x][1];  }  }  **return** x;  }  **void** reverse(**int** k)  {  splay(k, 0);  P(k);  **int** left = sz[ch[k][0]]+1;  **int** idx = kth(left+1);  **if**(idx == 0) flip[root] ^= 1;  **else** splay(idx, 0), P(idx), flip[ch[idx][0]] ^= 1;  }  **void** removeLeft()  {  **int** idx = kth(2);  splay(idx, 0);  P(idx);  **int** son = ch[idx][0];  pre[son] = 0;  ch[idx][0] = 0;  sz[son] = 0;  push\_up(idx);  }  **int** query()  {  **int** idx = mi[root];  splay(idx, 0);  P(idx);  **return** idx;  }  **void** Treaval(**int** x)  {  **if**(x)  {  P(x);  Treaval(ch[x][0]);  printf("%2d: left:%2d right:%2d father:%2d sz = %2d, mi = %2d, val.first = %2d, val.second = %2d\n", x, ch[x][0], ch[x][1], pre[x], sz[x], mi[x], val[x].first, val[x].second);  Treaval(ch[x][1]);  }  }  }sp;  **int** main(){  **// freopen("/home/rainto96/in.txt","r",stdin);**  **int** n;  **while**(~scanf("%d", &n) && n)  {  sp.init();  **for**(**int** i = 1; i <= n; i++)  {  **int** x;  scanf("%d", &x);  a[i] = PII(x, i);  }  **//root = sp.newnode(0, PII(INF, INF));**  sp.build(1, n, 0);  ch[0][0] = root;  **// sp.Treaval(root);**  **for**(**int** i = 1; i < n; i++)  {  **int** idx = sp.query();  **// cout<<idx<<" : "<<val[idx].first<<" "<<val[idx].second<<endl;**  printf("%d ", sz[ch[idx][0]]+1+i-1);  sp.reverse(idx);  sp.removeLeft();  **// cout<<" ======================== "<<endl;**  **// sp.Treaval(root);**  }  printf("%d\n", n);  }  **return** 0;  } |

### 树链剖分

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| **/\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **Author : kuangbin**  **Created Time: 2013/8/11 22:00:02**  **File Name : F:\2013ACM练习\专题学习\数链剖分\SPOJ\_QTREE.cpp**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* \*/**  **#include** <stdio.h>  **#include** <string.h>  **#include** <iostream>  **#include** <algorithm>  **#include** <vector>  **#include** <queue>  **#include** <set>  **#include** <map>  **#include** <string>  **#include** <math.h>  **#include** <stdlib.h>  **using** **namespace** std;  **const** **int** MAXN = 10010;  **int** top[MAXN];**//top[v]表示v所在的重链的顶端节点**  **int** fa[MAXN]; **//父亲节点**  **int** deep[MAXN];**//深度**  **int** num[MAXN];**//num[v]表示以v为根的子树的节点数**  **int** p[MAXN];**//p[v]表示v与其父亲节点的连边在线段树中的位置**  **int** fp[MAXN];**//和p数组相反**  **int** son[MAXN];**//重儿子**  **int** pos;  **struct** Edge  {  **int** to,next;  }edge[MAXN\*2];  **int** head[MAXN],tot;  **void** init()  {  tot = 0;  memset(head,-1,**sizeof**(head));  pos = 0;  memset(son,-1,**sizeof**(son));  }  **void** addedge(**int** u,**int** v)  {  edge[tot].to = v;edge[tot].next = head[u];head[u] = tot++;  }  **////////////////////线段树////////////////////**  **#define** lson(x) (x)<<1  **#define** rson(x) ((x)<<1)|1  **struct** Node  {  **int** l,r;  **int** num;  Node(**int** ll=0,**int** rr=0,**int** n=0){  l = ll,r = rr,num = n;  }  **//bool flag;**  }st[N\*6];  **struct** Seg{  **void** bulid(**int** idx,**int** l,**int** r)  {  st[idx] = Node(l,r,0);  **if**(l == r)  {  st[idx].num = w[fp[l]];  **return** ;  }  **int** mid = (l + r) / 2;  bulid(lson(idx),l,mid);  bulid(rson(idx),mid+1,r);  }  **void** pushdown(**int** idx)  {  **int** tmp = st[idx].num;  **if**(tmp)  {  st[lson(idx)].num += tmp;  st[rson(idx)].num += tmp;  }  st[idx].num = 0;  }  **void** update(**int** idx, **int** l, **int** r, **int** value)  {  **if**(st[idx].l >= l && st[idx].r <= r)  {  st[idx].num += value;  **return** ;  }  pushdown(idx);  **int** mid = (st[idx].l+st[idx].r)/2;  **if**(r <= mid) update(lson(idx),l,r,value);  **else** **if**(l > mid) update(rson(idx),l,r,value);  **else**{  update(lson(idx),l,mid,value);  update(rson(idx),mid+1,r,value);  }  }  **int** query(**int** idx, **int** k)  {  **if**(st[idx].l == st[idx].r && st[idx].l == k)  {  **//if(st[idx].num)**  **return** st[idx].num;  }  pushdown(idx);  **int** mid = (st[idx].l + st[idx].r)/2;  **if**(k <= mid) **return** query(lson(idx),k);  **else** **return** query(rson(idx),k);  }  }seg;  **////////////////////树链剖分////////////////////**  **struct** TreeLink{  **void** build(){  dfs1(1,0,0);  getpos(1,1);  }  **int** find(**int** u,**int** v)**//查询u->v边的最大值**  {  **int** f1 = top[u], f2 = top[v];  **int** tmp = 0;  **while**(f1 != f2)  {  **if**(deep[f1] < deep[f2])  {  swap(f1,f2);  swap(u,v);  }  tmp = max(tmp,seg.query(1,p[f1],p[u]));  u = fa[f1]; f1 = top[u];  }  **if**(u == v)**return** tmp;  **if**(deep[u] > deep[v]) swap(u,v);  **return** max(tmp,seg.query(1,p[son[u]],p[v]));**//如果属性在点上，那这里的p[son[u]]需要修改为p[u].**  }  **/\*Useless\*/**  **void** dfs1(**int** u,**int** pre,**int** d) **//第一遍dfs求出fa,deep,num,son**  {  deep[u] = d;  fa[u] = pre;  num[u] = 1;  **for**(**int** i = head[u];i != -1; i = edge[i].next)  {  **int** v = edge[i].to;  **if**(v != pre)  {  dfs1(v,u,d+1);  num[u] += num[v];  **if**(son[u] == -1 || num[v] > num[son[u]])  son[u] = v;  }  }  }  **void** getpos(**int** u,**int** sp) **//第二遍dfs求出top和p**  {  top[u] = sp;  **if**(son[u] != -1)  {  p[u] = pos++;  fp[p[u]] = u;  getpos(son[u],sp);  }  **else**  {  p[u] = pos++;  fp[p[u]] = u;  **return**;  }  **for**(**int** i = head[u] ; i != -1; i = edge[i].next)  {  **int** v = edge[i].to;  **if**(v != son[u] && v != fa[u])  getpos(v,v);  }  }  }trlnk;  **int** e[MAXN][3];  **int** main()  {  **//freopen("in.txt","r",stdin);**  **//freopen("out.txt","w",stdout);**  **int** T;  **int** n;  scanf("%d",&T);  **while**(T--)  {  init();  scanf("%d",&n);  **for**(**int** i = 0;i < n-1;i++)  {  scanf("%d%d%d",&e[i][0],&e[i][1],&e[i][2]);  addedge(e[i][0],e[i][1]);  addedge(e[i][1],e[i][0]);  }  trlnk.build();  seg.build(1,0,pos-1);  **for**(**int** i = 0;i < n-1; i++)  {  **if**(deep[e[i][0]] > deep[e[i][1]])  swap(e[i][0],e[i][1]);  seg.update(1,p[e[i][1]],e[i][2]);  }  **char** op[10];  **int** u,v;  **while**(scanf("%s",op) == 1)  {  **if**(op[0] == 'D')**break**;  scanf("%d%d",&u,&v);  **if**(op[0] == 'Q')  printf("%d\n",trlnk.find(u,v));  **else** seg.update(1,p[e[u-1][1]],v);  }  }  **return** 0;  } |

### LCT动态树

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| **#include** <cstdio>  **#include** <algorithm>  **#include** <iostream>  **#include** <string.h>  **#include** <stdio.h>  **const** **int** maxn=100011;  **const** **int** INF=0x7fffffff;  **using** **namespace** std;  **struct** SplayTree  {  **int** val,mn,lazy;  **bool** remark;  **int** ch[2],pre;  };  SplayTree \*tree;  **int** N;  **int** val[maxn];  **void** Init\_Splay(**int** x)  {  tree[x].ch[0]=tree[x].ch[1]=tree[x].pre=0;  tree[x].remark=0;  tree[x].val=val[x];  tree[x].mn=val[x];  }  **bool** IsRoot(**int** x)  {  **return** !tree[x].pre || (tree[tree[x].pre].ch[0]!=x && tree[tree[x].pre].ch[1]!=x);  }  **void** DynamicTree(**int** n)  {  N=n;  tree=**new** SplayTree[n+1];  **for**(**int** i=0; i<=n; i++) Init\_Splay(i);  tree[0].val=-INF;  tree[0].mn=-INF;  }  **void** Inc(**int** x,**int** d)  {  tree[x].val+=d;  tree[x].mn+=d;  tree[x].lazy+=d;  }  **void** Rev(**int** x)  {  swap(tree[x].ch[0],tree[x].ch[1]);  tree[x].remark^=1;  }  **void** PushDown(**int** x)  {  **if**(!x) **return**;  **if**(tree[x].lazy)  {  **if**(tree[x].ch[0]) Inc(tree[x].ch[0],tree[x].lazy);  **if**(tree[x].ch[1]) Inc(tree[x].ch[1],tree[x].lazy);  tree[x].lazy=0;  }  **if**(tree[x].remark)  {  **if**(tree[x].ch[0]) Rev(tree[x].ch[0]);  **if**(tree[x].ch[1]) Rev(tree[x].ch[1]);  tree[x].remark=0;  }  }  **void** Update(**int** x)  {  **if**(!x) **return**;  tree[x].mn=tree[x].val;  **if**(tree[x].ch[0]) tree[x].mn=max(tree[tree[x].ch[0]].mn,tree[x].mn);  **if**(tree[x].ch[1]) tree[x].mn=max(tree[tree[x].ch[1]].mn,tree[x].mn);  }  **void** Rotate(**int** p,**int** c)  {  **int** x=tree[p].pre,y=tree[x].pre;  tree[p].pre=y;  tree[x].pre=p;  **if**(y) **if**(x==tree[y].ch[0]) tree[y].ch[0]=p;  **else** **if**(x==tree[y].ch[1]) tree[y].ch[1]=p;  tree[x].ch[!c]=tree[p].ch[c];  **if**(tree[x].ch[!c]) tree[tree[x].ch[!c]].pre=x;  tree[p].ch[c]=x;  Update(x);  }  **int** stack[maxn];  **void** Splay(**int** x)  {  **int** top=1;  stack[0]=x;  **for**(**int** q=x; !IsRoot(q);) stack[top++]=(q=tree[q].pre);  **while**(top) PushDown(stack[--top]);  **while**(!IsRoot(x))  {  **int** q=tree[x].pre;  **if**(IsRoot(q)) **if**(tree[q].ch[0]==x) Rotate(x,1);  **else** Rotate(x,0);  **else**  {  **if**(q==tree[tree[q].pre].ch[0])  **if**(tree[q].ch[0]==x) Rotate(q,1),Rotate(x,1);  **else** Rotate(x,0),Rotate(x,1);  **else** **if**(x==tree[q].ch[1]) Rotate(q,0),Rotate(x,0);  **else** Rotate(x,1),Rotate(x,0);  }  }  Update(x);  }  **int** Head(**int** x)  {  Splay(x);  **for**(PushDown(x); tree[x].ch[0]; x=tree[x].ch[0]) PushDown(x);  Splay(x);  **return** x;  }  **int** Expose(**int** x)  {  **int** y;  **for**(y=0; x; x=tree[x].pre) Splay(x),PushDown(x),tree[x].ch[1]=y,Update(y=x);  **return** y;  }  **void** ChangeRoot(**int** x)  {  Rev(Expose(x));  }  **void** Change(**int** x,**int** y,**int** val)  {  ChangeRoot(y);  Expose(x);  Splay(x);  tree[x].val+=val;  tree[x].lazy+=val;  tree[x].mn+=val;  **// PushDown(x);**  **// Update(x);**  }  **int** AskMax(**int** x,**int** y)  {  ChangeRoot(x);  Expose(y);  Splay(y);  **return** tree[y].mn;  }  **void** Link(**int** x,**int** y)**//link操作即为链接两个树，那么要先进性expose操作，把到路径上的边都变为实边，这样才能进行把x调整到根部，进而通过更改祖先来进行链接**  {  ChangeRoot(x);  Splay(x);  tree[x].pre=y;  }  **void** Cut(**int** x,**int** y)  {  ChangeRoot(y);  Splay(x);  **if**(tree[x].ch[0])  {  tree[tree[x].ch[0]].pre=tree[x].pre;  tree[x].pre=tree[x].ch[0]=0;  }  **else** tree[x].pre=0;  }  **int** LCA(**int** x,**int** y)  {  **int** p=Head(Expose(x));  **int** q=Expose(y),w=Head(q);  **if**(p==w) **return** q;  **return** 0;  }  **struct** data  {  **int** x,y;  } a[maxn];  **int** main()  {  **int** n,m;  **while**(scanf("%d",&n)==1)  {  **for**(**int** i=1; i<n; i++) scanf("%d%d",&a[i].x,&a[i].y);  val[0]=val[n+1]=-INF;  **for**(**int** i=1; i<=n; i++) scanf("%d",&val[i]);  DynamicTree(n+1);  **for**(**int** i=1; i<n; i++) Link(a[i].x,a[i].y);  scanf("%d",&m);  **for**(**int** i=1; i<=m; i++)  {  **int** c;  **int** x,y,val;  scanf("%d",&c);  **if**(c==1)  {  scanf("%d%d",&x,&y);  **if**(!LCA(x,y)) Link(x,y);  **else** printf("-1\n");  }  **else** **if**(c==2)  {  scanf("%d%d",&x,&y);  **if**(LCA(x,y) && x!=y) Cut(y,x);  **else** printf("-1\n");  }  **else** **if**(c==3)  {  scanf("%d%d%d",&val,&x,&y);  **if**(LCA(x,y)) Change(x,y,val);  **else** printf("-1\n");  }  **else** **if**(c==4)  {  scanf("%d%d",&x,&y);  **int** tmp=LCA(x,y);  **if**(tmp) printf("%d\n",AskMax(x,y));  **else** printf("-1\n");  }  }  printf("\n");  }  **return** 0;  } |

### LCT\_Kuangbin

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| **//BZOJ\_3669\_维护最小生成树**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 200010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **struct** edge{  **int** u, v, a, b;  edge(){}  edge(**int** \_u, **int** \_v, **int** \_a, **int** \_b){  u = \_u, v = \_v, a = \_a, b = \_b;  }  **bool** **operator**<(**const** edge& o) **const**{  **return** a < o.a;  }  }e[N];  **int** n, m;  **int** pa[N];  **int** find(**int** x)  {  **return** pa[x] == x ? x : pa[x] = find(pa[x]);  }  **void** unite(**int** u, **int** v)  {  u = find(u), v = find(v);  **if**(u == v) **return** ;  pa[u] = v;  }  **struct** LCT{  **int** ch[N][2],pre[N], rev[N];**//rev这个数组是不能去掉的**  **int** ma[N], maid[N];  **bool** rt[N];  **void** Treaval(**int** x) {  **if**(x) {  Treaval(ch[x][0]);  printf("结点%2d:左儿子 %2d 右儿子 %2d 父结点 %2d size = %2d ,key = %2d \n",x, ch[x][0], ch[x][1], pre[x], sz[x], sum[x]);  Treaval(ch[x][1]);  }  }  **void** Update\_Add(**int** r,**int** d)  {  **// if(!r)return;**  **// key[r] += d;**  **// add[r] += d;**  **// Max[r] += d;**  }  **void** Update\_Rev(**int** r)  {  **if**(!r)**return**;  swap(ch[r][0],ch[r][1]);  rev[r] ^= 1;  }  **void** push\_down(**int** r)  {  **// if(add[r])**  **// {**  **// Update\_Add(ch[r][0],add[r]);**  **// Update\_Add(ch[r][1],add[r]);**  **// add[r] = 0;**  **// }**  **if**(rev[r])  {  Update\_Rev(ch[r][0]);  Update\_Rev(ch[r][1]);  rev[r] = 0;  }  }  **void** push\_up(**int** r)  {  maid[r] = r;  **if**(ma[maid[r]] < ma[maid[ch[r][0]]]) maid[r] = maid[ch[r][0]];  **if**(ma[maid[r]] < ma[maid[ch[r][1]]]) maid[r] = maid[ch[r][1]];  **// Max[r] = max(max(Max[ch[r][0]],Max[ch[r][1]]),key[r]);**  }  **void** init(**int** n, **int** m)  {  **for**(**int** i = 1; i <= n; i++)  rev[i] = pre[i] = ch[i][0] = ch[i][1] = 0, rt[i] = **true**, ma[i] = 0, maid[i] = i;  **for**(**int** i = 1; i <= m; i++)  {  **int** id = i + n;  rev[id] = pre[id] = ch[id][0] = ch[id][1] = 0;  rt[id] = **true**;  ma[id] = e[i].b;  maid[id] = id;  }  }  **void** Rotate(**int** x)  {  **int** y = pre[x], kind = ch[y][1]==x;  ch[y][kind] = ch[x][!kind];  pre[ch[y][kind]] = y;  pre[x] = pre[y];  pre[y] = x;  ch[x][!kind] = y;  **if**(rt[y])  rt[y] = **false**, rt[x] = **true**;  **else**  ch[pre[x]][ch[pre[x]][1]==y] = x;  push\_up(y);  }  **//P函数先将根结点到r的路径上所有的结点的标记逐级下放**  **void** P(**int** r)  {  **if**(!rt[r])P(pre[r]);  push\_down(r);  }  **void** Splay(**int** r)  {  P(r);  **while**( !rt[r] )  {  **int** f = pre[r], ff = pre[f];  **if**(rt[f])  Rotate(r);  **else** **if**( (ch[ff][1]==f)==(ch[f][1]==r) )  Rotate(f), Rotate(r);  **else**  Rotate(r), Rotate(r);  }  push\_up(r);  }  **int** Access(**int** x)  {  **int** y = 0;  **for**( ; x ; x = pre[y=x])  {  Splay(x);  rt[ch[x][1]] = **true**, rt[ch[x][1]=y] = **false**;  push\_up(x);  }  **return** y;  }  **//判断是否是同根(真实的树，非splay)**  **bool** judge(**int** u,**int** v)  {  **while**(pre[u]) u = pre[u];  **while**(pre[v]) v = pre[v];  **return** u == v;  }  **//先Access(r),形成一条路径，再使r成为它所在的树的根**  **void** mroot(**int** r)  {  Access(r);  Splay(r);  Update\_Rev(r);  }  **//调用后u是原来u和v的lca,v和ch[u][1]分别存着lca的2个儿子**  **//(原来u和v所在的2颗子树)**  **void** lca(**int** &u,**int** &v)  {  Access(v), v = 0;  **while**(u)  {  Splay(u);  **if**(!pre[u])**return**;  rt[ch[u][1]] = **true**;  rt[ch[u][1]=v] = **false**;  push\_up(u);  u = pre[v = u];  }  }  **int** kth(**int** k, **int** root)  {  **int** x = root;  **while**(x){  push\_down(x);  push\_up(x);  **if**(sz[ch[x][0]] >= k) x = ch[x][0];  **else** {  k -= sz[ch[x][0]] + 1;**//**  **if**(k == 0) **return** x;  x = ch[x][1];  }  }  **return** x;  }  **void** link(**int** u,**int** v)  {  **if**(judge(u,v))  {  **// puts("-1");**  **return**;  }  mroot(u);**//这里的换根操作需要特别注意，有的题目不能换根**  pre[u] = v;  }  **//先将u变为将v与他的父亲连边切断**  **void** cut(**int** x, **int** v)  {  mroot(x);**//这里的换根操作需要特别注意，有的题目不能换根**  Splay(v);  pre[ch[v][0]] = pre[v];  pre[v] = 0;  rt[ch[v][0]] = **true**;  ch[v][0] = 0;  push\_up(v);  }  **//------------End---------------**  **int** queryid(**int** x, **int** y)  {  mroot(x);  Access(y);  Splay(y);  **return** maid[y];  }  **int** query(**int** x, **int** y)  {  **return** ma[queryid(x, y)];  }  }lct;  **int** main()  {  **// Open();**  **while**(~scanf("%d%d", &n, &m))  {  **for**(**int** i = 0 ; i <= n; i++) pa[i] = i;  **for**(**int** i = 1; i <= m; i++)  {  **int** u, v, a, b;scanf("%d%d%d%d", &u, &v, &a, &b);  e[i] = edge(u, v, a, b);  }  sort(e+1, e+1+m);  lct.init(n, m);  **int** ans = INF;  **for**(**int** i = 1; i <= m; i++)  {  **int** u = e[i].u, v = e[i].v, w = e[i].b;  **if**(find(u) != find(v)){  unite(u, v);  lct.link(u, n+i);  lct.link(v, n+i);  }**else** {  **int** id = lct.queryid(u, v);  **if**(w < lct.ma[id]){  lct.cut(e[id - n].u, id);  lct.cut(e[id - n].v, id);  lct.link(u, n+i);  lct.link(v, n+i);  }  }  **if**(find(1) == find(n)){  ans = min(ans, e[i].a + lct.query(1, n));  }  }  **if**(ans == INF) ans = -1;  printf("%d\n", ans);  }  **return** 0;  } |

### RMQ(区间最值，区间GCD)

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| **#include**<iostream>  **#include**<cmath>  **#include**<algorithm>  **using** **namespace** std;    **#define** M 100010  **#define** MAXN 500  **#define** MAXM 500  **int** dp[M][18];  **/\***  **\*一维RMQ ST算法 左闭右闭区间**  **\*构造RMQ数组 makermq(int n,int b[]) O(nlog(n))的算法复杂度**  **\*dp[i][j] 表示从i到i+2^j -1中最小的一个值(从i开始持续2^j个数)**  **\*dp[i][j]=min{dp[i][j-1],dp[i+2^(j-1)][j-1]}**  **\*查询RMQ rmq(int s,int v)**  **\*将s-v 分成两个2^k的区间**  **\*即 k=(int)log2(s-v+1)**  **\*查询结果应该为 min(dp[s][k],dp[v-2^k+1][k])**  **\*/**  **void** makermq(**int** n,**int** b[],**int** dp[][18])  {  **int** i,j;  **for**(i=0;i<n;i++)  dp[i][0]=b[i];  **for**(j=1;(1<<j)<=n;j++)  **for**(i=0;i+(1<<j)-1<n;i++)  dp[i][j]=min(dp[i][j-1],dp[i+(1<<(j-1))][j-1]);  }  **int** rmq(**int** s,**int** v,**int** dp[][18])  {  **int** k=(**int**)(log((v-s+1)\*1.0)/log(2.0));  **return** min(dp[s][k],dp[v-(1<<k)+1][k]);  }  **void** makeRmqIndex(**int** n,**int** b[],**int** dp[][18]) **//返回最小值对应的下标**  {  **int** i,j;  **for**(i=0;i<n;i++)  dp[i][0]=i;  **for**(j=1;(1<<j)<=n;j++)  **for**(i=0;i+(1<<j)-1<n;i++)  dp[i][j]=b[dp[i][j-1]] < b[dp[i+(1<<(j-1))][j-1]]? dp[i][j-1]:dp[i+(1<<(j-1))][j-1];  }  **int** rmqIndex(**int** s,**int** v,**int** b[],**int** dp[][18])  {  **int** k=(**int**)(log((v-s+1)\*1.0)/log(2.0));  **return** b[dp[s][k]]<b[dp[v-(1<<k)+1][k]]? dp[s][k]:dp[v-(1<<k)+1][k];  }    **int** main()  {  **int** a[]={3,4,5,7,8,9,0,3,4,5};  **//返回下标**  makeRmqIndex(**sizeof**(a)/**sizeof**(a[0]),a);  cout<<rmqIndex(0,9,a)<<endl;  cout<<rmqIndex(4,9,a)<<endl;  **//返回最小值**  makermq(**sizeof**(a)/**sizeof**(a[0]),a);  cout<<rmq(0,9)<<endl;  cout<<rmq(4,9)<<endl;  **return** 0;  }  **//下标从1开始**  **void** initRMQ(**int** n)  {  mm[0] = -1;  **for**(**int** i = 1;i <= n;i++)  {  mm[i] = ((i&(i-1)) == 0)?mm[i-1]+1:mm[i-1];  dp1[i][0] = a[i];  dp2[i][0] = a[i];  }  **for**(**int** j = 1;j <= mm[n];j++)  **for**(**int** i = 1;i + (1<<j) - 1 <= n;i++)  {  dp1[i][j] = max(dp1[i][j-1],dp1[i + (1<<(j-1))][j-1]);  dp2[i][j] = min(dp2[i][j-1],dp2[i + (1<<(j-1))][j-1]);  }  }  **//下标从0开始**  **void** makermqmi(**int** n,**int** b[],**int** dp[][22])  {  **int** i,j;  mm[0] = -1;  **for**(i=0;i<n;i++)  mm[i+1] = ((i&(i+1)) == 0)?mm[i]+1:mm[i], dp[i][0]=b[i];  **for**(j=1;(1<<j)<=n;j++)  **for**(i=0;i+(1<<j)-1<n;i++)  dp[i][j]=min(dp[i][j-1],dp[i+(1<<(j-1))][j-1]);  }  **int** rmq(**int** x,**int** y)**//[x, y]**  {  **int** k = mm[y-x+1];  **return** max(dp1[x][k],dp1[y-(1<<k)+1][k]) - min(dp2[x][k],dp2[y-(1<<k)+1][k]);  } |

### 可持久化字典树\_HDU\_4757

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| **/\***  **\* 题意：给出一棵树，给出询问u, v, z; 返回uv路径中与z异或的最大值**  **\***  **\* 解法：利用可持久化字典树，维护每个节点到根的信息，每个节点的信息从父亲节点继承，记录这个节点的cnt**  **\* 那么对于一个u，v来说，如果u到LCA(u,v)+v到LCA(u,v)间的cnt大于1的话，表明当前节点可走。具体可看代码。**  **\***  **\***  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **struct** node{  **int** go[2];  **int** cnt;  }pool[N\*20];  **int** tot;**//**  vector<**int**> G[N];**//**  **int** pa[20][N];**//**  **int** w[N];**//**  **int** dep[N];**//**  **int** n,m;  **int** root[N];**//**  **int** insert(**int** pre, **int** val)  {  **int** p = ++tot, ret = p;  pool[p] = pool[pre];  **for**(**int** i = 15; i >= 0; i--)  {  **int** tmp = (val>>i)&1;  **int** cur = ++tot;  pool[cur] = pool[pool[p].go[tmp]];  pool[cur].cnt++;  pool[p].go[tmp] = cur;  p = cur;  }  **return** ret;  }  **void** dfs(**int** v, **int** p, **int** d)  {  root[v] = insert(root[max(0, p)], w[v]);  pa[0][v] = p;  dep[v] = d;  **for**(**int** i = 0; i < G[v].size(); i ++)  **if**(G[v][i] != p) dfs(G[v][i], v, d+1);  }  **void** init()  {  tot = 0;  root[0] = 0;  memset(pool, 0, **sizeof**(pool));  dfs(1, -1, 0);  **for**(**int** k = 0; k + 1 < 20; k++)  **for**(**int** v = 1; v <= n; v++)  **if**(pa[k][v] < 0) pa[k+1][v] = -1;  **else** pa[k+1][v] = pa[k][pa[k][v]];  }  **int** lca(**int** u, **int** v)  {  **if**(dep[u] > dep[v]) swap(u, v);  **for**(**int** k = 0; k < 20; k++)  **if**((dep[v] - dep[u]) >> k & 1)  v = pa[k][v];  **if**(u == v) **return** u;  **for**(**int** k = 19; k >= 0; k--)  **if**(pa[k][u] != pa[k][v])  u = pa[k][u], v = pa[k][v];  **return** pa[0][u];  }  **int** getans(**int** u, **int** v, **int** val)  {  **int** LCA = lca(u, v);  **int** pu = root[u], pv = root[v], pl = root[LCA];  **int** ans = 0;  **for**(**int** i = 15; i >= 0; i--)  {  **int** tmp = (val >> i)&1;  **int** sum = pool[pool[pu].go[!tmp]].cnt + pool[pool[pv].go[!tmp]].cnt - 2 \* pool[pool[pl].go[!tmp]].cnt;  **if**(sum > 0){  pu = pool[pu].go[!tmp];  pv = pool[pv].go[!tmp];  pl = pool[pl].go[!tmp];  ans += 1<<i;  }**else**{  pu = pool[pu].go[tmp];  pv = pool[pv].go[tmp];  pl = pool[pl].go[tmp];  }  }  **return** max(val ^ w[LCA], ans);  }  **int** main()  {  **// Open();**  **while**(~scanf("%d%d", &n, &m))  {  **for**(**int** i = 1; i <= n; i++)  scanf("%d", &w[i]), G[i].clear();  **for**(**int** i = 1; i < n; i++)  {  **int** u, v;scanf("%d%d", &u, &v);  G[u].push\_back(v);  G[v].push\_back(u);  }  init();  **while**(m--)  {  **int** u, v, z;  scanf("%d%d%d", &u, &v, &z);  printf("%d\n", getans(u, v, z));  }  }  **return** 0;  } |

### 树状数组

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| **//树状数组**  **#define** N 100001  **int** n;  **int** c[N];**// 每个C数组代表v[i-lowbit(i)+1]到v[i]之间的和**  **void** add(**int** i,**int** x)  {  **while**(i<=n)  {  c[i]+=x;  c[i]%=mod;  i+= i & -i;  }  }  **int** getsum(**int** i)  {  **int** cnt=0;  **while**(i>0)  {  cnt+=c[i];  cnt%=mod;  i-=i & -i;  }  **return** cnt%mod;  }  **int** getK(**int** K) **//已知前n项和为K，返回n值！**  {  **int** ans = 0,cnt=0;  **for**(**int** i=18;i>=0;i--)**//i>=0**  {  ans+=(1<<i);  **if**(ans>=N||cnt+c[ans]>=K)ans-=(1<<i);  **else** cnt+=c[ans];  }  **return** ans+1;  }  **//树状数组**  **//求前缀最大, 更新值只能增大。**  **int** c[N];  **void** update(**int** x, **int** val)  {  **if**(x == 0) **return** ;  **for**(**int** i=x;i<=N;i+=i&-i) c[i] = max(c[i], val);  }  **int** getmax(**int** x)  {  **int** rnt = -INF;  **for**(**int** i=x;i>0;i-=i&-i) rnt = max(rnt, c[i]);  **return** rnt;  }  **//求前缀最大**  **//二维树状数组**  **int** Lowbit(**int** x)  {  **return** x & (-x);  }  **void** Updata(**int** x,**int** y,**int** a)  {  **int** i,k;  **for**(i=x; i<=n; i+=Lowbit(i))  **for**(k=y; k<=n; k+=Lowbit(k))  c[i][k]+=a;  }  **int** Getsum(**int** x,**int** y)  {  **int** i,k,sum = 0;  **for**(i=x; i>0; i-=Lowbit(i))  **for**(k=y; k>0; k-=Lowbit(k))  sum += c[i][k];  **return** sum;  }  **//二维树状数组**  **#include** <cstdlib>  **#include** <cstring>  **#include** <cstdio>  **#include** <algorithm>  **#include** <iostream>  **#include** <map>  **using** **namespace** std;  **#define** Lowbit(x) ((x)&(-x))  **/\***  **index from 1,like 1,2,3,4,5,,,,**  **array c is the 2-dimensional BIT array**  **\*/**  **int** c[4][4];  **int** m[4][4];  **int** n=3;  **void** add(**int** x, **int** y,**int** delta){  **int** i=y;  **while**(x<=n){  y=i;  **while**(y<=n){  c[x][y]+=delta;  y+=Lowbit(y);  }  x+=Lowbit(x);  }  }  **int** Sum(**int** x, **int** y){  **int** i=y, sum=0;  **while**(x>0){  y=i;  **while**(y>0){  sum+=c[x][y];  y-=Lowbit(y);  }  x-=Lowbit(x);  }  **return** sum;  }  **int** main() {  **//freopen("G:/in.txt","r",stdin);**  **/\* the input is**  **1 2 2**  **2 1 3**  **3 4 5**  **\*/**  **for**(**int** i=1;i<=3;i++)  **for**(**int** j=1;j<=3;j++){  scanf("%d",&m[i][j]);  add(i,j,m[i][j]);  }  **for**(**int** i=1;i<=3;i++){  **for**(**int** j=1;j<=3;j++){  cout<<Sum(i,j)<<' ';  }  cout<<endl;  }  **/\* the output should be**  **1 3 5**  **3 6 11**  **6 13 23**  **\*/**  **return** 0;  }  **//区间修改，点查询**  **long** **long** c[N];  **long** **long** sum[N];  **long** **long** n;  **long** **long** getnum(**long** **long** x)  {  **long** **long** rnt=0;  **for**(**long** **long** i=x;i<=n;i+=(i&(-i)))  {  rnt+=c[i];  }  **return** rnt;  }  **void** add(**long** **long** i,**long** **long** a)  {  **while**(i>=1)  {  c[i]+=a;  i-=(i&(-i));  }  }  **//区间修改，区间查询, cnt 相当于cas清空用**  LL query(LL a[][2], **int** x)  {  LL res = 0;  **for**(; x > 0; x -= (x&(-x)))  {  **if**(a[x][0] == cnt) res += a[x][1];  }  **return** res;  }  LL query(**int** l, **int** r)  {  **return** query(x1, l)\*(r-l+1)+ (r+1)\*(query(x1, r)-query(x1, l)) - (query(x2, r)-query(x2, l));  }  **void** add(LL a[][2], **int** x, LL c)  {  **for**(; x <= n; x += ((-x)&x))  {  **if**(a[x][0] == cnt) a[x][1] += c;  **else** a[x][0] = cnt, a[x][1] = c;  }  }  **void** add(**int** l, **int** r, **int** c)  {  add(x1, l, c);  add(x2, l, (LL)l\*c);  add(x1, r+1, -c);  add(x2, r+1, (LL)(r+1)\*(-c));  }  **//区间修改，区间查询**  **//推导: http://www.cnblogs.com/lazycal/archive/2013/08/05/3239304.html**  **//二维区间查询-区间修改**  **const** **int** N = 2210;  **#define** lowbit(x) ((x)&(-(x)))  PII a[N][N],b[N][N],c[N][N],d[N][N];  **int** X, Y;  **inline** **int** gs(PII a[N][N],**int** x,**int** y, **int** id){  **int** s=0,t;  **for**(; x; x-=lowbit(x))  **for**(t=y; t; t-=lowbit(t)){  **if**(a[x][t].second != id) a[x][t].first = 0;  a[x][t].second = id;  s+=a[x][t].first;  }  **return** s;  }  **inline** **void** gp(PII a[N][N],**int** x,**int** y,**int** w, **int** id)  {  **int** t;  **for**(; x<X+5 && x; x+=lowbit(x))  **for**(t=y; t<Y+5 && t; t+=lowbit(t)){  **if**(a[x][t].second != id) a[x][t].first = 0;  a[x][t].second = id;  a[x][t].first+=w;  }  }  **inline** **int** sum(**int** x,**int** y, **int** id)  {  **return** (x+1)\*(y+1)\*gs(a,x,y,id)-(y+1)\*gs(b,x,y,id)-(x+1)\*gs(c,x,y,id)+gs(d,x,y,id);  }  **inline** **int** sum(**int** x1, **int** y1, **int** x2, **int** y2, **int** id)  {  **if**(x1 > x2 || y1 > y2) **return** 0;  **return** sum(x2, y2, id) - sum(x1-1, y2, id) - sum(x2, y1-1, id) + sum(x1-1, y1-1, id);  }  **inline** **void** update(**int** x1,**int** y1,**int** x2,**int** y2,**int** w, **int** id)  {  **if**(x1 > x2 || y1 > y2) **return** ;  gp(a,x1,y1,w,id);  gp(a,x2+1,y1,-w,id);  gp(a,x1,y2+1,-w,id);  gp(a,x2+1,y2+1,w,id);  gp(b,x1,y1,w\*x1,id);  gp(b,x2+1,y1,-w\*(x2+1),id);  gp(b,x1,y2+1,-w\*x1,id);  gp(b,x2+1,y2+1,w\*(x2+1),id);  gp(c,x1,y1,w\*y1,id);  gp(c,x2+1,y1,-w\*y1,id);  gp(c,x1,y2+1,-w\*(y2+1),id);  gp(c,x2+1,y2+1,w\*(y2+1),id);  gp(d,x1,y1,w\*x1\*y1,id);  gp(d,x2+1,y1,-w\*(x2+1)\*y1,id);  gp(d,x1,y2+1,-w\*x1\*(y2+1),id);  gp(d,x2+1,y2+1,w\*(x2+1)\*(y2+1),id);  } |

### 线段树终极版

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 201000  **#define** lson x<<1  **#define** rson x<<1|1  **#define** mid ((lt[x].l+lt[x].r)/2)  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **typedef** pair<PII, **int**> PIII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** a[N];  **struct** node  {  **int** l, r;  **int** lazy;  **int** mi;  node(){}  node(**int** ll, **int** rr, **int** lazyy, **int** mii){  l = ll, r = rr, lazy = lazyy, mi = mii;  }  }lt[N\*10];  **void** push\_up(**int** x)  {  lt[x].mi = min(lt[lson].mi, lt[rson].mi);  }  **void** push\_down(**int** x)  {  **if**(lt[x].lazy){  lt[lson].mi += lt[x].lazy;  lt[lson].lazy += lt[x].lazy;  lt[rson].mi += lt[x].lazy;  lt[rson].lazy += lt[x].lazy;  lt[x].lazy = 0;  }  }  **void** build(**int** l, **int** r, **int** x)  {  lt[x] = node(l, r, 0, 0);  **if**(l == r){  lt[x].mi = a[l];  **return** ;  }  build(l, mid, lson);  build(mid+1, r, rson);  push\_up(x);  }  **void** update(**int** l, **int** r, **int** val, **int** x){  **if**(l > r) **return** ;  **if**(lt[x].l >= l && lt[x].r <= r){  lt[x].mi += val;  lt[x].lazy += val;  **return** ;  }  push\_down(x);  **if**(r <= mid) update(l, r, val, lson);  **else** **if**(l > mid) update(l, r, val, rson);  **else** update(l, mid, val, lson), update(mid+1, r, val, rson);  push\_up(x);  }  **int** query(**int** l, **int** r, **int** x)  {  **if**(lt[x].l == lt[x].r){  **if**(lt[x].mi == 0) **return** lt[x].l;  **else** **return** -1;  }  **if**(lt[x].l >= l && lt[x].r <= r && lt[x].mi > 0){  **return** -1;  }  push\_down(x);  **int** res;  **if**(r <= mid) res = query(l, r, lson);  **else** **if**(l > mid) res = query(l, r, rson);  **else** {  **int** lres = query(l, mid, lson);  **int** rres = query(mid+1, r, rson);  **if**(lres != -1) res = lres;  **else** **if**(rres != -1) res = rres;  **else** res = -1;  }  push\_up(x);  **return** res;  }  **int** ans[N];  **int** main()  {  Open();  **int** n;  **while**(scanf("%d",&n)==1)  {  **if**(!n)**break**;  **for**(**int** i = 1; i <= n; i++) scanf("%d", &a[i]);  build(1, n, 1);  **int** cnt = 2 \* n;  queue<**int**> q;  **bool** flag = **true**;  **int** tail = 0;  **while**(cnt-- && flag)  {  **int** idx = query(1, n, 1);  **if**(idx == -1){  **if**(q.empty()) {  flag = **false**;  **continue**;  }**else**{  **int** res = q.front();q.pop();  ans[tail++] = -res;  **// printf("%d", -res);**  update(res+1, n, -1, 1);  }  }**else**{  ans[tail++] = idx;  q.push(idx);  update(1, idx - 1, -1, 1);  update(idx, idx, INF, 1);  }  }  **if**(!flag){  printf("Impossible\n");  }**else**{  **for**(**int** i = tail - 1; i >= 0; i--)  {  printf("%d", ans[i]);  **if**(i) printf(" ");  **else** printf("\n");  }  }  }  **return** 0;  } |

### 主席树-区间K大-POJ-2104

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| **/\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **Author :kuangbin**  **Created Time :2013-9-4 20:13:20**  **File Name :POJ2104.cpp**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* \*/**  **#include** <stdio.h>  **#include** <string.h>  **#include** <iostream>  **#include** <algorithm>  **#include** <vector>  **#include** <queue>  **#include** <set>  **#include** <map>  **#include** <string>  **#include** <math.h>  **#include** <stdlib.h>  **#include** <time.h>  **using** **namespace** std;  **const** **int** MAXN = 100010;  **const** **int** M = MAXN \* 30;  **int** n,q,m,tot;  **int** a[MAXN], t[MAXN];  **int** T[M], lson[M], rson[M], c[M];  **void** Init\_hash()  {  **for**(**int** i = 1; i <= n;i++)  t[i] = a[i];  sort(t+1,t+1+n);  m = unique(t+1,t+1+n)-t-1;  }  **int** build(**int** l,**int** r)  {  **int** root = tot++;  c[root] = 0;  **if**(l != r)  {  **int** mid = (l+r)>>1;  lson[root] = build(l,mid);  rson[root] = build(mid+1,r);  }  **return** root;  }  **int** hash(**int** x)  {  **return** lower\_bound(t+1,t+1+m,x) - t;  }  **int** update(**int** root,**int** pos,**int** val)  {  **int** newroot = tot++, tmp = newroot;  c[newroot] = c[root] + val;  **int** l = 1, r = m;  **while**(l < r)  {  **int** mid = (l+r)>>1;  **if**(pos <= mid)  {  lson[newroot] = tot++; rson[newroot] = rson[root];  newroot = lson[newroot]; root = lson[root];  r = mid;  }  **else**  {  rson[newroot] = tot++; lson[newroot] = lson[root];  newroot = rson[newroot]; root = rson[root];  l = mid+1;  }  c[newroot] = c[root] + val;  }  **return** tmp;  }  **int** query(**int** left\_root,**int** right\_root,**int** k)  {  **int** l = 1, r = m;  **while**( l < r)  {  **int** mid = (l+r)>>1;  **if**(c[lson[left\_root]]-c[lson[right\_root]] >= k )  {  r = mid;  left\_root = lson[left\_root];  right\_root = lson[right\_root];  }  **else**  {  l = mid + 1;  k -= c[lson[left\_root]] - c[lson[right\_root]];  left\_root = rson[left\_root];  right\_root = rson[right\_root];  }  }  **return** l;  }  **int** main()  {  **//freopen("in.txt","r",stdin);**  **//freopen("out.txt","w",stdout);**  **while**(scanf("%d%d",&n,&q) == 2)  {  tot = 0;  **for**(**int** i = 1;i <= n;i++)  scanf("%d",&a[i]);  Init\_hash();  T[n+1] = build(1,m);  **for**(**int** i = n;i ;i--)  {  **int** pos = hash(a[i]);  T[i] = update(T[i+1],pos,1);  }  **while**(q--)  {  **int** l,r,k;  scanf("%d%d%d",&l,&r,&k);  printf("%d\n",t[query(T[l],T[r+1],k)]);  }  }  **return** 0;  } |

### 主席树-区间修改hihocoder couple tree

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| **/\***  **\* 题意：给出两棵树，有若干个询问，每次询问u,v,需要返回这两个节点分别在各自的树上的最近公共祖先；**  **\* 保证父亲节点的编号一定小于儿子。强制在线。**  **\***  **\* 做法： 首先考虑离线的做法，对于一个第一棵树上特定的u点，我们在线段树中保存根节点到u节点的信息，**  **\* 对于u节点到根上的节点x对于子树上的所有点来说都是父亲。如果将子树上面的所有点对应的第二棵**  **\* 树上的点都标记上父亲的标号，并且取最大标号留下的话，那么做完之后第二棵树中每个节点的标号**  **\* 就是这个节点与u节点的最近公共祖先(不同树上的)。那么也就是说这里对于第一棵树中每一个节点**  **\* 来说都得有一棵对应的线段树，那么很容易就想到了主席树的做法。每个节点的信息从父亲处继承下**  **\* 来。那么对于一个询问就在相应的线段树上面查询即可。**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **#define** M 2500010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** lson[M], rson[M], ma[M], tot, lazy[M], mi[M];**//维护的信息**  **int** Tn;  **int** dep[2][N];  **int** fa[2][N];  **int** st[N], ed[N];  vector<**int**> G[2][N];  **int** n, m;  **int** T[N];**//存储每个节点的线段树的根节点编号。**  **void** dfsseq(**int** u, vector<**int**> G[], **int** d)  {  dep[1][u] = d;  st[u] = ++Tn;  **for**(**int** i = 0; i < G[u].size(); i ++)  dfsseq(G[u][i], G, d + 1);  ed[u] = Tn;  }  **void** dfsdep(**int** u, **int** d)  {  dep[0][u] = d;  **for**(**int** i = 0; i < G[0][u].size(); i ++)  dfsdep(G[0][u][i], d+1);  }  **int** build(**int** l, **int** r)  {  **int** root = tot++;  ma[root] = 0, mi[root] = 0, lazy[root] = 0;  **if**(l == r) **return** root;  **int** mid = l + r >> 1;  lson[root] = build(l, mid);  rson[root] = build(mid+1, r);  **return** root;  }  **// 有的模板下放懒标记的时候，用一个数组标记了当前点的左右儿子是否是历史版本， 如果是的话再重新申请节点，如果不是就直接更新。**  **// 这么做的意义是为了节省空间，我个人测试之后发现这样做不得不再开一个与线段树大小相同的标记数组，其实大多数情况下内存是会更**  **// 大的...我一开始的做法就是，不管是不是历史版本， 只要懒标记有效，我就申请两个新节点当做儿子。**  **// 但是也会有恶心的数据会让这种不加标记的MLE的，所以注意取舍。**  **void** push\_down(**int** root){  **if**(lazy[root]){  lson[tot] = lson[lson[root]];  rson[tot] = rson[lson[root]];  ma[tot] = max(ma[lson[root]], lazy[root]);  mi[tot] = max(mi[lson[root]], lazy[root]);  lazy[tot] = max(lazy[lson[root]], lazy[root]);  lson[root] = tot++;  lson[tot] = lson[rson[root]];  rson[tot] = rson[rson[root]];  ma[tot] = max(ma[rson[root]], lazy[root]);  mi[tot] = max(mi[rson[root]], lazy[root]);  lazy[tot] = max(lazy[rson[root]], lazy[root]);  rson[root] = tot++;  lazy[root] = 0;  }  }  **void** push\_up(**int** root){  ma[root] = max(ma[lson[root]], ma[lson[root]]);  mi[root] = min(mi[lson[root]], mi[lson[root]]);  }  **int** update(**int** root, **int** L, **int** R, **int** l, **int** r, **int** val)**// [l, r]修改区间，[L, R]当前区间**  {  **if**(mi[root] >= val) **return** root;  **int** newroot = tot ++;  **if**(L >= l && R <= r){  lazy[newroot] = max(lazy[root], val);  ma[newroot] = max(ma[root], val);  mi[newroot] = max(mi[root], val);  lson[newroot] = lson[root];  rson[newroot] = rson[root];  **return** newroot;  }  lazy[newroot] = ma[newroot] = 0, mi[newroot] = 0;  push\_down(root);  **int** mid = L + R >> 1;  **if**(r <= mid)  {  lson[newroot] = update(lson[root], L, mid, l, r, val);  rson[newroot] = rson[root];  }**else** **if**(l > mid){  lson[newroot] = lson[root];  rson[newroot] = update(rson[root], mid+1, R, l, r, val);  }**else**{  lson[newroot] = update(lson[root], L, mid, l, mid, val);  rson[newroot] = update(rson[root], mid+1, R, mid+1, r, val);  }  push\_up(newroot);  **return** newroot;  }  **int** query(**int** root, **int** L, **int** R, **int** idx){  **if**(L == R && L == idx) **return** ma[root];  push\_down(root);  **int** mid = L + R >> 1;  **if**(idx <= mid) **return** query(lson[root], L, mid, idx);  **else** **return** query(rson[root], mid+1, R, idx);  }  **void** dfs(**int** u, vector<**int**> G[])  {  T[u] = update(T[fa[0][u]], 1, Tn, st[u], ed[u], u);  **for**(**int** i = 0; i < G[u].size(); i ++)  {  dfs(G[u][i], G);  }  }  **int** main()  {  Open();  **while**(~scanf("%d%d", &n, &m)){  Tn = 0;  tot = 0;  **for**(**int** i = 0; i <= n; i++) G[1][i].clear(), G[0][i].clear();  **for**(**int** i = 2; i <= n; i++)  {  scanf("%d", &fa[0][i]);  G[0][fa[0][i]].push\_back(i);  }  **for**(**int** i = 2; i <= n; i++)  {  scanf("%d", &fa[1][i]);  G[1][fa[1][i]].push\_back(i);  }  dfsseq(1, G[1], 1);  dfsdep(1, 1);  fa[0][1] = n + 1;  T[n+1] = build(1, Tn);  dfs(1, G[0]);  **int** preans = 0;  **while**(m--)  {  **int** u, v;  scanf("%d%d", &u, &v);  u += preans; u %= n; u++;  v += preans; v %= n; v++;  preans = query(T[u], 1, Tn, st[v]);  printf("%d %d %d\n", preans, dep[0][u] - dep[0][preans] + 1, dep[1][v] - dep[1][preans] + 1);  }  }  **return** 0;  } |

## 数论

### FFT

FFT，快速傅里叶变换，有时候做n次FFT的那种题，dp方程的含义可能会发生变化，但是如果不是需要知道特定值的话（比如只需要对所有结果求和），那么只需要保证每次fft的时候，两个多项式的对应关系没问题即可。

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **typedef** pair<**double**,**double**> PDD;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **///需要注意的是，有FFT的题目中，数组长度默认开四倍！否则会RE**  **const** **double** PI = acos(-1.0);  **struct** complex  {  **double** r,i;  complex(**double** \_r = 0,**double** \_i = 0)  {  r = \_r; i = \_i;  }  complex **operator** +(**const** complex &b)  {  **return** complex(r+b.r,i+b.i);  }  complex **operator** -(**const** complex &b)  {  **return** complex(r-b.r,i-b.i);  }  complex **operator** \*(**const** complex &b)  {  **return** complex(r\*b.r-i\*b.i,r\*b.i+i\*b.r);  }  };  **void** change(complex y[],**int** len)  {  **int** i,j,k;  **for**(i = 1, j = len/2;i < len-1;i++)  {  **if**(i < j)swap(y[i],y[j]);  k = len/2;  **while**( j >= k)  {  j -= k;  k /= 2;  }  **if**(j < k)j += k;  }  }  **void** FFT(complex y[],**int** len,**int** on)  {  change(y,len);  **for**(**int** h = 2;h <= len;h <<= 1)  {  complex wn(cos(-on\*2\*PI/h),sin(-on\*2\*PI/h));  **for**(**int** j = 0;j < len;j += h)  {  complex w(1,0);  **for**(**int** k = j;k < j+h/2;k++)  {  complex u = y[k];  complex t = w\*y[k+h/2];  y[k] = u+t;  y[k+h/2] = u-t;  w = w\*wn;  }  }  }  **if**(on == -1)  **for**(**int** i = 0;i < len;i++)  y[i].r /= len;  }  **//a, b:卷积数组，res结果数组，n,m 数组a,b的长度**  complex x1[N], x2[N];  **int** FFTstarto(LL \*a, LL \*b, LL \*res, **int** n, **int** m)  {  **int** len1 = max(n, m);  **int** len = 1;  **while**(len < len1 \* 2) len <<= 1;  **for**(**int** i = 0; i < len; i++)  {  **if**(i < n) x1[i] = complex(a[i], 0);  **else** x1[i] = complex(0, 0);  **if**(i < m) x2[i] = complex(b[i], 0);  **else** x2[i] = complex(0, 0);  }  FFT(x1, len, 1);  FFT(x2, len, 1);  **for**(**int** i = 0; i < len; i++)  x1[i] = x1[i] \* x2[i];  FFT(x1, len, -1);  **for**(**int** i = 0; i < len; i++)  res[i] = x1[i].r + 0.5;  **return** len;  }  **const** **int** N = 400020;  **int** a[N];  LL num[N];  **struct** Reader  {  **static** **const** **int** MSIZE = 1000 \* 8 \* 1024;  **char** buf[MSIZE], \*pt = buf, \*o = buf;  **void** init()  {  fread(buf, 1, MSIZE, stdin);  }  **int** getint()  {  **int** f = 1, x = 0;  **while**(\*pt != '-' && !isdigit(\*pt)) pt++;  **if**(\*pt == '-') f = -1, pt++;  **else** x = \*pt++ - 48;  **while**(isdigit(\*pt)) x = x\*10 + \*pt++ - 48;  **return** x \* f;  }  }frd;  **int** main()  {  Open();  frd.init();  **int** T;  T = frd.getint();  **// scanf("%d", &T);**  **while**(T--)  {  memset(num, 0, **sizeof**(num));  **int** n;  n = frd.getint();  **// scanf("%d", &n);**  **int** ma = 0;  **for**(**int** i = 0; i < n; i++)  {  a[i] = frd.getint();  **// scanf("%d", &a[i]);**  ma = max(a[i], ma);  num[a[i]]++;  }  sort(a, a+n);  ma++;  **int** len = FFTstarto(num, num, num, ma, ma, x1, x2);  **for**(**int** i = 0; i < n; i++)  num[a[i]+a[i]]--;  **for**(**int** i = 0; i < len; i++)  num[i] /= 2;  **for**(**int** i = 1; i < len; i++)  num[i] += num[i-1];  LL ans = 0;  **for**(**int** i = 0; i < n; i++)  {  ans += num[len-1] - num[a[i]];  ans -= (LL)(n - i - 1) \* i;  ans -= (LL)(n - i - 1) \* (n - i - 2) / 2;  ans -= (LL)(n - 1);  }  printf("%.7f\n", ans\*1.0 / ((LL)(n)\*(n-1)/2\*(n-2)/3));  }  **return** 0;  } |

### FFT+快速幂CF632E

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| **/\***  **\* CF\_632E 有n种数，每种数可以无限拿，问取出正好K个数，能够组成的数有哪些。**  **\* 设dp[i][j]=1,表示数字i可以用j个数字组成，那dp[i][j] = (sigma(dp[i-k][j-1]&v[k]))>0 v[k] = 1,当且仅当k是题中给出的数**  **\* 那么就可以卷积+快速幂求得结果。复杂度n\*logn\*logn N=1000000;**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **#include** <bitset>  **//#include <unordered\_map>**  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<LL,LL> PII;  **const** LL INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 1000100;  **const** **double** PI = acos(-1.0);  **struct** complex  {  **double** r,i;  complex(**double** \_r = 0,**double** \_i = 0)  {  r = \_r; i = \_i;  }  complex **operator** +(**const** complex &b)  {  **return** complex(r+b.r,i+b.i);  }  complex **operator** -(**const** complex &b)  {  **return** complex(r-b.r,i-b.i);  }  complex **operator** \*(**const** complex &b)  {  **return** complex(r\*b.r-i\*b.i,r\*b.i+i\*b.r);  }  };  **void** change(complex y[],**int** len)  {  **int** i,j,k;  **for**(i = 1, j = len/2;i < len-1;i++)  {  **if**(i < j)swap(y[i],y[j]);  k = len/2;  **while**( j >= k)  {  j -= k;  k /= 2;  }  **if**(j < k)j += k;  }  }  **void** FFT(complex y[],**int** len,**int** on)  {  change(y,len);  **for**(**int** h = 2;h <= len;h <<= 1)  {  complex wn(cos(-on\*2\*PI/h),sin(-on\*2\*PI/h));  **for**(**int** j = 0;j < len;j += h)  {  complex w(1,0);  **for**(**int** k = j;k < j+h/2;k++)  {  complex u = y[k];  complex t = w\*y[k+h/2];  y[k] = u+t;  y[k+h/2] = u-t;  w = w\*wn;  }  }  }  **if**(on == -1)  **for**(**int** i = 0;i < len;i++)  y[i].r /= len;  }  complex x1[N\*4], x2[N\*4];  **void** mul(**int** a[], **int** b[], **int** &la, **int** lb)  {  **int** len = 1;  **while**(len <= la + lb) len <<= 1;  **for**(**int** i = 0; i <= la; i++)  x1[i] = complex(a[i], 0);  **for**(**int** i = la+1; i < len; i++)  x1[i] = complex(0, 0);  **for**(**int** i = 0; i <= lb; i++)  x2[i] = complex(b[i], 0);  **for**(**int** i = lb+1; i < len; i++)  x2[i] = complex(0, 0);  FFT(x1, len, 1);  FFT(x2, len, 1);  **for**(**int** i = 0; i < len; i++) x1[i] = x1[i] \* x2[i];  FFT(x1, len, -1);  **for**(**int** i = 0; i < len; i++)  a[i] = ((**int**)(x1[i].r+0.5))>0;  la += lb;  }  **int** dp[N\*4];  **int** v[N\*4];  **int** main()  {  **//Open();**  **int** n, k;  scanf("%d%d", &n, &k);  **int** ma = 0;  **for**(**int** i = 0; i < n; i++)  {  **int** ttt;  scanf("%d", &ttt);  ma = max(ma, ttt);  v[ttt] = 1;  }  ma;  dp[0] = 1;  **int** la = 1, lb = ma;  **while**(k)  {  **if**(k & 1) mul(dp, v, la, lb);  mul(v, v, lb, lb);  k >>= 1;  }  **for**(**int** i = 1; i <= N; i++)  {  **if**(dp[i] != 0) printf("%d ", i);  }  **return** 0;  } |

### namespace FFT

据说该版本fft会有些许精度误差（如果结果数特别大）

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **#include** <set>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 200050;  **namespace** FFT {  **int** pos[N];  **struct** comp {  **double** r , i ;  comp ( **double** \_r = 0 , **double** \_i = 0 ) : r ( \_r ) , i ( \_i ) {}  comp **operator** + ( **const** comp& x ) {  **return** comp ( r + x.r , i + x.i ) ;  }  comp **operator** - ( **const** comp& x ) {  **return** comp ( r - x.r , i - x.i ) ;  }  comp **operator** \* ( **const** comp& x ) {  **return** comp ( r \* x.r - i \* x.i , i \* x.r + r \* x.i ) ;  }  comp conj () {  **return** comp ( r , -i ) ;  }  } A[N] , B[N] ;  **const** **double** pi = acos ( -1.0 ) ;  **void** FFT ( comp a[] , **int** n , **int** t ) {  **for** ( **int** i = 1 ; i < n ; ++ i ) **if** ( pos[i] > i ) swap ( a[i] , a[pos[i]] ) ;  **for** ( **int** d = 0 ; ( 1 << d ) < n ; ++ d ) {  **int** m = 1 << d , m2 = m << 1 ;  **double** o = pi \* 2 / m2 \* t ;  comp \_w ( cos ( o ) , sin ( o ) ) ;  **for** ( **int** i = 0 ; i < n ; i += m2 ) {  comp w ( 1 , 0 ) ;  **for** ( **int** j = 0 ; j < m ; ++ j ) {  comp& A = a[i + j + m] , &B = a[i + j] , t = w \* A ;  A = B - t ;  B = B + t ;  w = w \* \_w ;  }  }  }  **if** ( t == -1 ) **for** ( **int** i = 0 ; i < n ; ++ i ) a[i].r /= n ;  }  **void** mul ( **int** \*a , **int** \*b , **int** \*c ,**int** k) {  **int** i , j ;  **for** ( i = 0 ; i < k ; ++ i ) A[i] = comp ( a[i] , b[i] ) ;  j = \_\_builtin\_ctz ( k ) - 1 ;  **for** ( **int** i = 0 ; i < k ; ++ i ) {  pos[i] = pos[i >> 1] >> 1 | ( ( i & 1 ) << j ) ;  }  FFT ( A , k , 1 ) ;  **for** ( **int** i = 0 ; i < k ; ++ i ) {  j = ( k - i ) & ( k - 1 ) ;  B[i] = ( A[i] \* A[i] - ( A[j] \* A[j] ).conj () ) \* comp ( 0 , -0.25 ) ;  }  FFT ( B , k , -1 ) ;  **for** ( **int** i = 0 ; i < k ; ++ i ) {  c[i] += ( B[i].r + 0.5 );  }  }  }  **using** **namespace** FFT;  **int** f[5];  **int** a[5][N], b[5][N], c[5][5][N];  **int** d[N];  **char** s1[N], s2[N];  **int** main()  {  **// Open();**  scanf("%s%s", s1, s2);  **int** n = strlen(s1);  **for**(**int** i = 0; i < n; i++)  a[s1[i]-'A'][i] = a[s1[i]-'A'][i+n] = 1, b[s2[i]-'a'][n-i] = 1;  **for**(**int** i = 0; i < 5; i++)  f[i] = i;  **int** len = 1;  **while**(len<2\*n) len <<= 1;  **for**(**int** i = 0; i < 5; i++)  **for**(**int** j = 0; j < 5; j++)  {  mul(a[i], b[j], c[i][j], len);  }  **int** ans = 0;  **do**{  **for**(**int** i = n; i<2\*n; i++) d[i] = 0;  **for**(**int** i = 0; i < 5; i++)  **for**(**int** j = n; j < 2\*n; j++)  d[j] += c[i][f[i]][j];  ans = max(ans, \*max\_element(d+n, d+2\*n));  }**while**(next\_permutation(f, f+5));  **// cout<<ans<<endl;**  printf("%d\n", n-ans);  **return** 0;  } |

### 对小模数取模的FFT

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 2000020;  **const** **int** mod=1000003;  **const** **double** PI=acos(-1.0);  **struct** Complex  {  **double** x,y;  Complex(**double** \_x=0,**double** \_y=0):x(\_x),y(\_y){}  Complex **operator** + (**const** Complex &b)**const**  {  **return** Complex(x+b.x,y+b.y);  }  Complex **operator** - (**const** Complex &b)**const**  {  **return** Complex(x-b.x,y-b.y);  }  Complex **operator** \* (**const** Complex &b)**const**  {  **return** Complex(x\*b.x-y\*b.y,x\*b.y+y\*b.x);  }  Complex **operator** / (**const** **double** &b)**const**  {  **return** Complex(x/b,y/b);  }  };  **void** change(Complex y[],**int** len)  {  **for**(**int** i=1,j=len/2;i<len-1;i++)  {  **if**(i<j)swap(y[i],y[j]);  **int** k=len/2;  **while**(j>=k)  {  j-=k;  k/=2;  }  **if**(j<k)j+=k;  }  }  **void** fft(Complex y[],**int** len,**int** on)  {  change(y,len);  **for**(**int** h=2;h<=len;h<<=1)  {  Complex wn(cos(-on\*2\*PI/h),sin(-on\*2\*PI/h));  **for**(**int** j=0;j<len;j+=h)  {  Complex w(1,0);  **for**(**int** k=j;k<j+h/2;k++)  {  Complex u=y[k];  Complex v=w\*y[k+h/2];  y[k]=u+v;  y[k+h/2]=u-v;  w=w\*wn;  }  }  }  **if**(on==-1)**for**(**int** i=0;i<len;i++)  y[i]=y[i]/len;  }  Complex p1[N],p2[N],p3[N],q1[N],q2[N];  **void** multiply(**int** p[],**int** q[],**int** m)  {  **int** t=sqrt(mod),len=1;  **while**(len<2\*m)len<<=1;  **for**(**int** i=0;i<len;i++)  {  p1[i]=(i<m ? p[i]/t : 0);  p2[i]=(i<m ? p[i]%t : 0);  p3[i]=0;  q1[i]=(i<m ? q[i]/t : 0);  q2[i]=(i<m ? q[i]%t : 0);  }  fft(p1,len,1),fft(p2,len,1),fft(q1,len,1),fft(q2,len,1);  **for**(**int** i=0;i<len;i++)  {  p3[i]=p1[i]\*q2[i]+p2[i]\*q1[i];  p1[i]=p1[i]\*q1[i];  p2[i]=p2[i]\*q2[i];  }  fft(p1,len,-1),fft(p2,len,-1),fft(p3,len,-1);  **for**(**int** i=0;i<len;i++)  {  **long** **long** t1=p1[i].x+0.5,t2=p2[i].x+0.5,t3=p3[i].x+0.5;  p[i]=(t1\*t\*t+t\*t3+t2)%mod;  }  **for**(**int** i=m;i<len;i++)  {  p[i%m]=(p[i%m]+p[i])%mod;  p[i]=0;  }  }  **int** f[N], g[N], t[N];  LL pow\_mod(LL x, LL k, LL m)  {  LL res = 1;  **while**(k)  {  **if**(k & 1) res = res \* x % mod;  x = x\*x%mod;  k >>= 1;  }  **return** res;  }  **int** main()  {  **// Open();**  **int** n, m, p;  scanf("%d%d%d", &n, &m, &p);  **for**(**int** i = 'A'; i <= 'Z'; i++) g[i%m]++;  f[0] = 1;  **while**(n)  {  **if**(n&1)  {  memset(t, 0, **sizeof**(t));  **for**(**int** i = 0; i < m; i++)  t[i] = (t[i] + f[i\*p%m])%mod;  multiply(t, g, m);  memcpy(f, t, **sizeof**(t));  }  memset(t, 0, **sizeof**(t));  **for**(**int** i = 0; i < m; i++)  t[i] = (t[i] + g[i\*p%m])%mod;  multiply(t, g, m);  memcpy(g, t, **sizeof**(t));  p = 1LL\*p\*p%m;  n >>= 1;  }  LL ans = 0;  LL inv2 = pow\_mod(2, mod-2, mod);  **// cout<<inv2<<endl;**  **for**(**int** i = 0; i < m; i++)  {  ans = (ans + (LL)f[i]\*(f[i]-1)\*inv2%mod)%mod;  }  cout<<ans<<endl;  **return** 0;  } |

### 矩阵行列式的值

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<n)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 222;  LL mod;  LL a[N][N];  **//求行列式的值**  **//先化为上三角矩阵，然后将对角线的值相乘即可，由于有交换行列的操作，每交换一次，答案的符号改变一次。**  LL Det(LL a[][N], LL n)  {  **for**(LL i = 0; i < n; i++)  **for**(LL j = 0; j < n; j++)  a[i][j] = (a[i][j]%mod+mod)%mod;  LL ans = 1;  **for**(LL i = 0; i < n; i++)  {  **for**(LL j = i+1; j < n; j++)  {  **//欧几里得辗转相消**  **while**(a[j][i])  {  LL t = a[i][i] / a[j][i];  **for**(LL k = i; k < n; k++)  a[i][k] = (a[i][k] - a[j][k]\*t%mod)%mod;  **for**(LL k = i; k < n; k++)  swap(a[i][k], a[j][k]);  ans = -ans;  }  }  **if**(!a[i][i]) **return** 0;  ans = ans\*a[i][i]%mod;  }  **return** (ans + mod) % mod;  }  **int** main()  {  **// Open();**  LL n;  **while**(~scanf("%lld%lld", &n, &mod))  {  **for**(LL i = 0; i < n; i++)  **for**(LL j = 0; j < n; j++)  scanf("%lld", &a[i][j]);  printf("%lld\n", Det(a, n));  }  **return** 0;  } |

### 矩阵快速幂

推荐使用最后一种结构题的实现，需要注意调用resize函数

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| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <cstring>  **#include** <cstdlib>  **#include** <cmath>  **#include** <algorithm>  **#define** N 6  **using** **namespace** std;  **const** **int** mod=1e9+7;  **void** printfm(**int** A[N][N],**int** n,**int** m)  {  **for**(**int** i=0;i<n;i++)  **for**(**int** j=0;j<m;j++)  {  printf("%d%c",A[i][j],(j==m-1)?'\n':' ');  }  printf("\n");  }  **void** mul(**int** A[N][N],**int** B[N][N],**int** t[N][N],**int** n,**int** m,**int** l)**//A 为n\*m的矩阵，B为m\*l的矩阵,t为结果矩阵**  {  **int** tmp[N][N];**//为了防止冲突**  **for**(**int** i=0;i<n;i++)  **for**(**int** j=0;j<l;j++){  tmp[i][j]=0;  **for**(**int** k=0;k<m;k++)  tmp[i][j]=(tmp[i][j]+A[i][k]\*B[k][j])%mod;  }  **for**(**int** i=0;i<n;i++) **for**(**int** j=0;j<l;j++) t[i][j]=tmp[i][j];  }  **void** expo(**int** p[N][N],**int** e[N][N],**int** k,**int** n)**//P为n\*n的矩阵，k为计算k次幂，e为结果矩阵**  {  **for**(**int** i = 0; i < n; ++i) **for**(**int** j = 0; j < n; ++j) e[i][j] = (i == j);  **while**(k) {  **if**(k&1) mul(e,p,e,n,n,n);  mul(p,p,p,n,n,n);  k>>=1;  }  }  **int** a[N][N];  **int** b[N][N];  **int** c[N][N];  **int** main()  {  **#ifndef** ONLINE\_JUDGE  **//freopen("E:/in.txt","r",stdin);**  **//freopen("E:/my.txt","w",stdout);**  **#endif**  **int** n,a0,ax,ay,b0,bx,by;  **while**(~scanf("%d%d%d%d%d%d%d",&n,&a0,&ax,&ay,&b0,&bx,&by))  {  memset(a,0,**sizeof**(a));  memset(b,0,**sizeof**(b));  memset(c,0,**sizeof**(c));  a[0][0]=0,a[0][1]=a0\*b0%mod,a[0][2]=a0,a[0][3]=b0,a[0][4]=1;  b[0][0]=1,b[1][0]=1,b[1][1]=ax\*bx%mod,b[2][1]=ax\*by%mod,b[2][2]=ax,b[3][1]=bx\*ay%mod;  b[3][3]=bx,b[4][1]=ay\*by%mod,b[4][2]=ay,b[4][3]=by,b[4][4]=1;  **//printfm(a,1,5);**  **//printfm(b,5,5);**  expo(b,c,n,5);  mul(a,c,c,1,5,5);  printf("%d\n",c[0][0]);  }  **return** 0;  }  **//比较优雅的方式**  **struct** Matrix  {  ll a[2][2];  Matrix()  {  memset(a,0,**sizeof**(a));  }  **void** init()  {  **for**(**int** i=0;i<2;i++)  **for**(**int** j=0;j<2;j++)  a[i][j]=(i==j);  }  Matrix **operator** \* (**const** Matrix &B)**const**  {  Matrix C;  **for**(**int** i=0;i<2;i++)  **for**(**int** j=0;j<2;j++)  **for**(**int** k=0;k<2;k++)  C.a[i][j]=(C.a[i][j]+a[i][k]\*B.a[k][j])%Mod;  **return** C;  }  Matrix **operator** ^ (**const** ll &t)**const**  {  Matrix res,A=(\***this**);  ll p=t;  res.init();  **while**(p)  {  **if**(p&1)res=res\*A;  A=A\*A;  p>>=1;  }  **return** res;  }  }t[MAXM];  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** MN = 110;  **///该快速幂板子运算前一定要记得将矩阵的初始化**  **struct** Mat{  **int** n, m;  LL mat[MN][MN];  Mat(**int** \_n = MN, **int** \_m = MN){n = \_n, m = \_m;}  **void** resize(**int** \_n, **int** \_m){n = \_n, m = \_m;memset(mat, 0, **sizeof**(mat));}  **void** unit(**int** \_n, **int** \_m)  {  n = \_n, m = \_m;memset(mat, 0, **sizeof**(mat));  **for**(**int** i = 0; i < n; i++) mat[i][i] = 1;  }  **void** print()  {  **for**(**int** i = 0; i < n; i++, printf("\n"))  **for**(**int** j = 0; j < m; j++)  printf("%d ", mat[i][j]);  }  };  Mat **operator**\*(Mat a, Mat b)  {  **int** n = a.n, m = a.m, k = b.m;  Mat c;  c.resize(n, k);  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0; j < k; j++)  **for**(**int** l = 0; l < m; l++)  {  **if**(a.mat[i][l] && b.mat[l][j])  c.mat[i][j] += a.mat[i][l]\*b.mat[l][j];  }  **return** c;  }  Mat **operator**^(Mat A, **int** x)  {  Mat c;  c.unit(A.n, A.m);  **while**(x)  {  **if**(x & 1) c = c\*A;  A = A\*A;  x >>= 1;  }  **return** c;  }  **char** op[3];  **int** main()  {  **// Open();**  **int** n, m, k;  **while**(~scanf("%d%d%d", &n, &m, &k))  {  **if**(n+m+k == 0) **break**;  Mat res, tmp, ini;  res.unit(n+1, n+1);  **while**(k--)  {  scanf("%s", op);  **int** x, y;  **if**(op[0] == 'g')  {  scanf("%d", &x);  x--;  **for**(**int** i = 0; i < n+1; i++)  {  res.mat[i][x]+=res.mat[i][n];  }  }  **if**(op[0] == 's')  {  scanf("%d%d", &x, &y);  **if**(x == y) **continue**;  x--, y--;  **for**(**int** i = 0; i < n+1; i++)  swap(res.mat[i][x], res.mat[i][y]);  }  **if**(op[0] == 'e')  {  scanf("%d", &x);  x--;  **for**(**int** i = 0; i < n+1; i++)  res.mat[i][x] = 0;  }  }  ini.resize(1, n+1);  ini.mat[0][n] = 1;  res = res^m;  ini = ini\*res;  **for**(**int** i = 0; i < n; i++)  {  printf("%lld%c", ini.mat[0][i], " \n"[i == n-1]);  }  }  **return** 0;  } |

### 快速乘法

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| **//两个大数相乘爆long long，但是相加不会爆**  LL mul(LL x, LL y)  {  LL ret = 0;  **while**(y)  {  **if**(y & 1) ret = (ret+x) %mod;  x = (x+x)%mod;  y >>= 1;  }  **return** ret;  } |

### 朴素筛素数

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| //  **int** prime[N];  **int** pn;  **void** get\_prime()  {  **for**(**int** i=2;i<N;i++)  {  **if**(vis[i]) **continue**;  prime[pn++]=i;  **for**(**int** j=i;j<N;j+=i)  {  vis[j]=1;  }  }  }  //朴素筛素数  //--------------------O(n)筛法------------------------//  bool pvis[N];  **int** pri[N];  **int** prin;  **void** getpri(){  prin = 0;  memset(pvis, 0, sizeof(pvis));  **for**(**int** i = 2; i < N; i++) {  **if**(pvis[i] == 0) pri[prin++] = i;  **for**(**int** j = 0; j < prin && (**long** **long**)pri[j]\*i < N; j++) {  pvis[pri[j]\*i] = 1;  **if**(i % pri[j] == 0) **break**;  }  }  } |

### HDU5768\_CRT

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| **#include** <stdio.h>  **#include** <stdlib.h>  **#include** <string.h>  **#include** <math.h>  **#include** <ctype.h>  **#include** <time.h>  **#include** <iostream>  **#include** <algorithm>  **#include** <vector>  **#include** <stack>  **#include** <queue>  **#include** <deque>  **#include** <set>  **#include** <map>  **#include** <bitset>  **#include** <list>  **#include** <climits>  **using** **namespace** std;  **#define** MAXN 20  **typedef** **unsigned** **long** **long** ULL;  **typedef** **long** **long** LL;  **long** **long** p[MAXN];  **long** **long** a[MAXN];  **long** **long** tp[MAXN] = {7};  **long** **long** ta[MAXN];  LL mul(LL a, LL b, LL c)  {  **if**(a < 0) a+= c;  **if**(b < 0) b+= c;  LL ans = 0;  **while**(b)  {  **if**(b&1) ans = (ans+a)%c;  a = a\*2%c;  b >>= 1;  }  **return** ans;  }  **long** **long** extend\_gcd(**long** **long** a, **long** **long** b, **long** **long**& x, **long** **long**& y)  {  **if**(!b)  {  x = 1;  y = 0;  **return** a;  }  **long** **long** r = extend\_gcd(b, a%b, y, x);  y -= x \* (a / b);  **return** r;  }  **long** **long** M;  **long** **long** crt(**long** **long** n, **long** **long**\* a, **long** **long**\* m)  {  **long** **long** ret=0, x, y, tm, i;  **for**(i=0, M=1; i<n; i++)  M \*= m[i];  **for**(i=0; i<n; i++)  {  tm = M / m[i];  extend\_gcd(tm, m[i], x, y);  ret = (ret + mul(a[i], mul(tm, x%M, M), M))%M;  **//ret = (ret + tm\*x%M\*a[i]%M)%M;**  }  **return** (ret + M) % M;  }  **int** main()  {  **//cout<<tp[0]<<endl;**  **// freopen("/home/qingping/in.txt", "r", stdin);**  **// cout<<LLONG\_MAX<<endl;**  **// cout<<(long long)1e18<<endl;**  **long** **long** T, t, n, i, j, cnt, ans;  **long** **long** x, y, r;  scanf("%I64d", &T);  **for**(t=1; t<=T; t++)  {  scanf("%I64d%I64d%I64d", &n, &x, &y);  **for**(i=0; i<n; i++)  scanf("%I64d%I64d", p+i, a+i);  **for**(i=ans=0; i<(1<<n); i++)  {  tp[0] = 7, ta[0] = 0;  **for**(j=cnt=0; j<n; j++)  {  **if**(i & (1 << j))  {  tp[++cnt] = p[j];  ta[cnt] = a[j];  }  }  **// printf("cnt:%I64d\n", cnt);**  r = crt(cnt + 1, ta, tp);  **if**(x < r && y < r) **continue**;  **long** **long** st = (x-r)%M == 0 ? (x-r)/M : ceil((**long** **double**)(1.0\*(x-r))/M);  **long** **long** ed = (y-r)%M == 0 ? (y-r)/M : floor((**long** **double**)(1.0\*(y-r))/M);  **long** **long** sum = max(0LL, ed - st + 1);  ans += (cnt & 1) ? -sum : sum;  }  printf("Case #%I64d: %I64d\n", t, ans);  }  **return** 0;  } |

### 中国剩余定理

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<LL,LL> PII;  **const** LL INF=0x3f3f3f3f3f3f3f3fLL;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **// freopen("/home/qingping/in.txt","r",stdin);**  **// freopen("/home/qingping/out.txt","w",stdout);**  **// freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** LL N = 100100;  PII p[N];  LL n, m;  **void** ex\_gcd(LL a, LL b,LL &x, LL &y)  {  **if**(b == 0){  x = 1;y = 0;**return** ;  }  ex\_gcd(b, a%b, x, y);  LL tmp = x;  x = y;  y = tmp - (a/b)\*y;  }  LL CRT(LL a[],LL m[],LL n)  {  LL M = 1;  LL ans = 0;  **for**(LL i=1; i<=n; i++)  M \*= m[i];  **for**(LL i=1; i<=n; i++)  {  LL x, y;  LL Mi = M / m[i];  ex\_gcd(Mi, m[i], x, y);  \\\\\\\\\这里很容易爆long **long///////**  ans = (ans + Mi \* x \* a[i]) % M;  }  **if**(ans < 0) ans += M;  **return** ans;  }  LL check(LL x, LL y)  {  **if**(abs(x-y)%\_\_gcd(2\*n, 2\*m)) **return** INF;  LL g = \_\_gcd(2\*n, 2\*m);  LL a[] = {x, y};  LL M[] = {2\*n, 2\*m};  LL X, Y;  ex\_gcd(2\*n, 2\*m, X, Y);  X \*= abs(x-y)/g;  Y \*= abs(x-y)/g;  **//将X和Y放置到距离0最近的位置**  X -= 2\*m/g\*(X/(2\*m/g));  Y -= 2\*n/g\*(Y/(2\*n/g));  **while**(X\*2\*n+x<=0) X += 2\*m/g;  **while**(Y\*2\*m+y<=0) Y += 2\*n/g;  **//**  LL val = min(X\*2\*n+x, Y\*2\*m+y);  **return** val;  }  LL solve(LL x, LL y)  {  LL val = check(x, y);  val = min(val, check(2\*n-x, 2\*m-y));  val = min(val, check(2\*n-x, y));  val = min(val, check(x, 2\*m-y));  **return** val;  }  **int** main(){  **// Open();**  LL k;  scanf("%I64d%I64d%I64d", &n, &m, &k);  LL mit = solve(0, m);  mit = min(mit, solve(n, 0));  mit = min(mit, solve(n, m));  **// cout<<mit<<endl;**  **for**(LL i = 0; i < k; i++)  {  LL x, y;  scanf("%I64d%I64d", &x, &y);  **if**(n == m)  {  **if**(x == y) printf("%I64d\n", x);  **else** printf("-1\n");  **continue**;  }  LL val = solve(x, y);  **if**(val >= mit) val = -1;  printf("%I64d\n", val);  }  **return** 0;  } |

### FWT：AND

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| **///用之前记得修改数据类型**  **///按照网上的写的，没有测试过正确性**  **///来源：http://www.chanmefang.com/?tag=fwt**  **///来源：http://picks.logdown.com/posts/179290-fast-walsh-hadamard-transform#**  **void** fwt(LL \*x, LL n, **int** op) {  **int** mm;  **for** (mm = 1; mm < n; mm <<= 1) { **//2m**  **for** (**int** st = 0; st < n; st += mm << 1)  **for** (LL i = 0; i < mm; i ++) {  LL a = x[st + i], b = x[st + i + mm];  **if**(op == 1)x[st+i] = (a+b)%mod;  **else** x[st+i] = (a-b)%mod;  **if**(x[st+i] < 0) x[st+i] += mod;  x[st+i+mm] = b;  }  }  } |

### FWT：OR

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| **///用的时候记得将mod改回去**  **///以及数据类型**  **///卷积外面的部分与普通FFT，FWT相同**  **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <bitset>  **#define** CHECK(x, y) ((x)>=0&&(x)<n&&(y)>=0&&(y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<LL, LL> PII;  **const** LL INF = 0x3f3f3f3f3f3f3f3fLL;  **//const LL mod = 1e9+7.5;**  **const** LL N = 1010;  **const** LL mod = 1LL<<32;  **typedef** **unsigned** **int** uint;  uint cur = 0;  uint a, b;  uint nextRand()  {  cur = cur \* a + b;  **return** cur / (1<<16);  }  uint f[1<<17], g[1<<17];  **void** fwt(uint \*x, uint n, **int** op) {  **int** mm;  **for** (mm = 1; mm < n; mm <<= 1) { **//2m**  **for** (**int** st = 0; st < n; st += mm << 1)  **for** (uint i = 0; i < mm; i ++) {  uint a = x[st + i], b = x[st + i + mm];  x[st+i] = a;  **if**(op == 1) x[st + i + mm] = (b+a)%mod;  **else** x[st+i+mm] = (b-a)%mod;  **if**(x[st+i+mm] < 0) x[st+i+mm] += mod;  }  }  }  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  uint n, T;  scanf("%u%u", &n, &T);  scanf("%u%u", &a, &b);  **// cout<<n<<" "<<T<<endl;**  **while**(T--)  {  uint limit = 1<<n;  memset(f, 0, **sizeof**(f));  memset(g, 0, **sizeof**(g));  **for**(uint i = 0; i < limit; i++)  {  f[i] = nextRand();  **// cout<<f[i]<<" ";**  }  **// cout<<endl;**  **for**(uint i = 0; i < limit; i++)  {  g[i] = nextRand();  **// cout<<g[i]<<" ";**  }  **// cout<<endl;**  uint len = limit<<1;  fwt(f, len, 1);  fwt(g, len, 1);  **for**(uint i = 0; i < len; i++)  f[i] = f[i] \* g[i] % mod;  fwt(f, len, -1);  uint ans = 0;  **for**(uint i = 0; i < limit; i++)  {  **// cout<<f[i]<<" ";**  ans += f[i] \* (i+1)%mod;  }  **// cout<<endl;**  printf("%u\n", ans);  }  **return** 0;  } |

### 欧拉函数：求小于n的有多少个数与n互质

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| **//欧拉函数：求小于n的有多少个数与n互质O(sqrt(n))，**  **//这里根据代码逻辑，似乎可以先打出质数表，利用质数表的话效率会更高才对**  **//O(sqrt(n))**  **int** phi(**int** n)  {  **int** res=n,a=n;  **for**(**int** i=2;i\*i<=a;i++){  **if**(a%i==0){  res=res/i\*(i-1);**//先进行除法是为了防止中间数据的溢出**  **while**(a%i==0) a/=i;  }  }  **if**(a>1) res=res/a\*(a-1);  **return** res;  }  **//先打质数表的版本，复杂度O(logn)**  **bool** vis[N];  **int** pri[N];  **int** pt;  **void** getpri()  {  pt = 0;  **for**(**int** i = 2; i < N; i++)  {  **if**(vis[i]) **continue**;  pri[pt++] = i;  **for**(**int** j = i; j < N; j += i) vis[j] = 1;  }  }  **int** phi(**int** n)  {  **int** res=n,a=n;  **for**(**int** i=0;pri[i]\*pri[i]<=a;i++){  **if**(a%pri[i]==0){  res=res-res/pri[i];**//先进行除法是为了防止中间数据的溢出**  **while**(a%pri[i]==0) a/=pri[i];  }  }  **if**(a>1) res=res-res/a;  **return** res;  }  **//欧拉函数：求小于n的有多少个数与n互质**  **//筛法欧拉函数，复杂度与素数表一样**  **int** euler[N];  **void** getEuler(**int** UP)  {  memset(euler, 0, **sizeof**(euler));  euler[1] = 1;  **for**(**int** i = 2; i <= UP; i++)  {  **if**(!euler[i])  {  **for**(**int** j = i; j <= UP; j += i)  {  **if**(!euler[j]) euler[j] = j;  euler[j] = euler[j] / i \* (i-1);  }  }  }  }  **//筛法欧拉函数**  **///O(N)**  **void** linear\_phi\_table2()  {  **int** i, j, k = 0;  **for** (i = 2; i < mx; i++)  {  **if** (!unprime[i]) **///若i为素数，phi(i)=i-1**  {  prime[k++] = i;  phi[i] = i - 1;  }  **for** (j = 0; j < k && prime[j] \* i < maxn; j++)  {  unprime[prime[j] \* i] = **true**;  **if** (i % prime[j]) **///若i和p互素，则phi(i\*p) = phi(i) \* phi(p) = phi(i) \* (p-1)**  phi[prime[j] \* i] = phi[i] \* (prime[j] - 1);  **else**  {  **///此时有i=kp，则**  **///phi(p\*kp) = phi(k\*p^2) = p\*phi(kp)**  phi[prime[j] \* i] = phi[i] \* prime[j];  **break**;  }  }  }  } |

### 快速幂运算（模）

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| **//快速幂运算（模）**  **int** mod\_pow(**int** x,**int** n)  {  **int** res=1;  **while**(n>0)  {  **if**(n&1) res=(**long** **long**)res\*x%mod;  x=x\*x%mod;  n>>=1;  }  **return** res;  }  **//快速幂运算（模）**  **//如果乘法可能爆long long的话， 使用下面的板子**  ll mul(ll a,ll b){  **return** ((a\*b-ll(((**long** **double**)a)/mod\*b+1e-3)\*mod)%mod+mod)%mod;  }  ll pow\_mod(ll a, ll n) {  a%=mod;  ll r = 1;  **while**(n) {  **if**(n&1) r = mul(r,a);  a=mul(a,a);  n>>=1;  }  **return** r;  } |

### 康拓展开hash阶乘

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| **int** fac[]={1,1,2,6,24,120,720,5040,40320,362880}; //康拖展开判重  // 0!1!2!3! 4! 5! 6! 7! 8! 9!  **int** Cantor(**int** s[],n){ //康拖展开求该序列的hash值  **int** sum=0;  **for**(**int** i=0;i<n;i++){  **int** cnt=0;  **for**(**int** j=i+1;j<n;j++)  **if**(s[i]>s[j])  cnt++;  sum+=(cnt\*fac[n-i-1]);  }  **return** sum;  }  **void** invCantor(**int** ans[], **int** n, **int** k)  {  **int** vis[20] = {0};  **int** i, j, t;  **for** (i = 0; i < n; ++i)  {  t = k / fac[n - i - 1];  **for** (j = 1; j <= n; j++)  **if** (!vis[j])  {  **if** (t == 0) **break**;  --t;  }  ans[i] = j, vis[j] = **true**;  k %= fac[n - i - 1];///余数  }  } |

### 高斯消元(异或)

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| **int** cal(**int** row) **//高斯消元中，有num-row个自由元，枚举自由元之后计算结果，回代过程**  {  **for**(**int** i=row-1;i>=0;i--)  {  ans[i] = mat[i][num];  **for**(**int** j=i+1;j<num;j++)  ans[i]^=mat[i][j]\*ans[j];  }  **int** rnt = 0;  **//枚举自由元之后的操作**  **for**(**int** i=0;i<num;i++)  rnt += ans[i];  **return** rnt;  }  **int** gauss(**int** ty)  {  init(ty);**//初始化系数矩阵**  **int** row = 0, col = 0;  **while**(row < num && col < num)  {  **int** i;  **for**(i = row; i<num; i++)  **if**(mat[i][col]) **break**;  **if**(i == num){  col++;**continue**;  }  **if**(i != row)**// 这里的行交换和普通高斯消元相同，将矩阵变为上三角矩阵**  {  **for**(**int** j = col; j <= num;j++)  swap(mat[i][j], mat[row][j]);  }  **if**(row != col)**// 这里的列交换是为了将自由元移动到后面，方便处理**  {  **for**(**int** j=0;j<num;j++)  swap(mat[j][row], mat[j][col]);  }  **for**(**int** i = row + 1; i < num; i++)  {  **if**(mat[i][row] == 0) **continue**;  **for**(**int** j = row; j <= num; j++)  mat[i][j] ^= mat[row][j];  }  row++, col++;  }  **for**(**int** i = row; i < num; i++) **// 检测所有全0行的结果是否为1，如果为1，则无解**  **if**(mat[i][num]) **return** -1;  **// 枚举自由元**  **int** free = num - row;  **int** len = 1<<free;  **int** rnt = INF;  **for**(**int** i = 0; i < len; i++)  {  **for**(**int** j = 0; j < free; j++)  ans[num - j - 1] = ((i >> j) & 1);  rnt = min(rnt , cal(row));  }  **return** rnt;  } |

### 分数类

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| **struct** Fraction{  LL num, den;  Fraction(LL num = 0, LL den = 1)  {  **if**(den < 0){  num = -num;  den = -den;  }  LL g = \_\_gcd(abs(num), den);  **this** -> num = num / g;  **this** -> den = den / g;  }  Fraction operator + (**const** Fraction& o)**const**{  **return** Fraction(num \* o.den + den \* o.num, den \* o.den);  }  Fraction operator + (**const** LL& o)**const**{  **return** Fraction(num + den \* o, den);  }  Fraction operator - (**const** Fraction& o)**const**{  **return** Fraction(num \* o.den - den \* o.num, den \* o.den);  }  Fraction operator \* (**const** Fraction& o)**const**{  **return** Fraction(num \* o.num, den \* o.den);  }  Fraction operator \* (**const** LL& o)**const**{  **return** Fraction(num \* o, den);  }  Fraction operator / (**const** Fraction& o)**const**{  **return** Fraction(num \* o.den, den \* o.num);  }  Fraction operator / (**const** LL& o)**const**{  **return** Fraction(num, den \* o);  }  bool operator < (**const** Fraction& o)**const**{  **return** num \* o.den < den \* o.num;  }  bool operator == (**const** Fraction& o)**const**{  **return** num \* o.den == den \* o.num;  }  }; |

### 大素数判断(无random)

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| LL mul(LL a,LL b, LL c)  {  LL ans=0;  **while**(b){  **if**(b&1)ans=(ans+a)%c;  a=(a\*2)%c;  b>>=1;  }  **return** ans;  }  LL pow(LL x,LL n,LL mod)  {  LL res=1;  **while**(n>0){  **if**(n&1)res=mul(res,x,mod);  x=mul(x,x,mod);  n>>=1;  }  **return** res;  }  bool test(LL nn,LL a,LL d)  {  **if**(nn==1) **return** **false**;  **if**(nn==2) **return** **true**;  **if**(nn==a) **return** **true**;  **if**((nn&1)==0) **return** **false**;  **while**(!(d&1))  d=d>>1;  LL t=pow(a,d,nn);  **while**((d!=nn-1)&&(t!=1)&&(t!=nn-1))  {  t=mul(t,t,nn);  d=d<<1;  }  **return** (t==nn-1||(d&1)==1);  }  bool isPrime(LL N)  {  **if**(N<2)  **return** **false**;  LL a[]={2,3,61};//一些质数  **for**(**int** i=0;i<=2;i++)//利用每个质数进行测试  {  **if**(!test(N,a[i],N-1))  **return** **false**;  }  **return** **true**;  } |

### 高精度(字符串)

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| **#include** <cstdio>  **#include** <cstring>  **#include** <cstdlib>  **//允许生成1120位（二进制）的中间结果**  **#define** BI\_MAXLEN 105  **#define** DEC 10  **#define** HEX 16  **class** CBigInt  {  **public**:  **//大数在0x100000000进制下的长度**  **unsigned** m\_nLength;  **//用数组记录大数在0x100000000进制下每一位的值**  **unsigned** **long** m\_ulValue[BI\_MAXLEN];  CBigInt();  ~CBigInt();  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **基本操作与运算**  **Mov，赋值运算，可赋值为大数或普通整数，可重载为运算符“=”**  **Cmp，比较运算，可重载为运算符“==”、“!=”、“>=”、“<=”等**  **Add，加，求大数与大数或大数与普通整数的和，可重载为运算符“+”**  **Sub，减，求大数与大数或大数与普通整数的差，可重载为运算符“-”**  **Mul，乘，求大数与大数或大数与普通整数的积，可重载为运算符“\*”**  **Div，除，求大数与大数或大数与普通整数的商，可重载为运算符“/”**  **Mod，模，求大数与大数或大数与普通整数的模，可重载为运算符“%”**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** Mov(**unsigned** \_\_int64 A);  **void** Mov(CBigInt& A);  CBigInt Add(CBigInt& A);  CBigInt Sub(CBigInt& A);  CBigInt Mul(CBigInt& A);  CBigInt Div(CBigInt& A);  CBigInt Mod(CBigInt& A);  CBigInt Add(**unsigned** **long** A);  CBigInt Sub(**unsigned** **long** A);  CBigInt Mul(**unsigned** **long** A);  CBigInt Div(**unsigned** **long** A);  **unsigned** **long** Mod(**unsigned** **long** A);  **int** Cmp(CBigInt& A);  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **输入输出**  **Get，从字符串按10进制或16进制格式输入到大数**  **Put，将大数按10进制或16进制格式输出到字符串**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** Get(**char** str[], **unsigned** **int** system=DEC);  **void** Put(**char** str[], **unsigned** **int** system=DEC);  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **RSA相关运算**  **Rab，拉宾米勒算法进行素数测试**  **Euc，欧几里德算法求解同余方程**  **RsaTrans，反复平方算法进行幂模运算**  **GetPrime，产生指定长度的随机大素数**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **int** Rab();  CBigInt Euc(CBigInt& A);  CBigInt RsaTrans(CBigInt& A, CBigInt& B);  **void** GetPrime(**int** bits);  };  **//小素数表**  **const** **static** **int** PrimeTable[550]=  { 3, 5, 7, 11, 13, 17, 19, 23, 29, 31,  37, 41, 43, 47, 53, 59, 61, 67, 71, 73,  79, 83, 89, 97, 101, 103, 107, 109, 113, 127,  131, 137, 139, 149, 151, 157, 163, 167, 173, 179,  181, 191, 193, 197, 199, 211, 223, 227, 229, 233,  239, 241, 251, 257, 263, 269, 271, 277, 281, 283,  293, 307, 311, 313, 317, 331, 337, 347, 349, 353,  359, 367, 373, 379, 383, 389, 397, 401, 409, 419,  421, 431, 433, 439, 443, 449, 457, 461, 463, 467,  479, 487, 491, 499, 503, 509, 521, 523, 541, 547,  557, 563, 569, 571, 577, 587, 593, 599, 601, 607,  613, 617, 619, 631, 641, 643, 647, 653, 659, 661,  673, 677, 683, 691, 701, 709, 719, 727, 733, 739,  743, 751, 757, 761, 769, 773, 787, 797, 809, 811,  821, 823, 827, 829, 839, 853, 857, 859, 863, 877,  881, 883, 887, 907, 911, 919, 929, 937, 941, 947,  953, 967, 971, 977, 983, 991, 997, 1009, 1013, 1019,  1021, 1031, 1033, 1039, 1049, 1051, 1061, 1063, 1069, 1087,  1091, 1093, 1097, 1103, 1109, 1117, 1123, 1129, 1151, 1153,  1163, 1171, 1181, 1187, 1193, 1201, 1213, 1217, 1223, 1229,  1231, 1237, 1249, 1259, 1277, 1279, 1283, 1289, 1291, 1297,  1301, 1303, 1307, 1319, 1321, 1327, 1361, 1367, 1373, 1381,  1399, 1409, 1423, 1427, 1429, 1433, 1439, 1447, 1451, 1453,  1459, 1471, 1481, 1483, 1487, 1489, 1493, 1499, 1511, 1523,  1531, 1543, 1549, 1553, 1559, 1567, 1571, 1579, 1583, 1597,  1601, 1607, 1609, 1613, 1619, 1621, 1627, 1637, 1657, 1663,  1667, 1669, 1693, 1697, 1699, 1709, 1721, 1723, 1733, 1741,  1747, 1753, 1759, 1777, 1783, 1787, 1789, 1801, 1811, 1823,  1831, 1847, 1861, 1867, 1871, 1873, 1877, 1879, 1889, 1901,  1907, 1913, 1931, 1933, 1949, 1951, 1973, 1979, 1987, 1993,  1997, 1999, 2003, 2011, 2017, 2027, 2029, 2039, 2053, 2063,  2069, 2081, 2083, 2087, 2089, 2099, 2111, 2113, 2129, 2131,  2137, 2141, 2143, 2153, 2161, 2179, 2203, 2207, 2213, 2221,  2237, 2239, 2243, 2251, 2267, 2269, 2273, 2281, 2287, 2293,  2297, 2309, 2311, 2333, 2339, 2341, 2347, 2351, 2357, 2371,  2377, 2381, 2383, 2389, 2393, 2399, 2411, 2417, 2423, 2437,  2441, 2447, 2459, 2467, 2473, 2477, 2503, 2521, 2531, 2539,  2543, 2549, 2551, 2557, 2579, 2591, 2593, 2609, 2617, 2621,  2633, 2647, 2657, 2659, 2663, 2671, 2677, 2683, 2687, 2689,  2693, 2699, 2707, 2711, 2713, 2719, 2729, 2731, 2741, 2749,  2753, 2767, 2777, 2789, 2791, 2797, 2801, 2803, 2819, 2833,  2837, 2843, 2851, 2857, 2861, 2879, 2887, 2897, 2903, 2909,  2917, 2927, 2939, 2953, 2957, 2963, 2969, 2971, 2999, 3001,  3011, 3019, 3023, 3037, 3041, 3049, 3061, 3067, 3079, 3083,  3089, 3109, 3119, 3121, 3137, 3163, 3167, 3169, 3181, 3187,  3191, 3203, 3209, 3217, 3221, 3229, 3251, 3253, 3257, 3259,  3271, 3299, 3301, 3307, 3313, 3319, 3323, 3329, 3331, 3343,  3347, 3359, 3361, 3371, 3373, 3389, 3391, 3407, 3413, 3433,  3449, 3457, 3461, 3463, 3467, 3469, 3491, 3499, 3511, 3517,  3527, 3529, 3533, 3539, 3541, 3547, 3557, 3559, 3571, 3581,  3583, 3593, 3607, 3613, 3617, 3623, 3631, 3637, 3643, 3659,  3671, 3673, 3677, 3691, 3697, 3701, 3709, 3719, 3727, 3733,  3739, 3761, 3767, 3769, 3779, 3793, 3797, 3803, 3821, 3823,  3833, 3847, 3851, 3853, 3863, 3877, 3881, 3889, 3907, 3911,  3917, 3919, 3923, 3929, 3931, 3943, 3947, 3967, 3989, 4001  };  **//构造大数对象并初始化为零**  CBigInt::CBigInt()  {  m\_nLength=1;  **for**(**int** i=0;i<BI\_MAXLEN;i++)m\_ulValue[i]=0;  }  **//解构大数对象**  CBigInt::~CBigInt()  {  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数比较**  **调用方式：N.Cmp(A)**  **返回值：若N<A返回-1；若N=A返回0；若N>A返回1**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **int** CBigInt::Cmp(CBigInt& A)  {  **if**(m\_nLength>A.m\_nLength)**return** 1;  **if**(m\_nLength<A.m\_nLength)**return** -1;  **for**(**int** i=m\_nLength-1;i>=0;i--)  {  **if**(m\_ulValue[i]>A.m\_ulValue[i])**return** 1;  **if**(m\_ulValue[i]<A.m\_ulValue[i])**return** -1;  }  **return** 0;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数赋值**  **调用方式：N.Mov(A)**  **返回值：无，N被赋值为A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::Mov(CBigInt& A)  {  m\_nLength=A.m\_nLength;  **for**(**int** i=0;i<BI\_MAXLEN;i++)m\_ulValue[i]=A.m\_ulValue[i];  }  **void** CBigInt::Mov(**unsigned** \_\_int64 A)  {  **if**(A>0xffffffff)  {  m\_nLength=2;  m\_ulValue[1]=(**unsigned** **long**)(A>>32);  m\_ulValue[0]=(**unsigned** **long**)A;  }  **else**  {  m\_nLength=1;  m\_ulValue[0]=(**unsigned** **long**)A;  }  **for**(**int** i=m\_nLength;i<BI\_MAXLEN;i++)m\_ulValue[i]=0;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相加**  **调用形式：N.Add(A)**  **返回值：N+A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Add(CBigInt& A)  {  CBigInt X;  X.Mov(\***this**);  **unsigned** carry=0;  **unsigned** \_\_int64 sum=0;  **if**(X.m\_nLength<A.m\_nLength)X.m\_nLength=A.m\_nLength;  **for**(**unsigned** i=0;i<X.m\_nLength;i++)  {  sum=A.m\_ulValue[i];  sum=sum+X.m\_ulValue[i]+carry;  X.m\_ulValue[i]=(**unsigned** **long**)sum;  carry=(**unsigned**)(sum>>32);  }  X.m\_ulValue[X.m\_nLength]=carry;  X.m\_nLength+=carry;  **return** X;  }  CBigInt CBigInt::Add(**unsigned** **long** A)  {  CBigInt X;  X.Mov(\***this**);  **unsigned** \_\_int64 sum;  sum=X.m\_ulValue[0];  sum+=A;  X.m\_ulValue[0]=(**unsigned** **long**)sum;  **if**(sum>0xffffffff)  {  **unsigned** i=1;  **while**(X.m\_ulValue[i]==0xffffffff){X.m\_ulValue[i]=0;i++;}  X.m\_ulValue[i]++;  **if**(m\_nLength==i)m\_nLength++;  }  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相减**  **调用形式：N.Sub(A)**  **返回值：N-A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Sub(CBigInt& A)  {  CBigInt X;  X.Mov(\***this**);  **if**(X.Cmp(A)<=0){X.Mov(0);**return** X;}  **unsigned** carry=0;  **unsigned** \_\_int64 num;  **unsigned** i;  **for**(i=0;i<m\_nLength;i++)  {  **if**((m\_ulValue[i]>A.m\_ulValue[i])||((m\_ulValue[i]==A.m\_ulValue[i])&&(carry==0)))  {  X.m\_ulValue[i]=m\_ulValue[i]-carry-A.m\_ulValue[i];  carry=0;  }  **else**  {  num=0x100000000+m\_ulValue[i];  X.m\_ulValue[i]=(**unsigned** **long**)(num-carry-A.m\_ulValue[i]);  carry=1;  }  }  **while**(X.m\_ulValue[X.m\_nLength-1]==0)X.m\_nLength--;  **return** X;  }  CBigInt CBigInt::Sub(**unsigned** **long** A)  {  CBigInt X;  X.Mov(\***this**);  **if**(X.m\_ulValue[0]>=A){X.m\_ulValue[0]-=A;**return** X;}  **if**(X.m\_nLength==1){X.Mov(0);**return** X;}  **unsigned** \_\_int64 num=0x100000000+X.m\_ulValue[0];  X.m\_ulValue[0]=(**unsigned** **long**)(num-A);  **int** i=1;  **while**(X.m\_ulValue[i]==0){X.m\_ulValue[i]=0xffffffff;i++;}  X.m\_ulValue[i]--;  **if**(X.m\_ulValue[i]==0)X.m\_nLength--;  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相乘**  **调用形式：N.Mul(A)**  **返回值：N\*A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Mul(CBigInt& A)  {  **if**(A.m\_nLength==1)**return** Mul(A.m\_ulValue[0]);  CBigInt X;  **unsigned** \_\_int64 sum,mul=0,carry=0;  **unsigned** i,j;  X.m\_nLength=m\_nLength+A.m\_nLength-1;  **for**(i=0;i<X.m\_nLength;i++)  {  sum=carry;  carry=0;  **for**(j=0;j<A.m\_nLength;j++)  {  **if**(((i-j)>=0)&&((i-j)<m\_nLength))  {  mul=m\_ulValue[i-j];  mul\*=A.m\_ulValue[j];  carry+=mul>>32;  mul=mul&0xffffffff;  sum+=mul;  }  }  carry+=sum>>32;  X.m\_ulValue[i]=(**unsigned** **long**)sum;  }  **if**(carry){X.m\_nLength++;X.m\_ulValue[X.m\_nLength-1]=(**unsigned** **long**)carry;}  **return** X;  }  CBigInt CBigInt::Mul(**unsigned** **long** A)  {  CBigInt X;  **unsigned** \_\_int64 mul;  **unsigned** **long** carry=0;  X.Mov(\***this**);  **for**(**unsigned** i=0;i<m\_nLength;i++)  {  mul=m\_ulValue[i];  mul=mul\*A+carry;  X.m\_ulValue[i]=(**unsigned** **long**)mul;  carry=(**unsigned** **long**)(mul>>32);  }  **if**(carry){X.m\_nLength++;X.m\_ulValue[X.m\_nLength-1]=carry;}  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相除**  **调用形式：N.Div(A)**  **返回值：N/A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Div(CBigInt& A)  {  **if**(A.m\_nLength==1)**return** Div(A.m\_ulValue[0]);  CBigInt X,Y,Z;  **unsigned** i,len;  **unsigned** \_\_int64 num,div;  Y.Mov(\***this**);  **while**(Y.Cmp(A)>=0)  {  div=Y.m\_ulValue[Y.m\_nLength-1];  num=A.m\_ulValue[A.m\_nLength-1];  len=Y.m\_nLength-A.m\_nLength;  **if**((div==num)&&(len==0)){X.Mov(X.Add(1));**break**;}  **if**((div<=num)&&len){len--;div=(div<<32)+Y.m\_ulValue[Y.m\_nLength-2];}  div=div/(num+1);  Z.Mov(div);  **if**(len)  {  Z.m\_nLength+=len;  **for**(i=Z.m\_nLength-1;i>=len;i--)Z.m\_ulValue[i]=Z.m\_ulValue[i-len];  **for**(i=0;i<len;i++)Z.m\_ulValue[i]=0;  }  X.Mov(X.Add(Z));  Y.Mov(Y.Sub(A.Mul(Z)));  }  **return** X;  }  CBigInt CBigInt::Div(**unsigned** **long** A)  {  CBigInt X;  X.Mov(\***this**);  **if**(X.m\_nLength==1){X.m\_ulValue[0]=X.m\_ulValue[0]/A;**return** X;}  **unsigned** \_\_int64 div,mul;  **unsigned** **long** carry=0;  **for**(**int** i=X.m\_nLength-1;i>=0;i--)  {  div=carry;  div=(div<<32)+X.m\_ulValue[i];  X.m\_ulValue[i]=(**unsigned** **long**)(div/A);  mul=(div/A)\*A;  carry=(**unsigned** **long**)(div-mul);  }  **if**(X.m\_ulValue[X.m\_nLength-1]==0)X.m\_nLength--;  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数求模**  **调用形式：N.Mod(A)**  **返回值：N%A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Mod(CBigInt& A)  {  CBigInt X,Y;  **unsigned** \_\_int64 div,num;  **unsigned** **long** carry=0;  **unsigned** i,len;  X.Mov(\***this**);  **while**(X.Cmp(A)>=0)  {  div=X.m\_ulValue[X.m\_nLength-1];  num=A.m\_ulValue[A.m\_nLength-1];  len=X.m\_nLength-A.m\_nLength;  **if**((div==num)&&(len==0)){X.Mov(X.Sub(A));**break**;}  **if**((div<=num)&&len){len--;div=(div<<32)+X.m\_ulValue[X.m\_nLength-2];}  div=div/(num+1);  Y.Mov(div);  Y.Mov(A.Mul(Y));  **if**(len)  {  Y.m\_nLength+=len;  **for**(i=Y.m\_nLength-1;i>=len;i--)Y.m\_ulValue[i]=Y.m\_ulValue[i-len];  **for**(i=0;i<len;i++)Y.m\_ulValue[i]=0;  }  X.Mov(X.Sub(Y));  }  **return** X;  }  **unsigned** **long** CBigInt::Mod(**unsigned** **long** A)  {  **if**(m\_nLength==1)**return**(m\_ulValue[0]%A);  **unsigned** \_\_int64 div;  **unsigned** **long** carry=0;  **for**(**int** i=m\_nLength-1;i>=0;i--)  {  div=m\_ulValue[i];  div+=carry\*0x100000000;  carry=(**unsigned** **long**)(div%A);  }  **return** carry;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **从字符串按10进制或16进制格式输入到大数**  **调用格式：N.Get(str,sys)**  **返回值：N被赋值为相应大数**  **sys暂时只能为10或16**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::Get(**char** str[], **unsigned** **int** system)  {  **int** len=strlen(str),k;  Mov(0);  **for**(**int** i=0;i<len;i++)  {  Mov(Mul(system));  **if**((str[i]>='0')&&(str[i]<='9'))k=str[i]-48;  **else** **if**((str[i]>='A')&&(str[i]<='F'))k=str[i]-55;  **else** **if**((str[i]>='a')&&(str[i]<='f'))k=str[i]-87;  **else** k=0;  Mov(Add(k));  }  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **将大数按10进制或16进制格式输出为字符串**  **调用格式：N.Put(str,sys)**  **返回值：无，参数str被赋值为N的sys进制字符串**  **sys暂时只能为10或16**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::Put(**char** str[], **unsigned** **int** system)  {  **if**((m\_nLength==1)&&(m\_ulValue[0]==0)){str="0";**return**;}  **char** t[]="0123456789ABCDEF";  **int** a;  **char** ch;  CBigInt X;  X.Mov(\***this**);  **int** i = 0;  **while**(X.m\_ulValue[X.m\_nLength-1]>0)  {  a=X.Mod(system);  ch=t[a];  str[i++] = ch;  X.Mov(X.Div(system));  }  str[i] = 0x00;    **int** len = strlen(str) - 1;  **int** half\_len = strlen(str) / 2;  **char** tmp;  **for** (i = 0; i<half\_len; i++)  {  tmp = str[i];  str[i] = str[len-i];  str[len-i] = tmp;  }  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **求不定方程ax-by=1的最小整数解**  **调用方式：N.Euc(A)**  **返回值：X,满足：NX mod A=1**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Euc(CBigInt& A)  {  CBigInt M,E,X,Y,I,J;  **int** x,y;  M.Mov(A);  E.Mov(\***this**);  X.Mov(0);  Y.Mov(1);  x=y=1;  **while**((E.m\_nLength!=1)||(E.m\_ulValue[0]!=0))  {  I.Mov(M.Div(E));  J.Mov(M.Mod(E));  M.Mov(E);  E.Mov(J);  J.Mov(Y);  Y.Mov(Y.Mul(I));  **if**(x==y)  {  **if**(X.Cmp(Y)>=0)Y.Mov(X.Sub(Y));  **else**{Y.Mov(Y.Sub(X));y=0;}  }  **else**{Y.Mov(X.Add(Y));x=1-x;y=1-y;}  X.Mov(J);  }  **if**(x==0)X.Mov(A.Sub(X));  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **求乘方的模**  **调用方式：N.RsaTrans(A,B)**  **返回值：X=N^A MOD B**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::RsaTrans(CBigInt& A, CBigInt& B)  {  CBigInt X,Y;  **int** i,j,k;  **unsigned** n;  **unsigned** **long** num;  k=A.m\_nLength\*32-32;  num=A.m\_ulValue[A.m\_nLength-1];  **while**(num){num=num>>1;k++;}  X.Mov(\***this**);  **for**(i=k-2;i>=0;i--)  {  Y.Mov(X.Mul(X.m\_ulValue[X.m\_nLength-1]));  Y.Mov(Y.Mod(B));  **for**(n=1;n<X.m\_nLength;n++)  {  **for**(j=Y.m\_nLength;j>0;j--)Y.m\_ulValue[j]=Y.m\_ulValue[j-1];  Y.m\_ulValue[0]=0;  Y.m\_nLength++;  Y.Mov(Y.Add(X.Mul(X.m\_ulValue[X.m\_nLength-n-1])));  Y.Mov(Y.Mod(B));  }  X.Mov(Y);  **if**((A.m\_ulValue[i>>5]>>(i&31))&1)  {  Y.Mov(Mul(X.m\_ulValue[X.m\_nLength-1]));  Y.Mov(Y.Mod(B));  **for**(n=1;n<X.m\_nLength;n++)  {  **for**(j=Y.m\_nLength;j>0;j--)Y.m\_ulValue[j]=Y.m\_ulValue[j-1];  Y.m\_ulValue[0]=0;  Y.m\_nLength++;  Y.Mov(Y.Add(Mul(X.m\_ulValue[X.m\_nLength-n-1])));  Y.Mov(Y.Mod(B));  }  X.Mov(Y);  }  }  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **拉宾米勒算法测试素数**  **调用方式：N.Rab()**  **返回值：若N为素数，返回1，否则返回0**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **int** CBigInt::Rab()  {  **unsigned** i,j,pass;  **for**(i=0;i<550;i++){**if**(Mod(PrimeTable[i])==0)**return** 0;}  CBigInt S,A,I,K;  K.Mov(\***this**);  K.m\_ulValue[0]--;  **for**(i=0;i<5;i++)  {  pass=0;  A.Mov(rand()\*rand());  S.Mov(K);  **while**((S.m\_ulValue[0]&1)==0)  {  **for**(j=0;j<S.m\_nLength;j++)  {  S.m\_ulValue[j]=S.m\_ulValue[j]>>1;  **if**(S.m\_ulValue[j+1]&1)S.m\_ulValue[j]=S.m\_ulValue[j]|0x80000000;  }  **if**(S.m\_ulValue[S.m\_nLength-1]==0)S.m\_nLength--;  I.Mov(A.RsaTrans(S,\***this**));  **if**(I.Cmp(K)==0){pass=1;**break**;}  }  **if**((I.m\_nLength==1)&&(I.m\_ulValue[0]==1))pass=1;  **if**(pass==0)**return** 0;  }  **return** 1;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **产生随机素数**  **调用方法：N.GetPrime(bits)**  **返回值：N被赋值为一个bits位（0x100000000进制长度）的素数**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::GetPrime(**int** bits)  {  **unsigned** i;  m\_nLength=bits;  begin:  **for**(i=0;i<m\_nLength;i++)m\_ulValue[i]=rand()\*0x10000+rand();  m\_ulValue[0]=m\_ulValue[0]|1;  **for**(i=m\_nLength-1;i>0;i--)  {  m\_ulValue[i]=m\_ulValue[i]<<1;  **if**(m\_ulValue[i-1]&0x80000000)m\_ulValue[i]++;  }  m\_ulValue[0]=m\_ulValue[0]<<1;  m\_ulValue[0]++;  **for**(i=0;i<550;i++){**if**(Mod(PrimeTable[i])==0)**goto** begin;}  CBigInt S,A,I,K;  K.Mov(\***this**);  K.m\_ulValue[0]--;  **for**(i=0;i<5;i++)  {  A.Mov(rand()\*rand());  S.Mov(K.Div(2));  I.Mov(A.RsaTrans(S,\***this**));  **if**(((I.m\_nLength!=1)||(I.m\_ulValue[0]!=1))&&(I.Cmp(K)!=0))**goto** begin;  }  }  **int** main()  {  **int** t;  **int** i, j;  CBigInt big\_a, big\_b, big\_ans;  **char** ans[2005], a[1005], b[1005];  **while** (scanf("%d", &t) != EOF)  {  **for** (i = 0; i<t; i++)  {  **if** (i != 0)  printf("/n");  scanf("%s%s", a, b);  big\_a.Get(a);  big\_b.Get(b);  big\_ans = big\_a.Add(big\_b);  big\_ans.Put(ans);  printf("Case %d:/n%s + %s = %s/n", i+1, a, b, ans);  }  }  **return** 0;  } |

### 大数(精简版)

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| **#include** <cstdio>  **#include** <cstring>  **#include** <cstdlib>  **//允许生成1120位（二进制）的中间结果**  **#define** BI\_MAXLEN 105  **#define** DEC 10  **#define** HEX 16  **class** CBigInt  {  **public**:  **//大数在0x100000000进制下的长度**  **unsigned** m\_nLength;  **//用数组记录大数在0x100000000进制下每一位的值**  **unsigned** **long** m\_ulValue[BI\_MAXLEN];  CBigInt();  ~CBigInt();  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **基本操作与运算**  **Mov，赋值运算，可赋值为大数或普通整数，可重载为运算符“=”**  **Cmp，比较运算，可重载为运算符“==”、“!=”、“>=”、“<=”等**  **Add，加，求大数与大数或大数与普通整数的和，可重载为运算符“+”**  **Sub，减，求大数与大数或大数与普通整数的差，可重载为运算符“-”**  **Mul，乘，求大数与大数或大数与普通整数的积，可重载为运算符“\*”**  **Div，除，求大数与大数或大数与普通整数的商，可重载为运算符“/”**  **Mod，模，求大数与大数或大数与普通整数的模，可重载为运算符“%”**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** Mov(**unsigned** \_\_int64 A);  **void** Mov(CBigInt A);  CBigInt Add(CBigInt& A);  CBigInt Sub(CBigInt A);  CBigInt Mul(CBigInt& A);  CBigInt Div(CBigInt& A);  CBigInt Mod(CBigInt& A);  CBigInt Add(**unsigned** **long** A);  CBigInt Sub(**unsigned** **long** A);  CBigInt Mul(**unsigned** **long** A);  CBigInt Div(**unsigned** **long** A);  **unsigned** **long** Mod(**unsigned** **long** A);  **int** Cmp(CBigInt& A);  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **输入输出**  **Get，从字符串按10进制或16进制格式输入到大数**  **Put，将大数按10进制或16进制格式输出到字符串**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** Get(**char** str[], **unsigned** **int** system=DEC);  **void** Put(**char** str[], **unsigned** **int** system=DEC);  };  **//构造大数对象并初始化为零**  CBigInt::CBigInt()  {  m\_nLength=1;  **for**(**int** i=0;i<BI\_MAXLEN;i++)m\_ulValue[i]=0;  }  **//解构大数对象**  CBigInt::~CBigInt()  {  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数比较**  **调用方式：N.Cmp(A)**  **返回值：若N<A返回-1；若N=A返回0；若N>A返回1**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **int** CBigInt::Cmp(CBigInt& A)  {  **if**(m\_nLength>A.m\_nLength)**return** 1;  **if**(m\_nLength<A.m\_nLength)**return** -1;  **for**(**int** i=m\_nLength-1;i>=0;i--)  {  **if**(m\_ulValue[i]>A.m\_ulValue[i])**return** 1;  **if**(m\_ulValue[i]<A.m\_ulValue[i])**return** -1;  }  **return** 0;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数赋值**  **调用方式：N.Mov(A)**  **返回值：无，N被赋值为A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::Mov(CBigInt A)  {  m\_nLength=A.m\_nLength;  **for**(**int** i=0;i<BI\_MAXLEN;i++)m\_ulValue[i]=A.m\_ulValue[i];  }  **void** CBigInt::Mov(**unsigned** \_\_int64 A)  {  **if**(A>0xffffffff)  {  m\_nLength=2;  m\_ulValue[1]=(**unsigned** **long**)(A>>32);  m\_ulValue[0]=(**unsigned** **long**)A;  }  **else**  {  m\_nLength=1;  m\_ulValue[0]=(**unsigned** **long**)A;  }  **for**(**int** i=m\_nLength;i<BI\_MAXLEN;i++)m\_ulValue[i]=0;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相加**  **调用形式：N.Add(A)**  **返回值：N+A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Add(CBigInt& A)  {  CBigInt X;  X.Mov(\***this**);  **unsigned** carry=0;  **unsigned** \_\_int64 sum=0;  **if**(X.m\_nLength<A.m\_nLength)X.m\_nLength=A.m\_nLength;  **for**(**unsigned** i=0;i<X.m\_nLength;i++)  {  sum=A.m\_ulValue[i];  sum=sum+X.m\_ulValue[i]+carry;  X.m\_ulValue[i]=(**unsigned** **long**)sum;  carry=(**unsigned**)(sum>>32);  }  X.m\_ulValue[X.m\_nLength]=carry;  X.m\_nLength+=carry;  **return** X;  }  CBigInt CBigInt::Add(**unsigned** **long** A)  {  CBigInt X;  X.Mov(\***this**);  **unsigned** \_\_int64 sum;  sum=X.m\_ulValue[0];  sum+=A;  X.m\_ulValue[0]=(**unsigned** **long**)sum;  **if**(sum>0xffffffff)  {  **unsigned** i=1;  **while**(X.m\_ulValue[i]==0xffffffff){X.m\_ulValue[i]=0;i++;}  X.m\_ulValue[i]++;  **if**(m\_nLength==i)m\_nLength++;  }  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相减**  **调用形式：N.Sub(A)**  **返回值：N-A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Sub(CBigInt A)  {  CBigInt X;  X.Mov(\***this**);  **if**(X.Cmp(A)<=0){X.Mov(0);**return** X;}  **unsigned** carry=0;  **unsigned** \_\_int64 num;  **unsigned** i;  **for**(i=0;i<m\_nLength;i++)  {  **if**((m\_ulValue[i]>A.m\_ulValue[i])||((m\_ulValue[i]==A.m\_ulValue[i])&&(carry==0)))  {  X.m\_ulValue[i]=m\_ulValue[i]-carry-A.m\_ulValue[i];  carry=0;  }  **else**  {  num=0x100000000+m\_ulValue[i];  X.m\_ulValue[i]=(**unsigned** **long**)(num-carry-A.m\_ulValue[i]);  carry=1;  }  }  **while**(X.m\_ulValue[X.m\_nLength-1]==0)X.m\_nLength--;  **return** X;  }  CBigInt CBigInt::Sub(**unsigned** **long** A)  {  CBigInt X;  X.Mov(\***this**);  **if**(X.m\_ulValue[0]>=A){X.m\_ulValue[0]-=A;**return** X;}  **if**(X.m\_nLength==1){X.Mov(0);**return** X;}  **unsigned** \_\_int64 num=0x100000000+X.m\_ulValue[0];  X.m\_ulValue[0]=(**unsigned** **long**)(num-A);  **int** i=1;  **while**(X.m\_ulValue[i]==0){X.m\_ulValue[i]=0xffffffff;i++;}  X.m\_ulValue[i]--;  **if**(X.m\_ulValue[i]==0)X.m\_nLength--;  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相乘**  **调用形式：N.Mul(A)**  **返回值：N\*A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Mul(CBigInt& A)  {  **if**(A.m\_nLength==1)**return** Mul(A.m\_ulValue[0]);  CBigInt X;  **unsigned** \_\_int64 sum,mul=0,carry=0;  **unsigned** i,j;  X.m\_nLength=m\_nLength+A.m\_nLength-1;  **for**(i=0;i<X.m\_nLength;i++)  {  sum=carry;  carry=0;  **for**(j=0;j<A.m\_nLength;j++)  {  **if**(((i-j)>=0)&&((i-j)<m\_nLength))  {  mul=m\_ulValue[i-j];  mul\*=A.m\_ulValue[j];  carry+=mul>>32;  mul=mul&0xffffffff;  sum+=mul;  }  }  carry+=sum>>32;  X.m\_ulValue[i]=(**unsigned** **long**)sum;  }  **if**(carry){X.m\_nLength++;X.m\_ulValue[X.m\_nLength-1]=(**unsigned** **long**)carry;}  **return** X;  }  CBigInt CBigInt::Mul(**unsigned** **long** A)  {  CBigInt X;  **unsigned** \_\_int64 mul;  **unsigned** **long** carry=0;  X.Mov(\***this**);  **for**(**unsigned** i=0;i<m\_nLength;i++)  {  mul=m\_ulValue[i];  mul=mul\*A+carry;  X.m\_ulValue[i]=(**unsigned** **long**)mul;  carry=(**unsigned** **long**)(mul>>32);  }  **if**(carry){X.m\_nLength++;X.m\_ulValue[X.m\_nLength-1]=carry;}  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数相除**  **调用形式：N.Div(A)**  **返回值：N/A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Div(CBigInt& A)  {  **if**(A.m\_nLength==1)**return** Div(A.m\_ulValue[0]);  CBigInt X,Y,Z;  **unsigned** i,len;  **unsigned** \_\_int64 num,div;  Y.Mov(\***this**);  **while**(Y.Cmp(A)>=0)  {  div=Y.m\_ulValue[Y.m\_nLength-1];  num=A.m\_ulValue[A.m\_nLength-1];  len=Y.m\_nLength-A.m\_nLength;  **if**((div==num)&&(len==0)){X.Mov(X.Add(1));**break**;}  **if**((div<=num)&&len){len--;div=(div<<32)+Y.m\_ulValue[Y.m\_nLength-2];}  div=div/(num+1);  Z.Mov(div);  **if**(len)  {  Z.m\_nLength+=len;  **for**(i=Z.m\_nLength-1;i>=len;i--)Z.m\_ulValue[i]=Z.m\_ulValue[i-len];  **for**(i=0;i<len;i++)Z.m\_ulValue[i]=0;  }  X.Mov(X.Add(Z));  Y.Mov(Y.Sub(A.Mul(Z)));  }  **return** X;  }  CBigInt CBigInt::Div(**unsigned** **long** A)  {  CBigInt X;  X.Mov(\***this**);  **if**(X.m\_nLength==1){X.m\_ulValue[0]=X.m\_ulValue[0]/A;**return** X;}  **unsigned** \_\_int64 div,mul;  **unsigned** **long** carry=0;  **for**(**int** i=X.m\_nLength-1;i>=0;i--)  {  div=carry;  div=(div<<32)+X.m\_ulValue[i];  X.m\_ulValue[i]=(**unsigned** **long**)(div/A);  mul=(div/A)\*A;  carry=(**unsigned** **long**)(div-mul);  }  **if**(X.m\_ulValue[X.m\_nLength-1]==0)X.m\_nLength--;  **return** X;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **大数求模**  **调用形式：N.Mod(A)**  **返回值：N%A**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  CBigInt CBigInt::Mod(CBigInt& A)  {  CBigInt X,Y;  **unsigned** \_\_int64 div,num;  **unsigned** **long** carry=0;  **unsigned** i,len;  X.Mov(\***this**);  **while**(X.Cmp(A)>=0)  {  div=X.m\_ulValue[X.m\_nLength-1];  num=A.m\_ulValue[A.m\_nLength-1];  len=X.m\_nLength-A.m\_nLength;  **if**((div==num)&&(len==0)){X.Mov(X.Sub(A));**break**;}  **if**((div<=num)&&len){len--;div=(div<<32)+X.m\_ulValue[X.m\_nLength-2];}  div=div/(num+1);  Y.Mov(div);  Y.Mov(A.Mul(Y));  **if**(len)  {  Y.m\_nLength+=len;  **for**(i=Y.m\_nLength-1;i>=len;i--)Y.m\_ulValue[i]=Y.m\_ulValue[i-len];  **for**(i=0;i<len;i++)Y.m\_ulValue[i]=0;  }  X.Mov(X.Sub(Y));  }  **return** X;  }  **unsigned** **long** CBigInt::Mod(**unsigned** **long** A)  {  **if**(m\_nLength==1)**return**(m\_ulValue[0]%A);  **unsigned** \_\_int64 div;  **unsigned** **long** carry=0;  **for**(**int** i=m\_nLength-1;i>=0;i--)  {  div=m\_ulValue[i];  div+=carry\*0x100000000;  carry=(**unsigned** **long**)(div%A);  }  **return** carry;  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **从字符串按10进制或16进制格式输入到大数**  **调用格式：N.Get(str,sys)**  **返回值：N被赋值为相应大数**  **sys暂时只能为10或16**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::Get(**char** str[], **unsigned** **int** system)  {  **int** len=strlen(str),k;  Mov(0);  **for**(**int** i=0;i<len;i++)  {  Mov(Mul(system));  **if**((str[i]>='0')&&(str[i]<='9'))k=str[i]-48;  **else** **if**((str[i]>='A')&&(str[i]<='F'))k=str[i]-55;  **else** **if**((str[i]>='a')&&(str[i]<='f'))k=str[i]-87;  **else** k=0;  Mov(Add(k));  }  }  **/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  **将大数按10进制或16进制格式输出为字符串**  **调用格式：N.Put(str,sys)**  **返回值：无，参数str被赋值为N的sys进制字符串**  **sys暂时只能为10或16**  **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**  **void** CBigInt::Put(**char** str[], **unsigned** **int** system)  {  **if**((m\_nLength==1)&&(m\_ulValue[0]==0)){str="0";**return**;}  **char** t[]="0123456789ABCDEF";  **int** a;  **char** ch;  CBigInt X;  X.Mov(\***this**);  **int** i = 0;  **while**(X.m\_ulValue[X.m\_nLength-1]>0)  {  a=X.Mod(system);  ch=t[a];  str[i++] = ch;  X.Mov(X.Div(system));  }  str[i] = 0x00;  **int** len = strlen(str) - 1;  **int** half\_len = strlen(str) / 2;  **char** tmp;  **for** (i = 0; i<half\_len; i++)  {  tmp = str[i];  str[i] = str[len-i];  str[len-i] = tmp;  }  }  **int** main()  {  **int** t;  **int** i, j;  CBigInt big\_a, big\_b, big\_ans;  **char** ans[2005], a[1005], b[1005];  **while** (scanf("%d", &t) != EOF)  {  **for** (i = 0; i<t; i++)  {  **if** (i != 0)  printf("\n");  scanf("%s%s", a, b);  big\_a.Get(a);  big\_b.Get(b);  big\_a.Put(a);  big\_b.Put(b);  big\_ans = big\_a.Add(big\_b);  big\_ans.Put(ans);  printf("Case %d:\n%s + %s = %s\n", i+1, a, b, ans);  }  }  **return** 0;  } |

### Pollard\_rho进行质因数分解

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| //\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  //pollard\_rho 算法进行质因数分解  //\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  **long** **long** factor[100];//质因数分解结果（刚返回时是无序的）  **int** tol;//质因数的个数。数组小标从0开始  **long** **long** gcd(**long** **long** a,**long** **long** b)  {  **if**(a==0)**return** 1;//???????  **if**(a<0) **return** gcd(-a,b);  **while**(b)  {  **long** **long** t=a%b;  a=b;  b=t;  }  **return** a;  }  **long** **long** Pollard\_rho(**long** **long** x,**long** **long** c)  {  **long** **long** i=1,k=2;  **long** **long** x0=rand()%x;  **long** **long** y=x0;  **while**(1)  {  i++;  x0=(mult\_mod(x0,x0,x)+c)%x;  **long** **long** d=gcd(y-x0,x);  **if**(d!=1&&d!=x) **return** d;  **if**(y==x0) **return** x;  **if**(i==k){y=x0;k+=k;}  }  }  //对n进行素因子分解  **void** findfac(**long** **long** n)  {  **if**(Miller\_Rabin(n))//素数  {  factor[tol++]=n;  **return**;  }  **long** **long** p=n;  **while**(p>=n)p=Pollard\_rho(p,rand()%(n-1)+1);  findfac(p);  findfac(n/p);  } |

### NTT快速数论变换-小常数

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| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <bitset>  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<LL, LL> PII;  **const** LL INF = 0x3f3f3f3f;  **const** LL mod = 1e9+7.5;  **const** LL N = 100020;  **const** **int** P = 998244353;**//119\*2^23 + 1**  **const** LL g = 3;  **const** LL NUM = 40; **//2^NUM > P**  LL wn[NUM];  LL G[NUM], nG[NUM];  LL a[N\*4], b[N\*4];**//这里要小心数组的大小要开大，一般原数组\*4**  LL c[N];  LL qpow\_mod(LL x, LL k)  {  LL res = 1;  **while**(k)  {  **if**(k & 1) res = x \* res % P;  x = x\*x%P;  k >>= 1;  }  **return** res;  }  **void** init()**/// /// /// /// /////////////////////////////////////// 一定要先调用这个函数**  {  LL now=(P-1)/2,ng=qpow\_mod(g,P-2),len=0;  **while** (now%2==0){  len++;  G[len]=qpow\_mod(g,now);  nG[len]=qpow\_mod(ng,now);  now>>=1;  }  }  **void** NTT(LL x[],LL n,LL fl){  **for** (LL i=(n>>1),j=1;j<n;j++){  **if** (i<j) swap(x[i],x[j]);  LL k;  **for** (k=(n>>1);i&k;i^=k,k>>=1); i^=k;  }  LL now=0;  **for** (LL m=2;m<=n;m<<=1){  LL w; now++;  **if** (fl==1) w=G[now];  **else** w=nG[now];  **for** (LL i=0;i<n;i+=m){  LL cur=1;  **for** (LL j=i;j<i+(m>>1);j++){  LL u=x[j],v=1ll\*x[j+(m>>1)]\*cur%P;  x[j]=(u+v)%P; x[j+(m>>1)]=(u-v+P)%P;  cur=1ll\*cur\*w%P;  }  }  }  **if**(fl == -1){  LL inv = qpow\_mod(n, P - 2);  **for**(LL i = 0; i < n; i++)  x[i] = x[i] % P \* inv % P;  }  }  **//求卷积**  **void** Conv(LL a[], LL b[], LL n)  {  NTT(a, n, 1);  NTT(b, n, 1);  **for**(LL i = 0; i < n; i++)  a[i] = a[i] \* b[i] % P;  NTT(a, n, -1);  }  LL f[N], invf[N];  LL two[N];  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  init();  two[0] = f[0] = invf[0] = 1;  **for**(LL i = 1; i < N; i++) f[i] = f[i-1]\*i%P, invf[i] = qpow\_mod(f[i], P-2), two[i] = two[i-1]\*2%P;  LL T;  **// T = frd.getint();**  **// read(T);**  scanf("%I64d", &T);  **while**(T--)  {  LL n;  scanf("%I64d", &n);  **for**(LL i = 0; i < n; i++)  {  scanf("%I64d", &c[i]);  }  sort(c, c+n);  LL len = 1;  **while**(len < n\*2) len<<= 1;  memset(a, 0, **sizeof**(a));  memset(b, 0, **sizeof**(b));  **for**(LL i = 0; i < n; i++)  {  a[n-i] = two[i]\*c[i]%P\*f[n-i-1]%P;  b[i] = invf[n-i];  }  b[n] = invf[0];  Conv(a, b, len);  LL last = 0;  **for**(LL i = 1; i <= n; i++)  {  last += a[i+n]\*invf[i-1]%P;  last %= P;  printf("%I64d ", last);  }  putchar('\n');  }  **return** 0;  } |

### NTT快速数论变换-完整版

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| **/\***  **题意就是节点数为n，高度为k的平衡二叉树的种类数。**  **于是dp[n][k] = sigma(dp[i][k-1]\*dp[n-i-1][k-1])**  **+ sigma(dp[i][k-1]\*dp[n-i-1][k-2])**  **+ sigma(dp[i][k-2]\*dp[n-i-1][k-1])**  **所以这里用NTT跑15遍预处理出答案即可。**  **来一发常用原根表，仅供参考！**  **998244353 3**  **1004535809 3**  **985661441 3**  **880803841 26**  **786433 10**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** LL mod = 786433;  LL wn[40];  **int** g,prime[10010],L=0;  LL pow(LL x,LL n,LL mod)  {  LL res=1;  **while**(n>0){  **if**(n&1)res=res\*x%mod;  x=x\*x%mod;  n>>=1;  }  **return** res;  }  **bool** check(**int** x)  {  **for**(**int** i=0;i<L;i++){  **if**(pow(x,(mod-1)/prime[i],mod)==1)**return** **false**;  }  **return** **true**;  }  **void** init()  {  LL x=mod-1;  L=0;  **for**(**int** i=2;i<=sqrt(x)+1;i++){  **if**(x%i!=0)**continue**;  **while**(x%i==0)x/=i;  prime[L++]=i;  }  **if**(x!=1)prime[L++]=x;  **for**(g=2;;g++){  **if**(check(g))**break**;  }  **for**(**int** i=0;i<20;i++){  LL x=1<<i;  wn[i]=pow(g,(mod-1)/x,mod);  }  }  **void** NTT(LL a[], **int** len, **int** on)  {  **int** j = len >> 1;  **for**(**int** i=1; i<len-1; i++)  {  **if**(i < j) swap(a[i], a[j]);  **int** k = len >> 1;  **while**(j >= k)  {  j -= k;  k >>= 1;  }  **if**(j < k) j += k;  }  **int** id = 0;  **for**(**int** h = 2; h <= len; h <<= 1)  {  id++;  **for**(**int** j = 0; j < len; j += h)  {  LL w = 1;  **for**(**int** k = j; k < j + h / 2; k++)  {  LL u = a[k] % mod;  LL t = w \* (a[k + h / 2] % mod) % mod;  a[k] = (u + t) % mod;  a[k + h / 2] = ((u - t) % mod + mod) % mod;  w = w \* wn[id] % mod;  }  }  }  **if**(on == -1)  {  **for**(**int** i = 1; i < len / 2; i++)  swap(a[i], a[len - i]);  LL Inv = pow(len, mod - 2, mod);  **for**(**int** i = 0; i < len; i++)  a[i] = a[i] % mod \* Inv % mod;  }  }  **int** dp[16][(1<<16)+10];  LL A[(1<<16)+10], B[(1<<16)+10], C[(1<<16)+10];  **int** main()  {  **//Open();**  init();  dp[0][1] = 1;  dp[1][1] = 0; dp[1][2] = 2; dp[1][3] = 1;  **for**(**int** k = 2; k <= 15; k++)  {  **int** len = 1 << k;  len <<= 1;  **for**(**int** i = 0; i < len; i++) A[i] = dp[k-1][i], B[i] = dp[k-2][i];  NTT(A, len, 1);  NTT(B, len, 1);  **for**(**int** i = 0; i < len; i++)  C[i] = A[i]\*A[i]%mod;  NTT(C, len, -1);  **for**(**int** i = 0; i < len; i++)  dp[k][i] = (dp[k][i] + C[i-1])%mod;  **for**(**int** i = 0; i < len; i++)  C[i] = A[i]\*B[i]%mod;  NTT(C, len, -1);  **for**(**int** i = 0; i < len; i++)  dp[k][i] = (dp[k][i] + C[i-1]\*2)%mod;  }  freopen("avl.in", "r", stdin);  freopen("avl.out", "w", stdout);  **int** n, k;  **while**(~scanf("%d%d",&n, &k))  {  printf("%d\n", dp[k][n]%mod);  }  **return** 0;  } |

### NTT快速数论变换

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| **//第二类斯特林数的快速求解。ZOJ 3899**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **#define** lson x<<1  **#define** rson x<<1|1  **#define** mid ((lt[x].l+lt[x].r)/2)  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<LL,LL> PII;  **const** LL INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** LL P = 880803841LL;**//119\*2^23 + 1**  **const** LL G = 26;  **const** LL NUM = 26; **//2^NUM > P**  LL wn[NUM];  LL a[N\*5], b[N\*5];**//这里要小心数组的大小要开大，一般原数组\*4**  LL qpow\_mod(LL x, LL k, LL m)  {  LL res = 1;  **while**(k)  {  **if**(k & 1) res = x \* res % m;  x = x\*x%m;  k >>= 1;  }  **return** res;  }  **void** getwn()  {  **for**(LL i = 0; i < NUM; i++)  {  LL t = 1LL << i;  wn[i] = qpow\_mod(G, (P-1)/t, P);  }  }  **void** Rader(LL a[], LL len)  {  LL j = len >> 1;  **for**(LL i = 1; i < len - 1; i ++)  {  **if**(i < j) swap(a[i], a[j]);  LL k = len >> 1;  **while**(j >= k)  {  j -= k;  k >>= 1;  }  **if**(j < k) j += k;  }  }  **void** NTT(LL a[], LL len, LL on)  {  Rader(a, len);  LL id = 0;  **for**(LL h = 2; h <= len; h <<= 1)  {  id ++;  **for**(LL j = 0; j < len; j += h){  LL w = 1;  **for**(LL k = j; k < j + h / 2; k ++)  {  LL u = a[k] % P;  LL t = w \* (a[k + h / 2] % P) % P;  a[k] = (u + t) % P;  a[k + h / 2] = ((u - t) % P + P) % P;  w = w \* wn[id] % P;  }  }  }  **if**(on == -1){  **for**(LL i = 1; i < len / 2; i++)  swap(a[i], a[len - i]);  LL inv = qpow\_mod(len, P - 2, P);  **for**(LL i = 0; i < len; i++)  a[i] = a[i] % P \* inv % P;  }  }  **//求卷积**  **void** Conv(LL a[], LL b[], LL n)  {  NTT(a, n, 1);  NTT(b, n, 1);  **for**(LL i = 0; i < n; i++)  a[i] = a[i] \* b[i] % P;  NTT(a, n, -1);  }  LL f[N], invf[N];  **//这边是线段树部分，无关的地方**  **struct** node  {  LL l, r, lazy, cnt;  node(){}  node(LL ll, LL rr){l = ll, r = rr, lazy = 0, cnt = r - l + 1;}  **void** UPDATE()  {  cnt = r - l + 1 - cnt;  }  }lt[N \* 8];  **void** build(LL l, LL r, LL x)  {  lt[x] = node(l, r);  **if**(l == r) **return** ;  build(l, mid, lson);  build(mid+1, r, rson);  }  **void** push\_up(LL x)  {  lt[x].cnt = lt[lson].cnt + lt[rson].cnt;  }  **void** push\_down(LL x)  {  **if**(lt[x].lazy){  lt[lson].lazy ^= 1;  lt[rson].lazy ^= 1;  lt[x].lazy = 0;  lt[lson].UPDATE();  lt[rson].UPDATE();  }  }  **void** update(LL l, LL r, LL x)  {  **if**(lt[x].l >= l && lt[x].r <= r)  {  lt[x].UPDATE();  lt[x].lazy ^= 1;  **return** ;  }  push\_down(x);  **if**(r <= mid) update(l, r, lson);  **else** **if**(l > mid) update(l, r, rson);  **else** update(l, mid, lson), update(mid+1, r, rson);  push\_up(x);  }  **int** main()  {  **// Open();**  f[0] = invf[0] = 1;  **for**(LL i = 1; i < N; i ++)  {  f[i] = f[i - 1] \* i % P;  invf[i] = qpow\_mod(f[i], P - 2, P);  }  getwn();  LL T;scanf("%lld", &T);  **while**(T--)  {  LL n, m, d;  scanf("%lld%lld%lld", &n, &m, &d);  LL len = 1;  **while**(len <= m \* 2) len <<= 1;  memset(a, 0, **sizeof**(a));  memset(b, 0, **sizeof**(b));  **for**(LL i = 0; i <= n; i++){  a[i] = (((i & 1) ? -1 : 1) \* invf[i] + P) % P;  b[i] = qpow\_mod(i, n, P) \* invf[i] % P;  }  Conv(a, b, len);  **//预处理数组的过程。**  build(1, m, 1);  **while**(d--)  {  LL x, y;  scanf("%lld%lld", &x, &y);  update(x, y, 1);  printf("%lld\n", a[lt[1].cnt]);  }  }  **return** 0;  } |

### open\_cup\_Siberia\_04\_FWT\_递归版

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| **/\***  **\* c[i] = sigma(str[u][j]\*str[v][j^i])**  **\* 于是裸裸的FWT，不需要取模的话，直接除2就好**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <bitset>  **using** **namespace** std;  **#define** fuck(x) cout<<#x<<" "<<x<<endl  **typedef** **long** **long** ll;  **const** **int** N = (1<<22)+10;  **void** arrMul(ll n, ll \*c, ll \*a, ll \*b)  {  **for**(ll i = 0; i < n; i++)  c[i] = a[i]\*b[i];  }  **void** FWT(**int** l, **int** r, **long** **long** a[], **int** rev)  {  **if**(l+1==r) **return**;  **int** len=(r-l)>>1, mid=len+l;  **for**(**int** i=l; i<mid; i++)  {  **long** **long** x1=a[i], x2=a[i+len];  **if**(rev==1)  {  a[i]=x1-x2;  a[i+len]=x1+x2;  }  **else**  {  **//如果需要取模的话，注意乘以2d逆元**  a[i]=(x1+x2)/2;  a[i+len]=(x2-x1)/2;  }  }  FWT(l,mid,a,rev);  FWT(mid,r,a,rev);  }  **int** str[7][N];  ll ans[N];  ll A[N], B[N];  **int** main()  {  **// freopen("/home/qingping/in.txt","r",stdin);**  ll n, m, k;  scanf("%lld%lld%lld", &n, &m, &k);  **for**(ll i = 0; i < m; i++)  **for**(ll j = 0; j < (1<<n); j++)  scanf("%1d", &str[i][j]);  ll len = 1;  **while**(len < (1<<n)) len <<= 1;  **//len <<= 1;**  **for**(ll i = 0; i < k; i++)  {  ll u, v;  scanf("%lld%lld", &u, &v);  **for**(ll j = 0; j < len; j++)  {  **if**(j < (1<<n)) A[j] = str[u][j], B[j] = str[v][j];  **else** B[j] = A[j] = 0;  }  FWT(0, len, A, 1);  FWT(0, len, B, 1);  arrMul(len, A, A, B);  FWT(0, len, A, -1);  **for**(ll j = 0; j < (1<<n); j++)  {  printf("%d", (A[j] > 0));  }  printf("\n");  }  **return** 0;  } |

### 高斯消元

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| **/\*以下代码中n代表方程个数，m代表未知数个数，f[]数组用来判断哪些未知数是**  **\* 变元，x[]数组用来存求得的解。**  **\***  **\* 该代码只在解为int的时候使用，如果有double解，要注意修改x数组的类型**  **\*/**  **int** gcd(**int** a,**int** b)  {  **return** b ? gcd(b,a%b):a;  }    **int** lcm(**int** a,**int** b)  {  **return** a / gcd(a,b) \* b;  }    **/\*\*n个方程，m个未知数，r代表当前处理的行，c代表当前处理的列\*/**  **void** Gauss(**int** a[][N],**int** n,**int** m,**int** &r,**int** &c)  {  r = c = 0;  **for**(; r<n && c<m; r++,c++)  {  **int** maxi = r;  **for**(**int** i=r+1; i<n; i++)  **if**(abs(a[i][c]) > abs(a[maxi][c]))  maxi = i;  **if**(maxi != r)  {  **for**(**int** i=r; i<m+1; i++)  swap(a[r][i],a[maxi][i]);  }  **if**(a[r][c] == 0)  {  r--;  **continue**;  }  **for**(**int** i=r+1; i<n; i++)  {  **if**(a[i][c] != 0)  {  **int** x = abs(a[i][c]);  **int** y = abs(a[r][c]);  **int** LCM = lcm(x,y);  **int** tx = LCM / x;  **int** ty = LCM / y;  **if**(a[i][c] \* a[r][c] < 0)  ty = -ty;  **for**(**int** j=c; j<m+1; j++)  a[i][j] = a[i][j] \* tx - a[r][j] \* ty;  }  }  }  }    **int** Rewind(**int** a[][N],**int** x[],**bool** f[],**int** n,**int** m,**int** r,**int** c)  {  **for**(**int** i=r; i<n; i++)  **if**(a[i][c] != 0)  **return** -1;  **if**(r < m)  {  memset(f,1,**sizeof**(f));  **for**(**int** i=r-1; i>=0; i--)  {  **int** id = 0;  **int** cnt = 0;  **for**(**int** j=0; j<m; j++)  {  **if**(a[i][j] != 0 && f[j])  {  cnt++;  id = j;  }  }  **//说明此时有自由元**  **if**(cnt > 1) **continue**;  **int** t = a[i][m];  **for**(**int** j=0; j<m; j++)  {  **if**(a[i][j] != 0 && j != id)  t -= a[i][j] \* x[j];  }  x[id] = t / a[i][id];  f[id] = 0;  }  **return** m - r;  }  **for**(**int** i=r-1; i>=0; i--)  {  **int** t = a[i][c];  **for**(**int** j=i+1; j<c; j++)  {  **if**(a[i][j] != 0)  t -= a[i][j] \* x[j];  }  **if**(t % a[i][i] != 0) **return** -2;  x[i] = t / a[i][i];  }  **return** 0;  }    **//HDU 5755**  **//给定一个只含{0,1,2}的n\*m的矩阵。**  **//有一种操作：将(x,y)位置+2同时(x-1,y),(x+1,y),(x,y-1),(x,y+1)都会+1。**  **//要求进行<=2\*n\*m次操作将矩阵变为全0，数据保证至少有一组解。**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** ls (x<<1)  **#define** rs (x<<1|1)  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=1 && (x)<=n && (y)>=1 && (y)<=m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **const** LL mod = 1000000007;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 903;  **int** lcm(**int** a,**int** b)  {  **return** a / \_\_gcd(a,b) \* b;  }  **int** a[N][N], x[N], r, c;  **bool** f[N];  **/\*\*n个方程，m个未知数，r代表当前处理的行，c代表当前处理的列\*/**  **void** Gauss(**int** a[][N],**int** n,**int** m,**int** &r,**int** &c)  {  r = c = 0;  **for**(; r<n && c<m; r++,c++)  {  **int** maxi = r;  **for**(**int** i=r+1; i<n; i++)  **if**(abs(a[i][c]) > abs(a[maxi][c]))  maxi = i;  **if**(maxi != r)  {  **for**(**int** i=r; i<m+1; i++)  swap(a[r][i],a[maxi][i]);  }  **if**(a[r][c] == 0)  {  r--;  **continue**;  }  **for**(**int** i=r+1; i<n; i++)  {  **if**(a[i][c] != 0)  {  **int** x = abs(a[i][c]), y = abs(a[r][c]);  **int** LCM = lcm(x,y);  **int** tx = LCM / x, ty = LCM / y;  **if**(a[i][c] \* a[r][c] < 0) ty = -ty;  **for**(**int** j=c; j<m+1; j++)  a[i][j] = (a[i][j] \* tx - a[r][j] \* ty)%3;  }  }  }  }  **int** sta[N];  **//返回自由元的个数**  **int** Rewind(**int** a[][N], **int** x[], **bool** f[], **int** n,**int** m,**int** r,**int** c)  {  **for**(**int** i=r; i<n; i++)  **if**(a[i][c] != 0)  **return** -1;  **if**(r < m)  {  memset(f,1,**sizeof**(**bool**)\*N);  **for**(**int** i=r-1; i>=0; i--)  {  **int** id = 0;  **int** cnt = 0;  **for**(**int** j=0; j<m; j++)  {  **//如果cnt>1,说明这些是自由元**  **if**(a[i][j] != 0 && f[j]) sta[cnt++] = j;  }  **//给cnt-1个自由元全赋值，最后一个自由元的值就确定了**  **for**(**int** j = 0; j < cnt-1; j++)  {  x[sta[j]] = 0;  f[sta[j]] = 0;  }  id = sta[cnt-1];  **//if(cnt > 1) continue;**  **int** t = a[i][m];  **for**(**int** j=0; j<m; j++)  {  **if**(a[i][j] != 0 && j != id)  t = (t - a[i][j] \* x[j]%3)%3;  }  x[id] = t \* a[i][id]%3;  **if**(x[id] < 0) x[id] += 3;  f[id] = 0;  }  **return** m - r;  }  **for**(**int** i=r-1; i>=0; i--)  {  **int** t = a[i][c];  **for**(**int** j=i+1; j<c; j++)  {  **if**(a[i][j] != 0)  t = (t - a[i][j] \* x[j]%3)%3;  }  **//if(t % a[i][i] != 0) return -2;**  x[i] = t \* a[i][i]%3;  **if**(x[i] < 0) x[i] += 3;  }  **return** 0;  }  **int** val[33][33], id[33][33];**//**  PII ans[2\*N\*N];  **int** main()  {  **// Open();**  **int** T;  scanf("%d", &T);  **while**(T--)  {  **int** n, m;  **int** t = 0;  scanf("%d%d", &n, &m);  memset(a, 0, **sizeof**(a));  memset(x, 0, **sizeof**(x));  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0; j < m; j++)  scanf("%d", &val[i][j]), id[i][j] = t++, a[id[i][j]][n\*m] = val[i][j];  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0; j < m; j++)  {  **int** cid = id[i][j];  a[cid][cid] = 2;  **if**(i > 0) a[cid][id[i-1][j]] = 1;  **if**(j > 0) a[cid][id[i][j-1]] = 1;  **if**(i < n-1) a[cid][id[i+1][j]] = 1;  **if**(j < m-1) a[cid][id[i][j+1]] = 1;  }  Gauss(a, n\*m, n\*m, r, c);  Rewind(a, x, f, n\*m, n\*m, r, c);  **int** num = 0;  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0 ; j < m; j++)  **while**(x[id[i][j]] % 3)  {  ans[num++] = PII(i+1,j+1);  **//printf("%d %d\n", i, j);**  x[id[i][j]] ++;  }  printf("%d\n", num);  **for**(**int** i = 0; i < num; i++)  printf("%d %d\n", ans[i].first, ans[i].second);  }  **return** 0;  } |

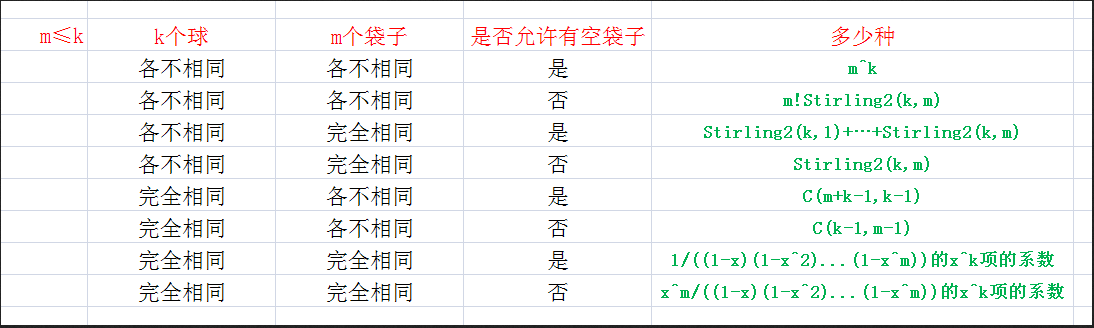
### Miller\_Rabin算法进行素数测试(random)

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| //\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  // Miller\_Rabin 算法进行素数测试  //速度快，而且可以判断 <2^63的数  //\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  **const** **int** S=20;//随机算法判定次数，S越大，判错概率越小  //计算 (a\*b)%c. a,b都是long long的数，直接相乘可能溢出的  // a,b,c <2^63  **long** **long** mult\_mod(**long** **long** a,**long** **long** b,**long** **long** c)  {  a%=c;  b%=c;  **long** **long** ret=0;  **while**(b)  {  **if**(b&1){ret+=a;ret%=c;}  a<<=1;  **if**(a>=c)a%=c;  b>>=1;  }  **return** ret;  }  //计算 x^n %c  **long** **long** pow\_mod(**long** **long** x,**long** **long** n,**long** **long** mod)//x^n%c  {  **if**(n==1)**return** x%mod;  x%=mod;  **long** **long** tmp=x;  **long** **long** ret=1;  **while**(n)  {  **if**(n&1) ret=mult\_mod(ret,tmp,mod);  tmp=mult\_mod(tmp,tmp,mod);  n>>=1;  }  **return** ret;  }  //以a为基,n-1=x\*2^t a^(n-1)=1(mod n) 验证n是不是合数  //一定是合数返回true,不一定返回false  bool check(**long** **long** a,**long** **long** n,**long** **long** x,**long** **long** t)  {  **long** **long** ret=pow\_mod(a,x,n);  **long** **long** last=ret;  **for**(**int** i=1;i<=t;i++)  {  ret=mult\_mod(ret,ret,n);  **if**(ret==1&&last!=1&&last!=n-1) **return** **true**;//合数  last=ret;  }  **if**(ret!=1) **return** **true**;  **return** **false**;  }  // Miller\_Rabin()算法素数判定  //是素数返回true.(可能是伪素数，但概率极小)  //合数返回false;  bool Miller\_Rabin(**long** **long** n)  {  **if**(n<2)**return** **false**;  **if**(n==2)**return** **true**;  **if**((n&1)==0) **return** **false**;//偶数  **long** **long** x=n-1;  **long** **long** t=0;  **while**((x&1)==0){x>>=1;t++;}  **for**(**int** i=0;i<S;i++)  {  **long** **long** a=rand()%(n-1)+1;//rand()需要stdlib.h头文件  **if**(check(a,n,x,t))  **return** **false**;//合数  }  **return** **true**;  } |

### Lucas定理-求组合数取模

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| **//C(n,m)%p=C(n/p,m/p)C(n%p,m%p), p为素数**  ll qPow (ll a, ll k, ll p) {  ll ans = 1;  **while** (k) {  **if** (k&1)  ans = (ans \* a) % p;  a = (a \* a) % p;  k /= 2;  }  **return** ans;  }  ll C (ll a, ll b, ll p) {  **if** (a < b)  **return** 0;  **if** (b > a - b)  b = a - b;  ll up = 1, down = 1;  **for** (ll i = 0; i < b; i++) {  up = up \* (a-i) % p;  down = down \* (i+1) % p;  }  **return** up \* qPow(down, p-2, p) % p; **// 逆元**  }  ll lucas (ll a, ll b, ll p) {  **if** (b == 0)  **return** 1;  **return** C(a%p, b%p, p) \* lucas(a/p, b/p, p) % p;  }  **/\***  **const int maxn = 25;**  **const ll mod = 1e9+7;**  **int n;**  **ll s, f[maxn];**  **ll solve () {**  **ll ans = 0;**  **for (int i = 0; i < (1<<n); i++) {**  **ll sign = 1, sum = s;**  **for (int j = 0; j < n; j++) {**  **if (i&(1<<j)) {**  **sum -= (f[j]+1);**  **sign \*= -1;**  **}**  **}**  **if (sum < 0)**  **continue;**  **ans += sign \* lucas(sum + n - 1, n - 1, mod);**  **ans %= mod;**  **}**  **return (ans + mod) % mod;**  **}**  **int main () {**  **scanf("%d%lld", &n, &s);**  **for (int i = 0; i < n; i++)**  **scanf("%lld", &f[i]);**  **printf("%lld\n", solve());**  **return 0;**  **}**  **\*/** |

### 排列组合n球m盒



### Hiho1230 FWT快速沃尔什变换-正常取模版

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| **/\***  **\* dp[i][j]=sigma(dp[i-1][k]\*b[f(k^j)]**  **\***  **\* 这个吊模板就是用来解决上述式子的，更为标准的是CF#259div1D那个题中的表达式。**  **\* 可以很快速的求解dp[n]的每一项。复杂度为m\*log(n)，m为第二维大小**  **\***  **\* 这个题，我的想法是这样的：首先枚举X，那么也就是需要在[x, m+x]中找出n个数，使得这n个数异或和为0，**  **\* 然后方案数加起来即可。那么对于每个枚举的X来说，我们记dp[i][j]表示前i个数，异或和为j的方案数，**  **\* 那么dp[i][j]=sigma(dp[i-1][k]\*b[k^j])。其中b[i]=1当且仅当x <= i <=x+m，否则为0；那么上述式子其实**  **\* 和上一题CF的题就没多大区别了。然后就直接套用fwt，当然这里需要注意的是模数必须乘上做fwt的那个数组**  **\* 的大小len(这里的len也和NTT,FFT一样必须是大于等于N的最小二次幂数)。最后答案也需要除以这个len。**  **\* 下面的解法中，直接用a[i]数组pow\_mod,我认为是因为dp[0][j]的初始值都与b[i]数组相同；**  **\* 验证发现的确两种方法都可以AC。**  **\***  **关于FWT modulo prime**  **我们可以显然地处理FWT modulo prime,只需要取个模就好了(不是废话么= =)..**  **还有...关于如何求2??1≡x(modp)**  **中的x**  **...直接x=(p+1)>>2...显然满足性质..**  **///FWT for xor 的模数需要与2互素. 只要互素就有逆元**  **\* \*\*\* 取模这么奇怪是因为当时CF那个题P不一定是质数，然而FWT的逆过程又需要不断的除2，所以最后计算完之后取一个长度的逆元即可。**  **\* \*\*\* 不一定对。。。还是老实每次都取2的逆元好了。。**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **const** LL mod = 1000000007;  LL inv2 = 500000004;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  LL mul(LL a, LL b, LL p) {a %= p;b %= p;**return** a\*b%p;}  **void** arrMul(LL n, LL \*c, LL \*a, LL \*b) {  **for** (**int** i = 0; i < n; ++i)  c[i] = mul(a[i], b[i], mod);  **//c[i] = a[i]\*b[i]%mod;**  }  LL pow\_mod(LL x, LL k, LL mod)  {  LL res = 1;  **while**(k){  **if**( k & 1) res = mul(res, x, mod);  x = mul(x, x, mod);  k >>= 1;  }  **return** res;  }  **void** fwt(LL \*x, **int** n, **int** op) {  **int** mm;  **for** (mm = 1; mm < n; mm <<= 1) { **//2m**  **for** (**int** st = 0; st < n; st += mm << 1)  **for** (**int** i = 0; i < mm; i ++) {  LL a = x[st + i], b = x[st + i + mm];  x[st + i] = (a + b) % mod;  x[st + i + mm] = (a - b) % mod;  **if**(x[st+i+mm] < 0) x[st+i+mm] += mod;  **if**(op == -1) x[st+i] = x[st+i]\*inv2%mod, x[st+i+mm] = x[st+i+mm]\*inv2%mod;  }  }  }  **void** Conv(LL \*A, LL \*B, **int** n, **int** t)**//t -> 运算次数，n -> 运算长度, B -> 为转换数组, A -> 结果/初值数组。**  {  fwt(A, n, 1);  fwt(B, n, 1);  **for** (; t; t >>= 1, arrMul(n, B, B, B)) **//类似快速幂**  **if** (t & 1) arrMul(n, A, A, B);  fwt(A, n, -1);  }  LL a[1<<12], b[1<<12];  LL solve(**int** n, **int** m, **int** L, **int** R)  {  LL len = 1;  **while**(len <= R) len \*= 2;  **//mod = basemod \* len;**  **for**(**int** i = 0; i < len ;i++)  a[i] = b[i] = (i >= L && i <= R);  Conv(a, b, len, 2\*n);  **return** (a[0] + mod)%mod;  }  **int** main()  {  **// Open();**  inv2 = pow\_mod(2, mod-2, mod);  **int** n, m, L, R;  **while**(~scanf("%d%d%d%d", &n, &m, &L, &R))  {  LL ans = 0;  **for**(**int** i = L; i <= R; i++)  ans = (ans + solve(n, m, i, i+m))%mod;  printf("%lld\n", ans);  }  **return** 0;  } |

### Hiho1230 FWT快速沃尔什变换

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| **/\***  **\* dp[i][j]=sigma(dp[i-1][k]\*b[f(k^j)]**  **\***  **\* 这个吊模板就是用来解决上述式子的，更为标准的是CF#259div1D那个题中的表达式。**  **\* 可以很快速的求解dp[n]的每一项。复杂度为m\*log(n)，m为第二维大小**  **\***  **\* 这个题，我的想法是这样的：首先枚举X，那么也就是需要在[x, m+x]中找出n个数，使得这n个数异或和为0，**  **\* 然后方案数加起来即可。那么对于每个枚举的X来说，我们记dp[i][j]表示前i个数，异或和为j的方案数，**  **\* 那么dp[i][j]=sigma(dp[i-1][k]\*b[k^j])。其中b[i]=1当且仅当x <= i <=x+m，否则为0；那么上述式子其实**  **\* 和上一题CF的题就没多大区别了。然后就直接套用fwt，当然这里需要注意的是模数必须乘上做fwt的那个数组**  **\* 的大小len(这里的len也和NTT,FFT一样必须是大于等于N的最小二次幂数)。最后答案也需要除以这个len。**  **\* 下面的解法中，直接用a[i]数组pow\_mod,我认为是因为dp[0][j]的初始值都与b[i]数组相同；**  **\* 验证发现的确两种方法都可以AC。**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **const** LL basemod = 1000000007;  LL mod = basemod;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **//防爆long long mul\_mod**  LL mul(LL a, LL b, LL p) {  **return** (a \* b - (LL)((**long** **double**)a / p \* b + 1e-3) \* p + p) % p;  }  **void** arrMul(LL n, LL \*c, LL \*a, LL \*b) {  **for** (**int** i = 0; i < n; ++i)  c[i] = mul(a[i], b[i], mod);  }  LL pow\_mod(LL x, LL k, LL mod)  {  LL res = 1;  **while**(k)  {  **if**( k & 1) res = mul(res, x, mod);  x = mul(x, x, mod);  k >>= 1;  }  **return** res;  }  **void** FWT(LL \*a, **int** n) {  **if** (n == 1) **return**;  **int** m = n >> 1;  FWT(a, m);  FWT(a + m, m);  **for** (**int** i = 0; i < m; ++i) {  LL u = a[i], v = a[i + m];  a[i] = (u + v) % mod;  a[i + m] = (u - v + mod) % mod;  }  }  **void** dFWT(LL \*a, **int** n) {  **if** (n == 1) **return**;  **int** m = n >> 1;  **for** (**int** i = 0; i < m; ++i) {  LL u = a[i], v = a[i + m];  a[i] = (u + v) % mod;  a[i + m] = (u - v + mod) % mod;  }  dFWT(a, m);  dFWT(a + m, m);  }  **void** Conv(LL \*A, LL \*B, **int** n, **int** t)**//t -> 运算次数，n -> 运算长度, B -> 为转换数组, A -> 结果/初值数组。**  {  FWT(A, n);  FWT(B, n);  **for** (; t; t >>= 1, arrMul(n, B, B, B)) **//类似快速幂**  **if** (t & 1) arrMul(n, A, A, B);  dFWT(A, n);  }  LL a[1<<12], b[1<<12];  LL solve(**int** n, **int** m, **int** L, **int** R)  {  LL len = 1;  **while**(len <= R) len \*= 2;  mod = basemod \* len;  **for**(**int** i = 0; i < len ;i++)  a[i] = b[i] = (i >= L && i <= R);  **// FWT(a, len);**  **// for(int i = 0; i < len; i++)**  **// a[i] = pow\_mod(a[i], 2 \* n + 1, mod);**  **// dFWT(a, len);**  Conv(a, b, len, 2\*n);  **return** (a[0] + mod)%mod/len;  }  **int** main()  {  Open();  **int** n, m, L, R;  **while**(~scanf("%d%d%d%d", &n, &m, &L, &R))  {  LL ans = 0;  **for**(**int** i = L; i <= R; i++)  ans = (ans + solve(n, m, i, i+m))%basemod;  printf("%lld\n", ans);  }  **return** 0;  } |

## 图论及树

### 最小生成树Prim

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| **//最小生成树**  **#include** <cstdio>  **#include** <algorithm>  **#include** <cstring>  **#include** <cmath>  **#include** <queue>  **#define** N 111  **using** **namespace** std;  **const** **int** INF=0x3f3f3f3f;  **int** last[N];**//**  **struct** edge  {  **int** u,v,w,nxt;  edge(){}  edge(**int** uu,**int** vv,**int** ww,**int** n):u(uu),v(vv),w(ww),nxt(n){}  }e[N\*N];  **typedef** pair<**int**,**int**> PII;  **int** ans,n,m;**//**  **bool** vis[N];**//**  **int** prim(**int** s)  {  priority\_queue<PII,vector<PII>,greater<PII> > que;  ans=0;  que.push(PII(0,s));  **int** prev=0;  **int** num=0;  **while**(!que.empty())  {  **int** u=que.top().second;  **int** w=que.top().first;  que.pop();  **if**(vis[u]) **continue**;  ans+=w;  vis[u]=**true**;  num++;  **if**(num==n) **return** ans;  **for**(**int** i=last[u];~i;i=e[i].nxt)  {  **int** v=e[i].v;  w=e[i].w;  **if**(vis[v]) **continue**;  que.push(PII(w,v));  }  }  **if**(num!=n) **return** -1;  }  **//////////** |

### 生成树计数

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| **/\***  **\* 基尔霍夫矩阵，Max-tree 矩阵，a[i][i]表示i节点的度数，如果有一条边(i,j)，则a[i][j]=-1**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 222;  LL mod;  LL a[N][N];  **//求行列式的值**  LL Det(LL a[][N], LL n)  {  **//mod = 1e9;**  **// for(LL i = 0; i < n; i++)**  **// for(LL j = 0; j < n; j++)**  **// a[i][j] = (a[i][j]%mod+mod)%mod;**  LL ans = 1;  **for**(LL i = 0; i < n; i++)  {  **for**(LL j = i+1; j < n; j++)  {  **//欧几里得辗转相消**  **while**(a[j][i])  {  LL t = a[i][i] / a[j][i];  **for**(LL k = i; k < n; k++)  **// a[i][k] = (a[i][k] - a[j][k]\*t%mod)%mod;**  a[i][k] -= a[j][k]\*t;  **for**(LL k = i; k < n; k++)  swap(a[i][k], a[j][k]);  ans = -ans;  }  }  **if**(!a[i][i]) **return** 0;  **// ans = ans\*a[i][i]%mod;**  ans = ans\*a[i][i];  }  **return** ans;  **// return (ans + mod) % mod;**  }  **int** main()  {  **// Open();**  **int** T;  scanf("%d", &T);  **int** n, m;  **while**(T--)  {  scanf("%d%d", &n, &m);  memset(a, 0, **sizeof**(a));  **while**(m--)  {  **int** u, v;  scanf("%d%d", &u, &v);  u--, v--;  a[u][u] ++, a[v][v]++;  a[v][u] --, a[u][v]--;  }  cout<<Det(a, n-1)<<endl;  **//printf("%d\n", Det(a, n-1));**  }  **return** 0;  } |

### 次小生成树

算法:

1)先用prim求出最小生成树T,在prim的同时,用一个矩阵max[u][v]记录在树中连接u-v的路径中权值最大的边.

2)枚举所有不在T中的边u-v,加入边u-v,删除权值为max[u][v]的边,不断枚举找到次小生成树.

这里max数组可以降低复杂度求，模板中是直接暴力搞的

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| **//次小生成树**  **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <cstring>  **#include** <cmath>  **#include** <queue>  **#define** N 111  **using** **namespace** std;  **const** **int** INF=0x3f3f3f3f;  **int** last[N];**//**  **struct** edge  {  **int** u,v,w,nxt;  edge(){}  edge(**int** uu,**int** vv,**int** ww,**int** n):u(uu),v(vv),w(ww),nxt(n){}  }e[N\*N\*2];  **typedef** pair<**int**,pair<**int**,**int**> > PII;**//三元组**  **int** ans,n,m;**//**  **bool** vis[N];**//**  **int** pre[N];**//**  **int** eMax[N][N];**//最小生成树中u,v路径上的最大边**  **int** prim(**int** s)  {  priority\_queue<PII,vector<PII>,greater<PII> > que;  ans=0;  que.push(PII(0,pair<**int**,**int**>(0,s)));  **int** num=0;  **while**(!que.empty())  {  **int** prev=que.top().second.first;  **int** u=que.top().second.second;  **int** w=que.top().first;  que.pop();  **if**(vis[u]) **continue**;  ans+=w;  vis[u]=**true**;  num++;  pre[u]=prev;  **for**(**int** i=1;i<=n;i++)  {  **if**(vis[i] && i!=u )  {  eMax[i][u]=eMax[u][i]=max(eMax[i][pre[u]],w);  }  }  **if**(num==n) **return** ans;  **for**(**int** i=last[u];i!=-1;i=e[i].nxt)  {  **int** v=e[i].v;  w=e[i].w;  **if**(vis[v]) **continue**;  que.push(PII(w,pair<**int**,**int**>(u,v)));  }  }  **if**(num!=n) **return** -1;  }  **int** main()  {  **int** t;  scanf("%d",&t);  **while**(t--){  memset(last,-1,**sizeof**(last));  memset(vis,0,**sizeof**(vis));  memset(eMax,0,**sizeof**(eMax));  memset(pre,0,**sizeof**(pre));  ans=0;  **int** edgeNum=0;  scanf("%d%d",&n,&m);  **for**(**int** i=0;i<m;i++)  {  **int** u,v,w;  scanf("%d%d%d",&u,&v,&w);  e[edgeNum]=edge(u,v,w,last[u]),last[u]=edgeNum++;  e[edgeNum]=edge(v,u,w,last[v]),last[v]=edgeNum++;  }  ans=prim(1);  **if**(ans==-1)  {  printf("0\n");  **continue**;  }  **bool** flag=**true**;  **for**(**int** i=0;i<edgeNum && flag;i+=2)  {  **int** u=e[i].u,v=e[i].v,w=e[i].w;  **if**(pre[u]==v || pre[v]==u)  **continue**;  **if**(w==eMax[u][v]) flag=**false**;  }  **if**(!flag)  printf("Not Unique!\n");  **else**  printf("%d\n",ans);  }  **return** 0;  } |

### HDU 4453 Splay

一定是要注意push\_down使用的位置

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| **/\***  **\* HDU 4453 Looploop**  **\* 。。。这个题太恶心了，写得精疲力尽，但是无疑是对splay又更加理解了**  **\* 六种操作：**  **\* 1. add x: 找到树中的第k2+1个点，旋转为根，然后给左儿子打标记即可**  **\* 2. reverse: 找到树中的第k1+1个点，旋转为根，然后给左儿子打标记即可**  **\* 3. insert x: 啊。。我这里是比较丑的写法，直接找到最左边的儿子，**  **\* 把新节点变成这个节点的父亲，然后暴力往上push\_up。。但是**  **\* 其实利用splay旋转的性质完全可以不这么做，比如说将最左边**  **\* 儿子旋转到根，然后再插入，这样更新会方便一些吧。**  **\* 4. delete: 就只是删除最左边一个点而已，旋转到根，然后删。**  **\* 5. move x: 将第一个点放到最后去，也就是将第一个点删除，然后给尾巴添加**  **\* 一个新节点。挺简单的一个操作。不过我这里写的太挫了。。**  **\* 6. query: 这个不用说啦，找到最左一个点，然后输出即可。**  **\***  **\* 需要注意的就是push\_down, push\_up需要随时考虑用不用**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 300010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** a[N];  **int** val[N];  **int** pre[N], ch[N][2], add[N], flip[N], sz[N];  **int** tot, root;  **struct** Splay  {  **void** Treaval(**int** x) {  **if**(x) {  Treaval(ch[x][0]);  printf("结点%2d:左儿子 %2d 右儿子 %2d 父结点 %2d size = %2d ,key = %2d \n",x, ch[x][0], ch[x][1], pre[x], sz[x], val[x]);  Treaval(ch[x][1]);  }  }  **void** init()  {  tot = root = 0;  }  **int** newnode(**int** fa, **int** v)  {  **int** k = ++tot;  ch[k][0] = ch[k][1] = 0;  pre[k] = fa;  val[k] = v;  add[k] = 0, flip[k] = 0;  sz[k] = 1;  **return** k;  }  **void** push\_down(**int** x)  {  **if**(add[x]){  **int** lc = ch[x][0];  **int** rc = ch[x][1];  **if**(lc != 0) val[lc] += add[x], add[lc] += add[x];  **if**(rc != 0) val[rc] += add[x], add[rc] += add[x];  add[x] = 0;  }  **if**(flip[x]){  flip[x] = 0;  swap(ch[x][0], ch[x][1]);  **if**(ch[x][0] != 0) flip[ch[x][0]] ^= 1;  **if**(ch[x][1] != 0) flip[ch[x][1]] ^= 1;  }  }  **void** push\_up(**int** x)  {  sz[x] = sz[ch[x][0]] + sz[ch[x][1]] + 1;  }  **void** rotate(**int** x)  {  **int** y = pre[x], d = (ch[y][1] == x);  push\_down(y);push\_down(x);  ch[y][d] = ch[x][!d];  **if**(ch[x][!d]) pre[ch[x][!d]] = y;  ch[x][!d] = y;  pre[x] = pre[y];  pre[y] = x;  **if**(pre[x]) ch[pre[x]][ch[pre[x]][1] == y] = x;  push\_up(y);  push\_up(x);  }  **void** splay(**int** x, **int** goal)  {  **while**(pre[x] != goal){  **int** f = pre[x], ff = pre[f];  push\_down(ff);push\_down(f);  **if**(ff == goal) rotate(x);  **else** **if**((ch[ff][1] == f) == (ch[f][1] == x))  rotate(f), rotate(x);  **else**  rotate(x), rotate(x);  }  push\_up(x);  **if**(goal == 0) root = x;  }  **int** kth(**int** k)  {  **int** x = root;  **while**(x)  {  push\_down(x);  **if**(sz[ch[x][0]] >= k) x = ch[x][0];  **else** {  k -= sz[ch[x][0]] + 1;  **if**(k == 0) **return** x;  x = ch[x][1];  }  }  **return** x;  }  **int** build(**int** l, **int** r, **int** fa){  **if**(l > r) **return** 0;  **int** mid = l + r >> 1;  **int** k = newnode(fa, a[mid]);  ch[k][0] = build(l, mid-1, k);  ch[k][1] = build(mid+1, r, k);  push\_up(k);  **return** k;  }  **void** increase(**int** k, **int** x)  {  **int** idx = kth(k + 1);  **if**(idx == 0){  val[root] += x;  add[root] += x;  **return** ;  }  splay(idx, 0);  val[ch[idx][0]] += x;  add[ch[idx][0]] += x;  }  **void** reverse(**int** k)  {  **int** idx = kth(k + 1);  **if**(idx == 0){  flip[root] ^= 1;  **return** ;  }  splay(idx, 0);  **// Treaval(root);**  flip[ch[idx][0]] ^= 1;  }  **void** remove()  {  **int** x = root;  push\_down(x);  **while**(ch[x][0]) x = ch[x][0], push\_down(x);  splay(x, 0);  **if**(ch[x][0] == 0){  root = ch[x][1];  pre[ch[x][1]] = 0;  **return** ;  }  **int** y = ch[x][0];  push\_down(y);  **while**(ch[y][1]) y = ch[y][1], push\_down(y);  splay(y, x);  ch[y][1] = ch[x][1];  **if**(ch[x][1]) pre[ch[x][1]] = y;  pre[y] = 0;  root = y;  push\_up(y);  }  **void** insert(**int** v){  **if**(ch[root][0] == 0) splay(ch[root][1], 0);  **int** x = root;  push\_down(x);  **while**(ch[x][0]) x = ch[x][0], push\_down(x);  **int** tmpk = newnode(pre[x], v);  ch[tmpk][0] = x, ch[tmpk][1] = ch[x][1];  ch[pre[x]][0] = tmpk;  **if**(ch[x][1] != 0) pre[ch[x][1]] = tmpk;  ch[x][1] = 0;  pre[x] = tmpk;  **while**(x) push\_up(x), x = pre[x];  }  **void** move(**int** kind){  **if**(kind == 1){  **int** x = root;push\_down(x);  **while**(ch[x][1]) x = ch[x][1], push\_down(x);  splay(x, 0);  **int** y = ch[x][0];push\_down(y);  **while**(ch[y][1]) y = ch[y][1], push\_down(y);  splay(y, x);  pre[y] = 0;  root = y;  push\_up(y);  ch[x][1] = ch[x][0] = 0;  y = root;push\_down(y);  **while**(ch[y][0]) y = ch[y][0], push\_down(y);  splay(y, 0);  ch[y][0] = x; pre[x] = y;  sz[x] = 1;  push\_up(y);  }**else**{  **int** x = root; push\_down(x);  **while**(ch[x][0]) x = ch[x][0], push\_down(x);  splay(x, 0);  **int** y = ch[x][1]; push\_down(y);  **while**(ch[y][0]) y = ch[y][0], push\_down(y);  splay(y, x);  pre[y] = 0; root = y;  push\_up(y);  ch[x][1] = ch[x][0] = 0;  y = root; push\_down(y);  **while**(ch[y][1]) y = ch[y][1], push\_down(y);  splay(y, 0);  ch[y][1] = x, pre[x] = y;  sz[x] = 1; push\_up(y);  }  }  **int** query()  {  **int** x = root;push\_down(x);  **while**(ch[x][0]) x = ch[x][0], push\_down(x);  **return** val[x];  }  }spl;  **char** tmp[22];  **int** main()  {  Open();  **int** n, m, k1, k2;  **int** cas = 1;  **while**(scanf("%d%d%d%d", &n, &m, &k1, &k2), n||m||k1||k2)  {  **for**(**int** i = 1; i <= n; i++) scanf("%d", &a[i]);  spl.init();  root = spl.build(1, n, 0);  **// spl.Treaval(root);**  printf("Case #%d:\n", cas++);  **while**(m --)  {  scanf("%s", tmp);  **if**(tmp[0] == 'm')  {  **int** kind;  scanf("%d", &kind);  spl.move(kind);  }  **if**(tmp[0] == 'q')  {  printf("%d\n", spl.query());  }  **if**(tmp[0] == 'i')  {  **int** v;scanf("%d", &v);  spl.insert(v);  }  **if**(tmp[0] == 'r')  {  spl.reverse(k1);  }  **if**(tmp[0] == 'a')  {  **int** v;scanf("%d", &v);  spl.increase(k2, v);  }  **if**(tmp[0] == 'd')  {  spl.remove();  }  **// printf("--------------------------%s------------------------\n", tmp);**  **// spl.Treaval(root);**  **int** asdfasd = 11212;  }  }  **return** 0;  } |

### Floyd最短路

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| **int** d[N][N];  **int** n;  **void** floyd(**int** d[][N])  {  **for**(**int** k=0;k<n;k++)  **for**(**int** i=0;i<n;i++)  **for**(**int** j=0;j<n;j++)  d[i][j]=min(d[i][j],d[i][k]+d[k][j]);  }  **////floyd 快速幂求解恰好有N条边的最短路**  **#include** <iostream>  **#include** <cstring>  **#include** <cstdio>  **#include** <algorithm>  **using** **namespace** std;  **#define** N 222  **int** v[1111];  **int** tmp[N][N];  **int** n,t,s,e;  **int** d[N][N];  **int** ans[N][N];  **int** V;  **void** floyd(**int** target[][N],**int** a[][N],**int** b[][N])  {  memset(tmp,0x3f,**sizeof**(tmp));  **for**(**int** k=0;k<V;k++)  **for**(**int** i=0;i<V;i++)  **for**(**int** j=0;j<V;j++)  tmp[i][j]=min((**long** **long**)tmp[i][j],(**long** **long**)a[i][k]+b[k][j]);  **for**(**int** i=0;i<V;i++)  **for**(**int** j=0;j<V;j++)  target[i][j]=tmp[i][j];  }  **void** quickfloyd(**int** n)  {  **while**(n)  {  **if**(n&1)  {  floyd(ans,ans,d);  }  floyd(d,d,d);  n>>=1;  }  }  **int** main()  {  memset(v,-1,**sizeof**(v));  memset(d,0x3f,**sizeof**(d));  scanf("%d%d%d%d",&n,&t,&s,&e);  V=0;  **for**(**int** i=0;i<t;i++)  {  **int** a,b,l;  scanf("%d%d%d",&l,&a,&b);  **if**(v[a]==-1) v[a]=V++;  **if**(v[b]==-1) v[b]=V++;  d[v[a]][v[b]]=l;  d[v[b]][v[a]]=l;  }  memset(ans,0x3f,**sizeof**(ans));  **for**(**int** i=0;i<V;i++)  ans[i][i]=0;  quickfloyd(n);  printf("%d\n",ans[v[s]][v[e]]);  **return** 0;  }  **/////** |

### Dijkstra最短路

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| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <cstring>  **#include** <cmath>  **#include** <queue>  **#define** N 50050  **using** **namespace** std;  **const** **int** INF=0x3f3f3f3f3f3f3f3fL;  **int** c[N];  **int** last[N];  **struct** edge  {  **int** v,w,nxt;  edge(){}  edge(**int** vv,**int** ww,**int** n):v(vv),w(ww),nxt(n){}  }e[N\*2];  **typedef** pair<**int**,**int**> PII;  **int** ans,n,m;  **int** d[N];  priority\_queue<PII,vector<PII>,greater<PII> > que;  **void** dijkstra(**int** s)  {  memset(d,0x3f,**sizeof**(d));  **//fill(d+1,d+V+1,INF);**  d[s]=0;  que.push(PII(0,s));  **while**(!que.empty())  {  PII pp=que.top();que.pop();  **int** u=pp.second;  **if**(d[u]<pp.first) **continue**;  **for**(**int** i=last[u];i!=-1;i=e[i].nxt){  **int** v=e[i].v,w=e[i].w;  **if**(d[v]>d[u]+w)  {  d[v]=d[u]+w;  que.push(PII(d[v],v));  }  }  }  } |

### Astar求K短路

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| **#include** <iostream>  **#include** <cstdio>  **#include** <cstring>  **#include** <algorithm>  **#include** <queue>  **using** **namespace** std;  **//const long long INF=0x7fffffffffffffffL;**  **#define** N 100010  **struct** edge  {  **int** v,w,nxt;  }e[N],reve[N];  **int** last[1010];  **int** revlast[1010];  **typedef** pair<**int**,**int**> PII;  **int** V;  **int** d[1010];  priority\_queue<PII,vector<PII>,greater<PII> > que;  **void** dijkstra(**int** s)  {  memset(d,0x3f,**sizeof**(d));  **//fill(d+1,d+V+1,INF);**  d[s]=0;  que.push(PII(0,s));  **while**(!que.empty())  {  PII pp=que.top();que.pop();  **int** u=pp.second;  **if**(d[u]<pp.first) **continue**;  **for**(**int** i=revlast[u];i!=-1;i=reve[i].nxt){  **int** v=reve[i].v,w=reve[i].w;  **if**(d[v]>d[u]+w)  {  d[v]=d[u]+w;  que.push(PII(d[v],v));  }  }  }  }  **struct** A  {  **int** u,g,f;  **bool** **operator**< (**const** A& a) **const**  {  **return** f > a.f;  }  A(**int** uu=0,**int** gg=0,**int** hh=0){u=uu,g=gg,f=hh;}  };  **int** cnt[1010];  **int** Astar(**int** s,**int** t,**int** k)  {  **if**(s==t) k++;  priority\_queue<A> Aque;  Aque.push(A(s,0,0));  **while**(!Aque.empty())  {  A tmp=Aque.top();Aque.pop();  **int** u=tmp.u,g=tmp.g,f=tmp.f;  cnt[u]++;  **if**(cnt[u]==k && u==t) **return** f;  **for**(**int** i=last[u];i!=-1;i=e[i].nxt)  {  **int** v=e[i].v,w=e[i].w;  **if**(cnt[v]<k)  Aque.push(A(v,g+w,g+w+d[v]));  }  }  **return** -1;  }  **int** main()  {  **int** n,m;  scanf("%d%d",&n,&m);  memset(last,-1,**sizeof**(last));  memset(revlast,-1,**sizeof**(revlast));  **for**(**int** i=0;i<m;i++)  {  **int** u,v,w;  scanf("%d%d%d",&u,&v,&w);  e[i].v=v,e[i].w=w,e[i].nxt=last[u],last[u]=i;  reve[i].v=u,reve[i].w=w,reve[i].nxt=revlast[v],revlast[v]=i;  }  **int** s,t,k;  scanf("%d%d%d",&s,&t,&k);  dijkstra(t);  printf("%d\n",Astar(s,t,k));  **return** 0;  } |

### 最小费用最大流(SPFA\_rujia)

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| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <unordered\_map>  **#include** <vector>  **#include** <climits>  **#include** <assert.h>  **#include** <bitset>  **using** **namespace** std;  **typedef** **long** **long** LL;  **const** **int** INF = 0x3f3f3f3f;  **typedef** pair<**int**, **int**> PII;  **const** **int** N = 201;  **struct** Edge{  **int** u, v, cap, flow, cost;  };  **struct** MCMF{  **int** n, m, s, t;  vector<Edge> edges;  vector<**int**> G[N];  **int** inq[N];  **int** d[N];  **int** p[N];  **int** a[N];  **void** init(**int** n, **int** s, **int** t) {  **this** -> n = n;  **this** -> s = s;  **this** -> t = t;  **for**(**int** i = 0; i<n; i++) G[i].clear();  edges.clear();  }  **void** addedge(**int** u, **int** v, **int** cap, **int** cost){  edges.push\_back((Edge){u, v, cap, 0, cost});  edges.push\_back((Edge){v, u, 0, 0, -cost});  m = edges.size();  G[u].push\_back(m-2);  G[v].push\_back(m-1);  **// cerr<<u<<" -> "<<v<<" : "<<cost<<endl;**  }  **bool** SPFA(**int**& flow, **int**& cost){  **for**(**int** i=0;i<n;i++) d[i] = INF;  memset(inq, 0, **sizeof**(inq));  d[s] = 0; inq[s] = 1; p[s] = 0; a[s] = INF;  queue<**int**> Q;  Q.push(s);  **while**(!Q.empty()){  **int** u = Q.front(); Q.pop();  inq[u] = 0;  **for**(**int** i = 0; i < G[u].size(); i++) {  Edge& e = edges[G[u][i]];  **if**(e.cap > e.flow && d[e.v] > d[u] + e.cost){  d[e.v] = d[u] + e.cost;  p[e.v] = G[u][i];  a[e.v] = min(a[u], e.cap - e.flow);  **if**(!inq[e.v]) {Q.push(e.v); inq[e.v] = 1;}  }  }  }  **//记得判断不可达的情况！！！！！！！！！！！！！！！！！**  **if**(d[t] == INF) **return** **false**;  flow += a[t];  cost += d[t]\*a[t];  **int** u = t;  **while**(u != s){  edges[p[u]].flow += a[t];  edges[p[u]^1].flow -= a[t];  u = edges[p[u]].u;  }  **return** **true**;  }  **int** Mincost() {  **int** flow = 0, cost = 0;  **while**(SPFA(flow, cost));  **return** cost;  }  }mcmf;  vector<Edge> pe;  **int** w[N];  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  **int** n, m;  scanf("%d%d", &n, &m);  **for**(**int** i = 0; i < m; i++)  {  **int** u, v, c, f;  scanf("%d%d%d%d", &u, &v, &c, &f);  w[v] += f;  w[u] -= f;  pe.push\_back((Edge){u, v, c, f, 0});  }  **int** s = 0, t = n+1;  mcmf.init(t+1, s, t);  mcmf.addedge(n, 1, INF, 0);  **for**(**int** i = 1; i <= n; i++)  {  **if**(w[i] > 0) mcmf.addedge(s, i, w[i], 0);  **if**(w[i] < 0) mcmf.addedge(i, t, -w[i], 0);  }  **int** ans = 0;  **for**(**int** i = 0; i < m; i++)  {  **int** u = pe[i].u, v = pe[i].v, c = pe[i].cap, f = pe[i].flow;  **if**(f > c) {  ans += f-c;  mcmf.addedge(u, v, INF, 2);  mcmf.addedge(v, u, f-c, 0);  mcmf.addedge(v, u, c, 1);  }**else**{  mcmf.addedge(u, v, c-f, 1);  mcmf.addedge(u, v, INF, 2);  mcmf.addedge(v, u, f, 1);  }  }  ans += mcmf.Mincost();  printf("%d\n", ans);  **return** 0;  } |

### ZKW费用流

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| **/\***  **\* 比一般费用流快很多，适用于边非常密集的地方**  **\* 本模板是不能直接用于任何有负权的图，更不能用于有负圈的情况**  **\*/**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **struct** ZKW\_flow{  **const** **static** **int** MAXN = 210;  **const** **static** **int** MAXE = 210\*210;  **int** st, ed, ecnt, n;  **int** head[MAXN];  **int** cap[MAXE], cost[MAXE], to[MAXE], next[MAXE];  **void** init(){  memset(head, 0, **sizeof**(head));  ecnt = 2;  }  **//cc容量，ww花费**  **void** addEdge(**int** u, **int** v, **int** cc, **int** ww){  cap[ecnt] = cc; cost[ecnt] = ww; to[ecnt] = v;  next[ecnt] = head[u]; head[u] = ecnt++;  cap[ecnt] = 0; cost[ecnt] = -ww; to[ecnt] = u;  next[ecnt] = head[v]; head[v] = ecnt++;  }  **int** dis[MAXN];  **void** SPFA(){  **for**(**int** i = 1; i <= n; ++i) dis[i] = INF;  priority\_queue<pair<**int**, **int**> > Q;  dis[st] = 0;  Q.push(make\_pair(0, st));  **while**(!Q.empty()){  **int** u = Q.top().second, d = -Q.top().first;  Q.pop();  **if**(dis[u] != d) **continue**;  **for**(**int** p = head[u]; p; p = next[p]){  **int** &v = to[p];  **if**(cap[p] && dis[v] > d + cost[p]){  dis[v] = d + cost[p];  Q.push(make\_pair(-dis[v], v));  }  }  }  **for**(**int** i = 1; i <= n; ++i) dis[i] = dis[ed] - dis[i];  }  **int** minCost, maxFlow;  **bool** use[MAXN];  **int** add\_flow(**int** u, **int** flow){  **if**(u == ed){  maxFlow += flow;  minCost += dis[st] \* flow;  **return** flow;  }  use[u] = **true**;  **int** now = flow;  **for**(**int** p = head[u]; p; p = next[p]){  **int** &v = to[p];  **if**(cap[p] && !use[v] && dis[u] == dis[v] + cost[p]){  **int** tmp = add\_flow(v, min(now, cap[p]));  cap[p] -= tmp;  cap[p^1] += tmp;  now -= tmp;  **if**(!now) **break**;  }  }  **return** flow - now;  }  **bool** modify\_label(){  **int** d = INF;  **for**(**int** u = 1; u <= n; ++u) **if**(use[u])  **for**(**int** p = head[u]; p; p = next[p]){  **int** &v = to[p];  **if**(cap[p] && !use[v]) d = min(d, dis[v] + cost[p] - dis[u]);  }  **if**(d == INF) **return** **false**;  **for**(**int** i = 1; i <= n; ++i) **if**(use[i]) dis[i] += d;  **return** **true**;  }  **//nn表示图中点的数量，图中的点编号从1开始。**  PII min\_cost\_flow(**int** ss, **int** tt, **int** nn){  st = ss, ed = tt, n = nn;  minCost = maxFlow = 0;  SPFA();  **while**(**true**){  **while**(**true**){  **for**(**int** i = 1; i <= n; ++i) use[i] = 0;  **if**(!add\_flow(st, INF)) **break**;  }  **if**(!modify\_label()) **break**;  }  **return** PII(minCost, maxFlow);  }  }G;  **int** n;  **struct** Point  {  **int** x, y, z, w;  **void** read()  {  scanf("%d%d%d%d", &x, &y, &z, &w);  }  **inline** **int** D(**int** x)  {  **return** x\*x;  }  **inline** **int** dist(Point& o)  {  **return** floor(sqrt((**double**)D(o.x - x) + D(o.y - y) + D(o.z - z)))+0.5;  }  }p[111];  **int** main()  {  **// Open();**  **while**(~scanf("%d", &n), n)  {  **int** allw = 0;  **for**(**int** i = 1; i <= n; i++)  {  p[i].read();  allw += p[i].w;  }  G.init();  **int** s = 2 \* n + 1, t = s + 1;  **for**(**int** i = 1; i <= n; i++){  G.addEdge(s, i, p[i].w, 0);  G.addEdge(i+n, t, p[i].w, 0);  **for**(**int** j = 1; j <= n; j++){  **if**(i == j) **continue**;  G.addEdge(i, j+n, INF, p[i].dist(p[j]));  }  }  PII res = G.min\_cost\_flow(s, t, t);  **if**(res.second != allw) res.first = -1;  printf("%d\n", res.first);  }  **return** 0;  } |

### 最小顶点覆盖/二分图最大匹配

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| **const** **int** MAXN=;**//$**  **////////////////最小顶点覆盖/二分图最大匹配///////////////////**  **//下标从0开始**  **struct** BPM{  **int** n,m;  vector<**int** > G[MAXN];  **int** left[MAXN];  **bool** T[MAXN];  **int** right[MAXN];  **bool** S[MAXN];  **void** init(**int** n,**int** m){  **this** -> n = n;  **this** -> m = m;  **for**(**int** i = 0;i < MAXN;i++) G[i].clear();  }  **void** add\_edge(**int** u,**int** v){  G[u].push\_back(v);  }  **bool** match(**int** u){  S[u] = **true**;  **for**(**int** i = 0;i < G[u].size();i++){  **int** v = G[u][i];  **if**(!T[v]){  T[v] = **true**;  **if**(left[v] == -1 || match(left[v])){  left[v] = u;  right[u] = v;  **return** **true**;  }  }  }  **return** **false**;  }  **//最大匹配数**  **int** solve(){  memset(left,-1,**sizeof**(left));  memset(right,-1,**sizeof**(right));  **int** ans = 0;  **for**(**int** u = 0;u < n;u++){  memset(S,0,**sizeof**(S));  memset(T,0,**sizeof**(T));  **if**(match(u)) ans++;  }  **return** ans;  }  **//计算最小顶点覆盖，返回点数，覆盖哪些点分别在X，Y中**  **int** mincover(vector<**int**>& X,vector<**int**>& Y){  **int** ans = solve();  memset(S,0,**sizeof**(S));  memset(T,0,**sizeof**(T));  **for**(**int** u = 0;u < n;u++)  **if**(right[u] == -1) match(u);  **for**(**int** u = 0;u < n;u++)  **if**(!S[u]) X.push\_back(u);  **for**(**int** v = 0;v < m;v++)  **if**(T[v]) Y.push\_back(v);  **return** ans;  }  }solver;  **/\*how to use**  **solver.init(m,n);//左边m个点，右边n个点**  **...solver.AddEdge(u,v) //下标从0开始**  **vector<int > X,Y;**  **int point\_num=solver.mincover(X,Y);//最小覆盖点数，也是最大匹配数**  **//输出覆盖了哪些点**  **for(int i = 0;i < X.size();i++)**  **printf(" r%d",X[i]);**  **for(int j = 0;j < Y.size();j++)**  **printf(" c%d",Y[j]);**  **\*/**  **////////////////最小顶点覆盖///////////////////**  **const** **int** maxn = 1000 + 5;  **struct** BPM{  **int** n,m;  vector<**int** > G[maxn];  **int** left[maxn];  **bool** T[maxn];  **int** right[maxn];  **bool** S[maxn];  **void** init(**int** n,**int** m){  **this** -> n = n;  **this** -> m = m;  **for**(**int** i = 0;i < maxn;i++) G[i].clear();  }  **void** AddEdge(**int** u,**int** v){  G[u].push\_back(v);  }  **bool** match(**int** u){  S[u] = **true**;  **for**(**int** i = 0;i < G[u].size();i++){  **int** v = G[u][i];  **if**(!T[v]){  T[v] = **true**;  **if**(left[v] == -1 || match(left[v])){  left[v] = u;  right[u] = v;  **return** **true**;  }  }  }  **return** **false**;  }  **int** solve(){  memset(left,-1,**sizeof**(left));  memset(right,-1,**sizeof**(right));  **int** ans = 0;  **for**(**int** u = 0;u < n;u++){  memset(S,0,**sizeof**(S));  memset(T,0,**sizeof**(T));  **if**(match(u)) ans++;  }  **return** ans;  }  **int** mincover(vector<**int**>& X,vector<**int**>& Y){  **int** ans = solve();  memset(S,0,**sizeof**(S));  memset(T,0,**sizeof**(T));  **for**(**int** u = 0;u < n;u++)  **if**(right[u] == -1) match(u);  **for**(**int** u = 0;u < n;u++)  **if**(!S[u]) X.push\_back(u);  **for**(**int** v = 0;v < n;v++)  **if**(T[v]) Y.push\_back(v);  **return** ans;  }  };  BPM solver;  **int** main(){  **int** n,r,c;  **while**(scanf("%d%d%d",&r,&c,&n)){  **if**(r == 0 && c == 0 && n == 0) **break**;  solver.init(r,c);  **while**(n--){  **int** x,y;  scanf("%d%d",&x,&y);x--;y--;**//模版中编号是从0开始的**  solver.AddEdge(x,y);  }  vector<**int**> X,Y;  printf("%d",solver.mincover(X,Y));  **for**(**int** i = 0;i < X.size();i++)  printf(" r%d",X[i]+1);**//最后别忘了加回来**  **for**(**int** j = 0;j < Y.size();j++)  printf(" c%d",Y[j]+1);  printf("\n");  }  **return** 0;  } |

### 最近公共祖先

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| **//最近公共祖先（LCA）**  **#include** <iostream>  **#include** <cmath>  **#include** <cstdio>  **#include** <cstring>  **using** **namespace** std;  **#include** <vector>  vector<**int**> g[N];**//**  **int** root;  **int** parent[LOG\_N][N];  **int** depth[N];  **void** dfs(**int** v,**int** p,**int** d)  {  parent[0][v]=p;  depth[v]=d;  **for**(**int** i=0;i<g[v].size();i++) **if**(g[v][i]!=p) dfs(g[v][i],v,d+1);  }  **//预处理**  **void** init()**//预处理出parent**  {  root = 0; **// or 1**  dfs(root,-1,0);  **for**(**int** k=0;k+1<LOG\_N;k++)  **for**(**int** v=1;v<=n;v++)**//这里根据顶点的起始下标改变**  **if**(parent[k][v]<0) parent[k+1][v]=-1;  **else** parent[k+1][v]=parent[k][parent[k][v]];  }  **//计算u和v的LCA**  **int** lca(**int** u,**int** v)  {  **//让u和v向上走到同一深度**  **if**(depth[u]>depth[v]) swap(u,v);  **for**(**int** k=0;k<LOG\_N;k++)  **if**((depth[v]-depth[u])>>k&1)  v=parent[k][v];  **if**(u==v) **return** u;  **//利用二分搜索计算LCA**  **for**(**int** k=LOG\_N-1;k>=0;k--)  **if**(parent[k][u]!=parent[k][v])  u=parent[k][u], v=parent[k][v];  **return** parent[0][u];  }  **//最近公共祖先（LCA）**  **//tarjan离线LCA，先将询问全部存下来，然后一次DFS求出所有询问的答案**  **struct** info{  **int** u, v, id;  info(**int** u = 0, **int** v = 0, **int** id = 0):u(u), v(v), id(id){}  };  **int** n, m;  vector<**int**> g[N];  vector<PII> query[N];  vector<info> rt[N];  **int** Uto[N], toU[N], ma[N], mi[N], sn[N], ans[N], fa[N];  **bool** vis[N];  **void** init()  {  **for**(**int** i=0;i<=n;i++)  {  vis[i] = 0;  g[i].clear();  query[i].clear();  rt[i].clear();  fa[i] = i;  Uto[i] = toU[i] = 0;  ma[i] = mi[i] = sn[i];  }  }  **int** Find(**int** u)  {  **if**(fa[u] == u) **return** u;  **int** root = Find(fa[u]);  Uto[u] = max(Uto[u], max(Uto[fa[u]], ma[fa[u]] - mi[u]));  toU[u] = max(toU[u], max(toU[fa[u]], ma[u] - mi[fa[u]]));  ma[u] = max(ma[u], ma[fa[u]]);  mi[u] = min(mi[u], mi[fa[u]]);  **return** fa[u] = root;  }  **void** lca(**int** u)  {  vis[u] = 1;  **for**(**int** i=0;i<query[u].size();i++)  {  **int** v = query[u][i].first, id = query[u][i].second;  **if**(vis[v])  {  **int** root = Find(v);  **if**(id < 0) rt[root].push\_back(info(v, u, -id));  **else** rt[root].push\_back(info(u, v, id));  }  }  **for**(**int** i=0;i<g[u].size();i++)  {  **int** v = g[u][i];  **if**(vis[v]) **continue**;  lca(v);  fa[v] = u;  }  **for**(**int** i=0;i<rt[u].size(); i++)  {  **int** x = rt[u][i].u, y = rt[u][i].v, id = rt[u][i].id;  **//cout<<"lca: "<<u<<"("<<x<<","<<y<<") ans:";**  Find(x), Find(y);  ans[id] = max(Uto[x], max(toU[y], ma[y] - mi[x]));  **//cout<<id<<":"<<ans[id]<<endl;**  }  }  **//离线LCA** |

### 最大流（DINIC-rujia）

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<n)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** N = 625\*500;  **struct** Edge  {  **int** from, to;  **int** cap, flow;  };  **struct** DINIC  {  **int** n, m, s, t;  vector<Edge> edges;  vector<**int**> G[N]; **// 邻接表，G[i][j]表示结点i的第j条边在e数组中的序号**  **bool** vis[N]; **// BFS使用**  **int** d[N]; **// 从起点到i的距离**  **int** cur[N]; **// 当前弧指针**  **void** AddEdge(**int** from, **int** to, **int** cap)  {  edges.push\_back((Edge){from, to, cap, 0});  edges.push\_back((Edge){to, from, 0, 0});  m = edges.size();  G[from].push\_back(m-2);  G[to].push\_back(m-1);  }  **bool** BFS()  {  memset(vis, 0, **sizeof**(vis));  queue<**int**> Q;  Q.push(s);  vis[s] = 1;  d[s] = 0;  **while**(!Q.empty())  {  **int** x = Q.front();  Q.pop();  **for**(**int** i = 0; i < G[x].size(); i++)  {  Edge& e = edges[G[x][i]];  **if**(!vis[e.to] && e.cap - e.flow > 0)  {  vis[e.to] = 1;  d[e.to] = d[x] + 1;  Q.push(e.to);  }  }  }  **return** vis[t];  }  **void** ClearAll(**int** n)  {  **this** -> n = n;  **for**(**int** i = 0; i < n; i++) G[i].clear();  edges.clear();  }  **void** ClearFlow()  {  **for**(**int** i = 0; i < edges.size(); i++) edges[i].flow = 0;  }  **int** DFS(**int** x, **int** a)  {  **if**(x == t||a == 0) **return** a;  **int** flow = 0, f;  **for**(**int** &i = cur[x]; i < G[x].size(); i++)  {  Edge& e = edges[G[x][i]];  **if**(d[x] + 1 == d[e.to] && (f = DFS(e.to, min(a, e.cap-e.flow))) > 0)  {  e.flow += f;  edges[G[x][i]^1].flow -= f;  flow += f;  a -= f;  **if**(a == 0) **break**;  }  }  **return** flow;  }  **int** Maxflow(**int** s, **int** t)  {  **this**->s = s;  **this**->t = t;  **int** flow = 0;  **while**(BFS())  {  memset(cur, 0, **sizeof**(cur));  flow += DFS(s, INF);  }  **return** flow;  }  vector<**int**> Mincut() **// call this after maxflow**  {  BFS();  vector<**int**> ans;  **for**(**int** i = 0; i < edges.size(); i++)  {  Edge& e = edges[i];  **if**(!vis[e.from] && vis[e.to] && e.cap > 0) ans.push\_back(i);  }  **return** ans;  }  **void** Reduce()  {  **for**(**int** i = 0; i < edges.size(); i++) edges[i].cap -= edges[i].flow;  }  **void** print()  {  printf("Graph:\n");  **for**(**int** i = 0; i < edges.size(); i++)  **if**(edges[i].cap != 0)  printf("%d->%d, %d, %d\n", edges[i].from, edges[i].to , edges[i].cap, edges[i].flow);  }  };  DINIC mf;  **char** str[35][35];  **int** dir[][2] = {-1, 0, 0, -1, 1, 0, 0, 1, 0, 0};  **int** main()  {  **// Open();**  **int** n;  **int** cas = 1;  **while**(~scanf("%d", &n) && n)  {  **for**(**int** i = 0; i < n; i++)  scanf("%s", &str[i]);  **bool** flag = **false**;  **for**(**int** st = n; !flag; st++)  {  **// cout<<"fUCK"<<endl;**  **int** s = 2\*n\*n\*st;  **int** t = s+1;  mf.ClearAll(t+1);  **for**(**int** i = 0; i < n; i++)  {  mf.AddEdge(s, i\*n, 1);  mf.AddEdge(2\*(st-1)\*n\*n+n\*n+i\*n+n-1, t, 1);  }  **for**(**int** ct = 0; ct+1 < st; ct++)  {  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0; j < n; j++)  {  **for**(**int** k = 0; k < 5; k++)  {  **int** cx = i + dir[k][0];  **int** cy = j + dir[k][1];  **if**(!CHECK(cx, cy) || str[cx][cy] == 'X') **continue**;  mf.AddEdge(2\*ct\*n\*n+i\*n+j+n\*n, 2\*(ct+1)\*n\*n+cx\*n+cy, 1);  }  mf.AddEdge(2\*ct\*n\*n+i\*n+j, 2\*ct\*n\*n+i\*n+j+n\*n, 1);  }  }  **int** ct = st-1;  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0; j < n; j++)  {  **// cerr<<2\*ct\*n\*n+i\*n+j<<"->"<<2\*ct\*n\*n+i\*n+j+n\*n<<endl;**  mf.AddEdge(2\*ct\*n\*n+i\*n+j, 2\*ct\*n\*n+i\*n+j+n\*n, 1);  }  **// mf.print();**  **// cout<<mf.Maxflow(s, t)<<endl;**  **int** tmp = mf.Maxflow(s, t);  **// cout<<st<<"->"<<tmp<<endl;**  **if**(tmp == n)  {  flag = **true**;  printf("Case %d: %d\n", cas++, st-1);  **break**;  }  **// if(st == 4) break;**  }  **// break;**  }  **return** 0;  } |

### 最大流(ISAP-rujia)

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 222  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **const** **double** eps = 1e-9;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** dcmp(**double** x)  {  **if**(fabs(x) < eps) **return** 0;  **return** x > eps;  }  **struct** Edge  {  **int** from, to;  **double** cap, flow;  };  **struct** ISAP  {  **int** n, m, s, t;  vector<Edge> edges;  vector<**int**> G[N]; **// 邻接表，G[i][j]表示结点i的第j条边在e数组中的序号**  **bool** vis[N]; **// BFS使用**  **int** d[N]; **// 从起点到i的距离**  **int** cur[N]; **// 当前弧指针**  **int** p[N]; **// 可增广路上的上一条弧**  **int** num[N]; **// 距离标号计数**  **void** AddEdge(**int** from, **int** to, **double** cap)  {  edges.push\_back((Edge)  {  from, to, cap, 0  });  edges.push\_back((Edge)  {  to, from, 0, 0  });  m = edges.size();  G[from].push\_back(m-2);  G[to].push\_back(m-1);  }  **bool** BFS()  {  memset(vis, 0, **sizeof**(vis));  queue<**int**> Q;  Q.push(t);  vis[t] = 1;  d[t] = 0;  **while**(!Q.empty())  {  **int** x = Q.front();  Q.pop();  **for**(**int** i = 0; i < G[x].size(); i++)  {  Edge& e = edges[G[x][i]^1];  **if**(!vis[e.from] && dcmp(e.cap - e.flow) > 0)  {  vis[e.from] = 1;  d[e.from] = d[x] + 1;  Q.push(e.from);  }  }  }  **return** vis[s];  }  **void** ClearAll(**int** n)  {  **this**->n = n;  **for**(**int** i = 0; i < n; i++) G[i].clear();  edges.clear();  }  **void** ClearFlow()  {  **for**(**int** i = 0; i < edges.size(); i++) edges[i].flow = 0;  }  **double** Augment()  {  **int** x = t;  **double** a = INF;  **while**(x != s)  {  Edge& e = edges[p[x]];  a = min(a, e.cap-e.flow);  x = edges[p[x]].from;  }  x = t;  **while**(x != s)  {  edges[p[x]].flow += a;  edges[p[x]^1].flow -= a;  x = edges[p[x]].from;  }  **return** a;  }  **double** Maxflow(**int** s, **int** t)  {  **this**->s = s;  **this**->t = t;  **double** flow = 0;  BFS();  memset(num, 0, **sizeof**(num));  **for**(**int** i = 0; i < n; i++) num[d[i]]++;  **int** x = s;  memset(cur, 0, **sizeof**(cur));  **while**(d[s] < n)  {  **if**(x == t)  {  flow += Augment();  x = s;  }  **int** ok = 0;  **for**(**int** i = cur[x]; i < G[x].size(); i++)  {  Edge& e = edges[G[x][i]];  **if**(dcmp(e.cap - e.flow) > 0 && d[x] == d[e.to] + 1) **// Advance**  {  ok = 1;  p[e.to] = G[x][i];  cur[x] = i; **// 注意**  x = e.to;  **break**;  }  }  **if**(!ok) **// Retreat**  {  **int** m = n-1; **// 初值注意**  **for**(**int** i = 0; i < G[x].size(); i++)  {  Edge& e = edges[G[x][i]];  **if**(dcmp(e.cap - e.flow) > 0) m = min(m, d[e.to]);  }  **if**(--num[d[x]] == 0) **break**;  num[d[x] = m+1]++;  cur[x] = 0; **// 注意**  **if**(x != s) x = edges[p[x]].from;  }  }  **return** flow;  }  vector<**int**> Mincut() **// call this after maxflow**  {  BFS();  vector<**int**> ans;  **for**(**int** i = 0; i < edges.size(); i++)  {  Edge& e = edges[i];  **if**(!vis[e.from] && vis[e.to] && e.cap > 0) ans.push\_back(i);  }  **return** ans;  }  **void** Reduce()  {  **for**(**int** i = 0; i < edges.size(); i++) edges[i].cap -= edges[i].flow;  }  **void** print()  {  printf("Graph:\n");  **for**(**int** i = 0; i < edges.size(); i++)  printf("%d->%d, %d, %d\n", edges[i].from, edges[i].to , edges[i].cap, edges[i].flow);  }  };  ISAP mf;  **int** U;  **int** n, a[N];  **int** deg[N];  **int** source, sink;  **int** check(**double** g)  {  mf.ClearAll(n+2);  memset(deg, 0, **sizeof**(deg));  **for**(**int** i=1; i<=n; i++)  **for**(**int** j = i+1; j <= n; j++)  **if**(a[j] < a[i]) mf.AddEdge(i, j, 1), mf.AddEdge(j, i, 1), deg[i]++, deg[j]++;  **for**(**int** i=1; i<=n; i++)  mf.AddEdge(source, i, U);  **for**(**int** i=1; i<=n; i++)  mf.AddEdge(i, sink, g\*2.0 + 1.0\*U - 1.0\*deg[i]);  **double** curf = mf.Maxflow(source, sink);  **return** dcmp((U\*n - curf)/2.0);  }  **int** main()  {  Open();  **int** T;  scanf("%d", &T);  **int** cas = 1;  **while**(T--)  {  scanf("%d", &n);  **for**(**int** i=1; i<=n; i++)  scanf("%d", &a[i]);  sink = n+1, source = 0;  U = n+3;  **double** lb = 0, ub = n\*n;  **while**(lb + eps < ub)  {  **double** mid = (lb + ub) / 2;  **int** tmp = check(mid);  **if**(tmp > 0) lb = mid;  **else** ub = mid;  }  printf("Case #%d: %.12f\n", cas++, lb+eps);  }  **return** 0;  } |

### 一般匹配-带花树开花算法

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| **#include** <cstdio>  **#include** <cstring>  **#include** <iostream>  **#include** <queue>  **using** **namespace** std;  **const** **int** N = 250;  **// 并查集维护**  **int** belong[N];  **int** findb(**int** x) {  **return** belong[x] == x ? x : belong[x] = findb(belong[x]);  }  **void** unit(**int** a, **int** b) {  a = findb(a);  b = findb(b);  **if** (a != b) belong[a] = b;  }  **int** n, match[N];  vector<**int**> e[N];  **int** Q[N], rear;  **int** next\_[N], mark[N], vis[N];  **// 朴素算法求某阶段中搜索树上两点x, y的最近公共祖先r**  **int** LCA(**int** x, **int** y) {  **static** **int** t = 0; t++;  **while** (**true**) {  **if** (x != -1) {  x = findb(x); **// 点要对应到对应的花上去**  **if** (vis[x] == t) **return** x;  vis[x] = t;  **if** (match[x] != -1) x = next\_[match[x]];  **else** x = -1;  }  swap(x, y);  }  }  **void** group(**int** a, **int** p) {  **while** (a != p) {  **int** b = match[a], c = next\_[b];  **// next数组是用来标记花朵中的路径的，综合match数组来用，实际上形成了**  **// 双向链表，如(x, y)是匹配的，next[x]和next[y]就可以指两个方向了。**  **if** (findb(c) != p) next\_[c] = b;  **// 奇环中的点都有机会向环外找到匹配，所以都要标记成S型点加到队列中去，**  **// 因环内的匹配数已饱和，因此这些点最多只允许匹配成功一个点，在aug中**  **// 每次匹配到一个点就break终止了当前阶段的搜索，并且下阶段的标记是重**  **// 新来过的，这样做就是为了保证这一点。**  **if** (mark[b] == 2) mark[Q[rear++] = b] = 1;  **if** (mark[c] == 2) mark[Q[rear++] = c] = 1;  unit(a, b); unit(b, c);  a = c;  }  }  **// 增广**  **void** aug(**int** s) {  **for** (**int** i = 0; i < n; i++) **// 每个阶段都要重新标记**  next\_[i] = -1, belong[i] = i, mark[i] = 0, vis[i] = -1;  mark[s] = 1;  Q[0] = s; rear = 1;  **for** (**int** front = 0; match[s] == -1 && front < rear; front++) {  **int** x = Q[front]; **// 队列Q中的点都是S型的**  **for** (**int** i = 0; i < (**int**)e[x].size(); i++) {  **int** y = e[x][i];  **if** (match[x] == y) **continue**; **// x与y已匹配，忽略**  **if** (findb(x) == findb(y)) **continue**; **// x与y同在一朵花，忽略**  **if** (mark[y] == 2) **continue**; **// y是T型点，忽略**  **if** (mark[y] == 1) { **// y是S型点，奇环缩点**  **int** r = LCA(x, y); **// r为从i和j到s的路径上的第一个公共节点**  **if** (findb(x) != r) next\_[x] = y; **// r和x不在同一个花朵，next标记花朵内路径**  **if** (findb(y) != r) next\_[y] = x; **// r和y不在同一个花朵，next标记花朵内路径**  **// 将整个r -- x - y --- r的奇环缩成点，r作为这个环的标记节点，相当于论文中的超级节点**  group(x, r); **// 缩路径r --- x为点**  group(y, r); **// 缩路径r --- y为点**  }  **else** **if** (match[y] == -1) { **// y自由，可以增广，R12规则处理**  next\_[y] = x;  **for** (**int** u = y; u != -1; ) { **// 交叉链取反**  **int** v = next\_[u];  **int** mv = match[v];  match[v] = u, match[u] = v;  u = mv;  }  **break**; **// 搜索成功，退出循环将进入下一阶段**  }  **else** { **// 当前搜索的交叉链+y+match[y]形成新的交叉链，将match[y]加入队列作为待搜节点**  next\_[y] = x;  mark[Q[rear++] = match[y]] = 1; **// match[y]也是S型的**  mark[y] = 2; **// y标记成T型**  }  }  }  }  **bool** g[N][N];  **int** main() {  freopen("perfect.in","r",stdin);  freopen("perfect.out","w",stdout);  scanf("%d", &n);  **for** (**int** i = 0; i < n; i++)  **for** (**int** j = 0; j < n; j++) g[i][j] = **false**;  **// 建图，双向边**  **for**(**int** i=0;i<n;i++){  **int** num;scanf("%d",&num);  **for**(**int** j=0;j<num;j++){  **int** x;scanf("%d",&x);  g[i][x-1]=**true**;  }  }  **for**(**int** i=0;i<n;i++){  **for**(**int** j=0;j<n;j++){  **if**(g[i][j]==**true** && g[j][i]==**true**){  e[i].push\_back(j), e[j].push\_back(i);  }**else**{  g[i][j]=g[j][i]=**false**;  }  }  }  **// int x, y; while (scanf("%d%d", &x, &y) != EOF) {**  **// x--, y--;**  **// if (x != y && !g[x][y])**  **// e[x].push\_back(y), e[y].push\_back(x);**  **// g[x][y] = g[y][x] = true;**  **// }**  **// 增广匹配**  **for** (**int** i = 0; i < n; i++) match[i] = -1;  **for** (**int** i = 0; i < n; i++) **if** (match[i] == -1) aug(i);  **// 输出答案**  **int** tot = 0;  **for** (**int** i = 0; i < n; i++) **if** (match[i] != -1) tot++;  **// printf("%d\n", tot);**  **// for (int i = 0; i < n; i++) if (match[i] > i)**  **// printf("%d %d\n", i + 1, match[i] + 1);**  **if**(tot==n){  puts("YES");  }**else**{  puts("NO");  }  **return** 0;  } |

### 匈牙利算法

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| //////////////最佳完美匹配KM算法//////////////////  //下标从1开始。设置w,lx,ly,slack的类型。所有变量无需清零，仅w需要重新赋值  //有slack数组的O(n^3) 版本  **int** n;//点数  **double** w[MAXN][MAXN];//边权  **double** lx[MAXN],ly[MAXN],slack[MAXN];//顶标  **int** s[MAXN],t[MAXN],left\_[MAXN];  **int** match(**int** i)  {  s[i] = 1;  **for**(**int** j = 1;j <= n;j++)  **if**(!t[j])  {  **double** tmp=lx[i]+ly[j]-w[i][j];  **if**( fabs(tmp) < EPS)  {  t[j] = 1;  **if**(!left\_[j] || match(left\_[j]))  {  left\_[j] = i;  **return** 1;  }  }  **else** slack[j] = min(tmp,slack[j]);  }  **return** 0;  }  **void** update()  {  **double** a = INF;  **for**(**int** i = 1;i <= n;i++)  **if**(!t[i]) a = min(a,slack[i]);  **for**(**int** i = 1;i <= n;i++)  {  **if**(s[i]) lx[i] -= a;  **if**(t[i]) ly[i] += a;  }  }  **void** km()  {  **for**(**int** i = 1;i <= n;i++)  {  left\_[i] = ly[i] = 0;  lx[i] = -INF;  **for**(**int** j = 1;j <= n;j++)  lx[i] = max(lx[i],w[i][j]);  }  **for**(**int** i = 1;i <= n;i++){  **for**(**int** j = 1;j <= n;j++)  slack[j] = INF;  **while**(1)  {  **for**(**int** j = 1;j <= n;j++) s[j] = t[j] = 0;  **if**(match(i)) **break**;  **else** update();  }  }  }  /\*how to use  for(int i = 1;i <= n;i++)  for(int j = 1;j <= n;j++)  w[i][j] = -cal\_dis(i,j);//赋权  km();  for(int i = 1;i <= n;i++)  printf("%d\n",left\_[i]);  \*/  //////////////最佳完美匹配KM算法////////////////// |

### 全局最小割-HDU 3691

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| **#include** <cstdio>  **#include** <algorithm>  **#include** <cstring>  **#include** <iostream>  **using** **namespace** std;  **typedef** **long** **long** LL;  **const** **int** MAXN = 310;  LL mat[MAXN][MAXN];  LL weight[MAXN];  **bool** del[MAXN], vis[MAXN];;  **int** n, m, st;  **void** init() {  memset(mat, 0, **sizeof**(mat));  memset(del, 0, **sizeof**(del));  }  LL StoerWagner(**int** &s, **int** &t, **int** cnt) {  memset(weight, 0, **sizeof**(weight));  memset(vis, 0, **sizeof**(vis));  **for**(**int** i = 1; i <= n; ++i)  **if**(!del[i]) {t = i; **break**; }  **while**(--cnt) {  vis[s = t] = **true**;  **for**(**int** i = 1; i <= n; ++i) **if**(!del[i] && !vis[i]) {  weight[i] += mat[s][i];  }  t = 0;  **for**(**int** i = 1; i <= n; ++i) **if**(!del[i] && !vis[i]) {  **if**(weight[i] >= weight[t]) t = i;  }  }  **return** weight[t];  }  **void** merge(**int** s, **int** t) {  **for**(**int** i = 1; i <= n; ++i) {  mat[s][i] += mat[t][i];  mat[i][s] += mat[i][t];  }  del[t] = **true**;  }  LL solve() {  LL ret = -1;  **int** s, t;  **for**(**int** i = n; i > 1; --i) {  **if**(ret == -1) ret = StoerWagner(s, t, i);  **else** ret = min(ret, StoerWagner(s, t, i));  merge(s, t);  }  **return** ret;  }  **int** main() {  **while**(scanf("%d%d%d", &n, &m, &st) != EOF) {  **if**(n == 0 && m == 0 && st == 0) **break**;  init();  **while**(m--) {  **int** x, y, z;  scanf("%d%d%d", &x, &y, &z);  mat[x][y] += z;  mat[y][x] += z;  }  cout<<solve()<<endl;  }  } |

### 判断是否为二分图(是否有奇圈)

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| **int** color[N];  //判断编号为b的双联通分量是否为二分图  bool bipartite(**int** u)  {  **for**(**int** i=0;i<G[u].size();i++)  {  **int** v = G[u][i];  **if**(color[v]== color[u]) **return** **false**;  **if**(!color[v]){  color[v]=3-color[u];  **if**(!bipartite(v,b)) **return** **false**;  }  }  **return** **true**;  } |

### 欧拉回路

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| **#include** <iostream>  **#include** <algorithm>  **#include** <cstdio>  **#include** <cstring>  **#define** N 55  **using** **namespace** std;  **int** du[N];  **int** par[N];  **int** eNum[N][N];  **int** Find(**int** x)  {  **return** par[x]==x?x:(par[x]=Find(par[x]));  }  **bool** connectable(**int** u)  {  **for**(**int** i=1;i<N;i++)  **if**(du[i] && (Find(i)!=Find(u) || (du[i] & 1)))  **return** **false**;  **return** **true**;  }  **int** dfs(**int** u)  {  **for**(**int** i=1;i<N;i++)  {  **if**(eNum[u][i])  {  eNum[i][u]--;  eNum[u][i]--;  dfs(i);  printf("%d %d\n",i,u);  }  }  }  **int** main()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **#endif** **// ONLINE\_JUDGE**  **int** t,cas=1;  scanf("%d",&t);  **while**(t--)  {  printf("Case #%d\n",cas++);  memset(du,0,**sizeof**(du));  memset(eNum,0,**sizeof**(eNum));  **for**(**int** i=1;i<N;i++)  par[i]=i;  **int** n;  **int** V=0;  scanf("%d",&n);  **int** pre;  **for**(**int** i=0;i<n;i++)  {  **int** u,v;  scanf("%d%d",&u,&v);  pre=u;  du[u]++,du[v]++;  eNum[u][v]++;  eNum[v][u]++;  **if**(Find(u)!=Find(v)) **//判断联通性**  par[Find(u)]=Find(v);  }  **if**(!connectable(pre))**//判断联通性！**  {  printf("some beads may be lost\n");  **if**(t) printf("\n");  **continue**;  }  dfs(pre);  **if**(t) printf("\n");  }  **return** 0;  } |

### 计算双联通分量

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| //如今的版本：  /\*  此版本可处理重边。  st: 某节点的dfs序  bccno: 某条边属于的分量编号  Tn: time\_stamp  b\_cnt: 分量编号标记  G: 图  iscut：标记某个点是否割点  \*/  **int** st[N], bccno[N\*10], Tn, b\_cnt;  vector<PII > G[N];  stack<**int**> S;  **int** iscut[N];  **int** dfs(**int** u, **int** fa)  {  **int** lowu = st[u] = ++Tn;  **int** child = 0;  bool flag = **true**;  **for**(**int** i = 0; i < G[u].size(); i++)  {  **int** v = G[u][i].first;  **int** No = G[u][i].second;  **if**(!st[v]){  S.push(No);  child++;  **int** lowv = dfs(v, u);  lowu = min(lowu, lowv);  **if**(lowv >= st[u]){  iscut[u] = 1;  b\_cnt++;  **while**(**true**)  {  **int** curNo = S.top();S.pop();  bccno[curNo] = b\_cnt;  **if**(curNo == No) **break**;  }  }  }**else** **if**(st[v] < st[u]){  **if**(v == fa && flag) {flag = **false**; **continue**;}  S.push(No);  lowu = min(lowu, st[v]);  }  }  **if**(fa < 0 && child == 1) iscut[u] = 0;  **return** lowu;  }  **void** find\_bcc(**int** n)  {  memset(st, 0, sizeof(st));  memset(iscut, 0, sizeof(iscut));  memset(bccno, 0, sizeof(bccno));  Tn = b\_cnt = 0;  **for**(**int** i = 1; i <= n; i++)  **if**(!st[i]) dfs(i, -1);  }  **typedef** pair<**int**,**int**> edge;  **int** pre[N],iscut[N],bccno[N],dfs\_clock,bcc\_cnt;  vector<**int**> G[N],bcc[N];  stack<edge> S;  /\*  点-双联通  G[],上述数组中唯一需要初始化的数组  dfs\_clock 时钟标记，记录访问路径中这个点的访问下标  bcc\_cnt 双联通分量的数量  bccno[] 数组表示每个点属于的双联通分量，有的点可能属于多个分量  iscut[] 标记该点是否为割顶  pre[] 每个点的时钟标记  bcc[] 每个双联通分量中有哪些点  \*/  **int** dfs(**int** u,**int** fa)  {  **int** lowu=pre[u] = ++dfs\_clock;  **int** child=0;  **for**(**int** i=0;i<G[u].size();i++)  {  **int** v=G[u][i];  edge e=edge(u,v);  **if**(!pre[v])  {  S.push(e);  child++;  **int** lowv=dfs(v,u);  lowu=min(lowu,lowv); //用后代的low函数更新u的low函数  **if**(lowv>=pre[u])  {  iscut[u]=**true**;  bcc\_cnt++;bcc[bcc\_cnt].clear(); // bcc从1开始编号  **for**(;;)  {  edge x = S.top();S.pop();  **if**(bccno[x.first]!=bcc\_cnt){  bcc[bcc\_cnt].push\_back(x.first);  bccno[x.first]=bcc\_cnt;  }  **if**(bccno[x.second]!=bcc\_cnt){  bcc[bcc\_cnt].push\_back(x.second);  bccno[x.second]=bcc\_cnt;  }  **if**(x.first == u && x.second == v) **break**;  }  }  }**else** **if**(pre[v] < pre[u] && v != fa){  //用反向边更新u的low函数  S.push(e);  lowu=min(lowu,pre[v]);  }  }  **if**(fa < 0 && child ==1) iscut[u]=0;  **return** lowu;  }  //函数顶点编号从0~n-1  **void** find\_bcc(**int** n)  {  //调用结束之后S都为空，不需要清空  memset(pre,0,sizeof(pre));  memset(iscut,0,sizeof(iscut));  memset(bccno,0,sizeof(bccno));  dfs\_clock=bcc\_cnt=0;  **for**(**int** i=0;i<n;i++)//遍历每个点  **if**(!pre[i]) dfs(i,-1);  } |

### 二分图最佳完美匹配(KM匈牙利算法)

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| //二分最佳完美匹配//  /\*下标从1开始，需要对nx，ny赋值，并不需要初始化其中的任何数组\*/  /\*如果求最大匹配，那么权值不变，如果求最小匹配，那么权值变为负数。\*/  //const int N = 101;  **const** **int** INF = 0x3f3f3f3f;  //const double EPS = 1e-9;  **typedef** **int** w\_type; /////权值的类型，int or double  w\_type w[N][N],lx[N],ly[N],slack[N]; //顶标,权值矩阵  **int** linky[N],linkx[N]; //二分匹配的对象  bool visx[N],visy[N]; //访问数组  **int** nx,ny; //x集合的大小nx，y集合的大小ny  bool find(**int** x)  {  visx[x] = **true**;  **for**(**int** y = 1; y <= ny; y++)  {  **if**(visy[y]) **continue**;  w\_type t = lx[x] + ly[y] - w[x][y];  //if(fabs(t) < EPS) //(double)t==0  **if**( t==0 ) //(int)t==0  {  visy[y] = **true**;  **if**(linky[y]==-1 || find(linky[y]))  {  linky[y] = x;  linkx[x] = y;  **return** **true**; //找到增广轨  }  }  **else** slack[y] = min(t,slack[y]);  }  **return** **false**; //没有找到增广轨（说明顶点x没有对应的匹配，与完备匹配(相等子图的完备匹配)不符）  }  w\_type KM() //返回最优匹配的值  {  **int** i,j;  memset(linky,-1,sizeof(linky));  memset(linkx,-1,sizeof(linkx));  memset(ly,0,sizeof(ly));  **for**(i = 1; i <= nx; i++)  **for**(j = 1,lx[i] = -INF; j <= ny; j++)  lx[i]=max(w[i][j],lx[i]);  /\* if(w[i][j] > lx[i])  lx[i] = w[i][j]; \*/  **for**(**int** x = 1; x <= nx; x++)  {  **for**(i = 1; i <= ny; i++) slack[i] = INF;  **while**(**true**)  {  memset(visx,0,sizeof(visx));  memset(visy,0,sizeof(visy));  **if**(find(x)) **break**; //找到增广轨，退出  w\_type d = INF;  **for**(i = 1; i <= ny; i++) //没找到，对l做调整(这会增加相等子图的边)，重新找  **if**(!visy[i]) d = min(d,slack[i]);  **for**(i = 1; i <= nx; i++)  **if**(visx[i]) lx[i] -= d;  **for**(i = 1; i <= ny; i++)  **if**(visy[i]) ly[i] += d;  }  }  //以下为判断是否完全匹配的代码。  //如下，-INF为权值矩阵的初始值。返回值可根据情况修改如下图，-INF为权值矩阵的初始值。  //返回值可根据情况修改，一般情况可删除。  // for(int i = 1; i <= ny; i++)  // if(w[linky[i]][i] == -INF)  // return 1;  w\_type result = 0;  **for**(i = 1; i <= ny; i++)  **if**(linky[i]>-1)  result += w[linky[i]][i];  **return** result;  }  /\*  \* //如果想要检查是否完全匹配，则需要遍历linkx或linky数组。  \* for(int i=1;i<=nx;i++)  \* for(int j=1;j<=ny;j++)  \* {  \* w[i][j] = -x[i].Distance(y[j]);  \* }  \* KM();  \* for(int i=1;i<=nx;i++)  \* {  \* printf("%d\n",linkx[i]);  \* }  \*/ |

### 计算点-双联通分量：

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| **//如今的版本：**  **/\***  **此版本可处理重边。**  **st: 某节点的dfs序**  **bccno: 某条边属于的分量编号**  **Tn: time\_stamp**  **b\_cnt: 分量编号标记**  **G: 图**  **iscut：标记某个点是否割点**  **\*/**  **int** st[N], bccno[N\*10], Tn, b\_cnt;  vector<PII > G[N];  stack<**int**> S;  **int** iscut[N];  **int** dfs(**int** u, **int** fa)  {  **int** lowu = st[u] = ++Tn;  **int** child = 0;  **bool** flag = **true**;  **for**(**int** i = 0; i < G[u].size(); i++)  {  **int** v = G[u][i].first;  **int** No = G[u][i].second;  **if**(!st[v]){  S.push(No);  child++;  **int** lowv = dfs(v, u);  lowu = min(lowu, lowv);  **if**(lowv >= st[u]){  iscut[u] = 1;  b\_cnt++;  **while**(**true**)  {  **int** curNo = S.top();S.pop();  bccno[curNo] = b\_cnt;  **if**(curNo == No) **break**;  }  }  }**else** **if**(st[v] < st[u]){  **if**(v == fa && flag) {flag = **false**; **continue**;}  S.push(No);  lowu = min(lowu, st[v]);  }  }  **if**(fa < 0 && child == 1) iscut[u] = 0;  **return** lowu;  }  **void** find\_bcc(**int** n)  {  memset(st, 0, **sizeof**(st));  memset(iscut, 0, **sizeof**(iscut));  memset(bccno, 0, **sizeof**(bccno));  Tn = b\_cnt = 0;  **for**(**int** i = 1; i <= n; i++)  **if**(!st[i]) dfs(i, -1);  }  **typedef** pair<**int**,**int**> edge;  **int** pre[N],iscut[N],bccno[N],dfs\_clock,bcc\_cnt;  vector<**int**> G[N],bcc[N];  stack<edge> S;  **/\***  **点-双联通**  **G[],上述数组中唯一需要初始化的数组**  **dfs\_clock 时钟标记，记录访问路径中这个点的访问下标**  **bcc\_cnt 双联通分量的数量**  **bccno[] 数组表示每个点属于的双联通分量，有的点可能属于多个分量**  **iscut[] 标记该点是否为割顶**  **pre[] 每个点的时钟标记**  **bcc[] 每个双联通分量中有哪些点**  **\*/**  **int** dfs(**int** u,**int** fa)  {  **int** lowu=pre[u] = ++dfs\_clock;  **int** child=0;  **for**(**int** i=0;i<G[u].size();i++)  {  **int** v=G[u][i];  edge e=edge(u,v);  **if**(!pre[v])  {  S.push(e);  child++;  **int** lowv=dfs(v,u);  lowu=min(lowu,lowv); **//用后代的low函数更新u的low函数**  **if**(lowv>=pre[u])  {  iscut[u]=**true**;  bcc\_cnt++;bcc[bcc\_cnt].clear(); **// bcc从1开始编号**  **for**(;;)  {  edge x = S.top();S.pop();  **if**(bccno[x.first]!=bcc\_cnt){  bcc[bcc\_cnt].push\_back(x.first);  bccno[x.first]=bcc\_cnt;  }  **if**(bccno[x.second]!=bcc\_cnt){  bcc[bcc\_cnt].push\_back(x.second);  bccno[x.second]=bcc\_cnt;  }  **if**(x.first == u && x.second == v) **break**;  }  }  }**else** **if**(pre[v] < pre[u] && v != fa){  **//用反向边更新u的low函数**  S.push(e);  lowu=min(lowu,pre[v]);  }  }  **if**(fa < 0 && child ==1) iscut[u]=0;  **return** lowu;  }  **//函数顶点编号从0~n-1**  **void** find\_bcc(**int** n)  {  **//调用结束之后S都为空，不需要清空**  memset(pre,0,**sizeof**(pre));  memset(iscut,0,**sizeof**(iscut));  memset(bccno,0,**sizeof**(bccno));  dfs\_clock=bcc\_cnt=0;  **for**(**int** i=0;i<n;i++)**//遍历每个点**  **if**(!pre[i]) dfs(i,-1);  } |

### 点双联通缩点

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| **const** **int** MAXN = 100005;  **const** **int** MAXE = 200300;  **struct** Edge{  **int** from,to,next;  bool cut;  }edge[2\*MAXE];  **int** head[MAXN],edgenum;  **int** Low[MAXN],DFN[MAXN],Stack[MAXN];//Belong数组的值是1~block  **int** dfn,top;  **int** Belong[MAXN],block;//新图的连通块标号（1~block）  bool Instack[MAXN];  **int** bridge; //割桥数量  **void** addedge(**int** u,**int** v){  Edge E={u,v,head[u],0}; edge[edgenum]=E; head[u] = edgenum++;  Edge E2={v,u,head[v],0};edge[edgenum]=E2;head[v] = edgenum++;  }  **void** Tarjan(**int** u,**int** pre){  **int** v;  Low[u] = DFN[u] = ++dfn;  Stack[top++] = u;  Instack[u] = **true**;  **for**(**int** i = head[u]; ~i ;i = edge[i].next){  v = edge[i].to;  // 如果重边有效的话下面这句改成: if(v == pre && pre\_num == 0){pre\_num++;continue;} pre\_num在for上面定义 int pre\_num=0;  **if**( v == pre )**continue**;  **if**( !DFN[v] ){  Tarjan(v,u);  Low[u] = min(Low[u], Low[v]);  **if**(Low[v] > DFN[u]){  bridge++;  edge[i].cut = **true**;  edge[i^1].cut = **true**;  }  }  **else** **if**(Instack[v])Low[u] = min(Low[u], DFN[v]);  }  **if**(Low[u] == DFN[u]){  block++;  **do**{  v = Stack[--top];  Instack[v] = **false**;  Belong[v] = block;  }**while**( v != u );  }  }  **void** work(**int** l, **int** r){  memset(DFN,0,sizeof(DFN));  memset(Instack,**false**,sizeof(Instack));  dfn = top = block = bridge = 0;  **for**(**int** i = l; i <= r; i++)**if**(!DFN[i])Tarjan(i,i);  }  vector<**int**>G[MAXN];//点标从1-block  **void** suodian(){  **for**(**int** i = 1; i <= block; i++)G[i].clear();  **for**(**int** i = 0; i < edgenum; i+=2){  **int** u = Belong[edge[i].from], v = Belong[edge[i].to];  **if**(u==v)**continue**;  G[u].push\_back(v), G[v].push\_back(u);  }  }  **void** init(){edgenum = 0; memset(head,-1,sizeof(head));} |

### 并查集

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| **//以下是并查集的函数**  **void** init(**int** n)  {  **for**(**int** i=0;i<n;i++)  {  par[i]=i;  rank[i]=0;  }  }  **int** find(**int** x)  {  **if**(par[x]==x)  **return** x;  **else**  **return** par[x]=find(par[x]);  }  **void** unite(**int** x,**int** y)  {  x=find(x);  y=find(y);  **if**(x==y) **return** ;  **if**(rank[x]<rank[y])  par[x]=y;  **else**  {  par[y]=x;  **if**(rank[x]==rank[y]) rank[x]++;  }  }  **bool** same(**int** x,**int** y)  {  **return** find(x)==find(y);  }  **//并查集**  **//构筑二分图的并查集， col[u]数组记录的节点颜色的信息，如果u为根(并查集的根)则表示自身颜色，否则表示与父亲颜色是否相同。**  **int** pa[N];  **int** col[N];  **int** son[N];  **inline** **void** init(**int** n)  {  **for**(**int** i = 0; i <= n; i++) pa[i] = i, col[i] = 0;  }  **//非递归的find，能够维护col数组，以及得到x节点的真实颜色**  **int** find(**int** x, **int**& cx)  {  **int** u = x;  **while**(u != pa[u])  {  son[pa[u]] = u;  u = pa[u];  }  **int** res = u, uc = col[u];  **while**(u != x)  {  u = son[u];  pa[u] = res;  uc ^= col[u];  col[u] = uc ^ col[res];  }  cx = uc;  **return** res;  }  **bool** unite(**int** u, **int** v)  {  **int** cu, cv;  **int** fu = find(u, cu), fv = find(v, cv);  **if**(fu == fv)  {  **if**(cu == cv) **return** **false**;  **return** **true**;  }  pa[fu] = fv;  **if**(cu != cv) col[fu] ^= col[fv];  **else** {  col[fu] ^= 1;  col[fu] ^= col[fv];  }  **return** **true**;  } |

### SPOJ QTREE5 树分治+优先队列

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 200010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int** > PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **struct** Reader{  **static** **const** **int** MSIZE = 1000 \* 8 \* 1024;  **char** buf[MSIZE], \*pt = buf, \*o = buf;  **void** init(){  fread(buf, 1, MSIZE, stdin);  }  **char** getch()  {  **char** ch;  **while**((\*pt < 'A' || \*pt > 'Z') && (\*pt < 'a' || \*pt > 'z')) pt++;  ch = \*pt;pt++;  **return** ch;  }  **int** getint()  {  **int** f = 1, x = 0;  **while**(\*pt != '-' && !isdigit(\*pt)) pt++;  **if**(\*pt == '-') f = -1, pt++;  **else** x = \*pt++ - 48;  **while**(isdigit(\*pt)) x = x \* 10 + \*pt++ - 48;  **return** x \* f;  }  }frd;  **struct** edge{  **int** to, nxt;  edge(){}  edge(**int** \_t, **int** \_n)  {  to = \_t, nxt = \_n;  }  }e[N\*2];  **int** head[N], eN = 0;  **void** addedge(**int** u, **int** v)  {  e[eN] = edge(v, head[u]);  head[u] = eN++;  }  priority\_queue<PII, vector<PII>, greater<PII > > que[N];  vector<PII > wV[N];  **int** col[N];  **//得到树的重心**  **int** root, s[N], f[N];  **bool** vis[N];  **int** n;  **int** maxn;  **int** getroot(**int** now, **int** fa, **int** sz)  {  **int** cnt=1;  **int** mx=0;  **for**(**int** i=head[now]; i!=-1; i=e[i].nxt)  {  **int** to=e[i].to;  **if**(to==fa || vis[to]) **continue**;  f[to]=getroot(to,now,sz);  mx = max(mx,f[to]);  cnt+=f[to];  }  mx = max(mx,sz-cnt);  **if**(mx<maxn)  {  maxn=mx, root=now;  **for**(**int** i = head[now]; i != -1; i = e[i].nxt)  {  **int** to = e[i].to;  **if**(vis[to]) **continue**;  **if**(to == fa)  {  s[to] = sz - cnt;  **continue**;  }  s[to] = f[to];  }  }  **return** cnt;  }  **void** dfsgao(**int** u, **int** fa, **int** rt, **int** dis)  {  wV[u].push\_back(PII(dis, rt));  **for**(**int** i = head[u]; ~i ; i = e[i].nxt)  {  **int** v = e[i].to;  **if**(vis[v] || v == fa) **continue**;  dfsgao(v, u, rt, dis+1);  }  }  **//在调用dfs之前一定要记得将s[u]赋好值**  **void** dfs(**int** u)  {  maxn = INF;  getroot(u, 0, s[u]);  **int** trt = root;  vis[trt] = 1;  dfsgao(trt, 0, trt, 0);  **for**(**int** i = head[trt]; ~i ; i = e[i].nxt)  {  **int** v = e[i].to;  **if**(vis[v]) **continue**;  dfs(v);  }  }  **bool** pvvis[N];  **int** main()  {  **// Open();**  frd.init();  memset(head, -1, **sizeof**(head));  n = frd.getint();  **// scanf("%d", &n);**  **for**(**int** i = 1; i < n; i++){  **int** x, y;  x = frd.getint();  y = frd.getint();  **// scanf("%d%d", &x, &y);**  addedge(x, y);  addedge(y, x);  }  s[1] = n;  dfs(1);  **int** q;  q = frd.getint();  **int** ndnum = 0;  **// scanf("%d", &q);**  **while**(q--){  **int** op, u;  op = frd.getint();  u = frd.getint();  **// scanf("%d%d", &op, &u);**  **if**(op == 0){  col[u] ^= 1;  **if**(col[u]) ndnum++;  **else** ndnum--;  **if**(col[u]){  **//pvvis[u] = 1;**  **for**(**int** i = 0; i < wV[u].size(); i ++)  {  **int** v = wV[u][i].second;  **int** dis = wV[u][i].first;  que[v].push(PII(dis, u));  }  }  }**else**{  **if**(ndnum == 0){  puts("-1");  **continue**;  }  **int** ans = INF;  **for**(**int** i = 0; i < wV[u].size(); i ++){  **int** v = wV[u][i].second;  **int** dis = wV[u][i].first;  **while**(!que[v].empty()){  PII pp = que[v].top();  **int** curv = pp.second, dist = pp.first;  **if**(!col[curv]) {que[v].pop(); **continue**;}  ans = min(ans, dist+dis);  **break**;  }  }  **if**(ans == INF) ans = -1;  **if**(ans == -1) **while**(1);  printf("%d\n", ans);  }  }  **return** 0;  } |

### SPFA

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| **#include** <iostream>  **#include** <cstdio>  **#include** <cmath>  **#include** <cstring>  **#include** <queue>  **#define** N 400100  **using** **namespace** std;  **struct** edge  {  **int** from,to,c,nxt;  }e[N];  **int** head[N];  **int** d[N];  **int** s;  **bool** vis[N];  **int** n,m;  **void** spfa(**int** s)  {  queue<**int**> q;  memset(d,0x3f,**sizeof**(d));  d[s]=0;  memset(vis,0,**sizeof**(vis));    q.push(s);  vis[s]=1;  **while**(!q.empty())  {  **int** x=q.front();  q.pop();  vis[x]=0;  **for**(**int** k=head[x];k!=-1;k=e[k].nxt)  {  **if**(d[e[k].to]>d[e[k].from]+e[k].c)  {  d[e[k].to]=d[e[k].from]+e[k].c;  **if**(!vis[e[k].to])  {  vis[e[k].to]=1;  q.push(e[k].to);  }  }  }  }    }  **//DFS版SPFA(判断正/负环非常快)伪代码**  Void SPFA(Node) {  Instack[Node]=**true**;  For (Node,v) ∈E  If dis[Node]+edge(Node,v)<dis[v] then {  dis[v]=dis[Node]+edge(Node,v);  If **not** Instack[v] then  SPFA(v);  Else{  Contain an negative cycle.  Halt;  }  }  Instack [Node] =**false**;  } |

### 2-SAT

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| /\*模型一：两者（A，B）不能同时取  　　那么选择了A就只能选择B’，选择了B就只能选择A’  　　连边A→B’，B→A’  模型二：两者（A，B）不能同时不取  　　那么选择了A’就只能选择B，选择了B’就只能选择A  　　连边A’→B，B’→A  模型三：两者（A，B）要么都取，要么都不取  　　那么选择了A，就只能选择B，选择了B就只能选择A，选择了A’就只能选择B’，选择了B’就只能选择A’  　　连边A→B，B→A，A’→B’，B’→A’  模型四：两者（A，A’）必取A  　　那么，那么，该怎么说呢？先说连边吧。  　　连边A’→A  AND 结果为1：建边 ~x->x,~y->y （两个数必须全为1）  AND 结果为0：建边 y->~x,x->~y （两个数至少有一个为0）  OR 结果为1：建边 ~x->y,~y->x （两个数至少有一个为1）  OR 结果为0：建边 x->~x,y->~y （两个数必须全为0）  XOR 结果为1：建边 x->~y,y->~x,~y->x,~x->y （两个数必须不同）  XOR 结果为0：建边 x->y,y->x,~x->~y,~y->~x （两个数必须相同）\*/  ////vector邻接表  /\*  hints:  ·构造一组由‘且’链接起来的二元布尔式子。对每一个式子建边。  ·需要初始化的有g[],rg[],  ·每次需要对V重新赋值  ·建边过程中只需要利用冲突的条件来建边，而满足的情况不需要在意。（有待确定）  ·（如：x与y冲突，则构造出(x且y=0)来建边）  \*/  **int** n;  **int** V;  vector<**int**> g[N];  vector<**int**> rg[N];  vector<**int**> vs;  bool used[N];  **int** cmp[N];  //0~n-1 true,n~2n-1 false  **void** init(**int** n)  {  **for**(**int** i=0;i<n\*2;i++)  g[i].clear(),rg[i].clear();  }  **void** add\_edge(**int** from,**int** to)  {  g[from].push\_back(to);  rg[to].push\_back(from);  }  **void** dfs(**int** v)  {  used[v]=1;  **for**(**int** i=0;i<g[v].size();i++)  **if**(!used[g[v][i]]) dfs(g[v][i]);  vs.push\_back(v);  }  **void** rdfs(**int** v,**int** k)  {  used[v]=1;  cmp[v]=k;  **for**(**int** i=0;i<rg[v].size();i++)  **if**(!used[rg[v][i]]) rdfs(rg[v][i],k);  }  **int** scc()  {  memset(used,0,sizeof(used));  vs.clear();  **for**(**int** v=0;v<V;v++)  **if**(!used[v]) dfs(v);  memset(used,0,sizeof(used));  **int** k=0;  **for**(**int** i=vs.size()-1;i>=0;i--)  **if**(!used[vs[i]])  rdfs(vs[i],k++);  **return** k;  }  **int** main()  {  /\*add\_edge\*/  V=n\*2;  scc();  bool flag=**true**;  **for**(**int** i=0;i<n && flag;i++)  **if**(cmp[i] == cmp[i+n])  flag=**false**;  **else**  ans.push\_back(Output[age[i]>=x][cmp[i]>cmp[i+n]]);//cmp[i]>cmp[i+n]说明i项应该为true；  }  //vector邻接表  ////////////  //用之前需要用init函数  //////////  **struct** Twosat{  **int** n;  vector<**int**> G[N\*2];  bool mark[N\*2];  **int** S[N\*2],c;  **void** init(**int** n)  {  **this**->n=n;  **for**(**int** i=0;i<n\*2;i++)  G[i].clear();  memset(mark,0,sizeof(mark));  }  bool dfs(**int** x)  {  **if**(mark[x^1]) **return** **false**;  **if**(mark[x]) **return** **true**;  mark[x]=**true**;  S[c++]=x;  **for**(**int** i=0;i<G[x].size();i++)  **if**(!dfs(G[x][i])) **return** **false**;  **return** **true**;  }  **void** add\_edge(**int** x,**int** xval,**int** y,**int** yval)  {  x=x\*2+xval;  y=y\*2+yval;  G[x^1].push\_back(y);  G[y^1].push\_back(x);  }  bool solve()  {  **for**(**int** i=0;i<n\*2;i+=2)  {  **if**(!mark[i] && !mark[i+1])  {  c=0;  **if**(!dfs(i))  {  **while**(c>0) mark[S[--c]]=**false**;  **if**(!dfs(i+1)) **return** **false**;  }  }  }  **return** **true**;  }  };  /////  //邻接矩阵  **int** m[MAXN][MAXN];  **int** id[MAXN];      **int** find\_components(**int** n,**int** mat[][MAXN],**int**\* id){  **int** ret=0,a[MAXN],b[MAXN],c[MAXN],d[MAXN],i,j,k,t;  **for** (k=0;k<n;id[k++]=0);  **for** (k=0;k<n;k++)  **if** (!id[k]){  **for** (i=0;i<n;i++)  a[i]=b[i]=c[i]=d[i]=0;  a[k]=b[k]=1;  **for** (t=1;t;)  **for** (t=i=0;i<n;i++){  **if** (a[i]&&!c[i])  **for** (c[i]=t=1,j=0;j<n;j++)  **if** (mat[i][j]&&!a[j])  a[j]=1;  **if** (b[i]&&!d[i])  **for** (d[i]=t=1,j=0;j<n;j++)  **if** (mat[j][i]&&!b[j])  b[j]=1;  }  **for** (ret++,i=0;i<n;i++)  **if** (a[i]&b[i])  id[i]=ret;  }  **return** ret;  } |

## 字符串

### AC自动机-数组版

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| **#include** <cstdio>  **#include** <cstring>  **#include** <algorithm>  **using** **namespace** std ;    **const** **int** maxN = 50005 ;  **const** **int** maxW = 256 ;  **const** **int** maxQ = 1000000 ;    **struct** Trie {  **int** next[ maxN ][ maxW ] ;  **int** fail[ maxN ] ;  **int** end[ maxN ] ;  **int** P , root ;  **int** head , tail ;  **int** Q[ maxN ] ;  **int** hash[ maxW << 1 | 1 ] ;    **int** New () {  **for** ( **int** i = 0 ; i < maxW ; ++ i )  next[ P ][ i ] = -1 ;  end[ P ] = -1 ;  **return** P ++ ;  }    **void** Init () {  P = 0 ;  root = New () ;  }    **void** Insert ( **unsigned** **char** s[] , **int** len , **int** id ) {  **int** now = root ;  **for** ( **int** i = 0 ; i < len ; ++ i ) {  **int** idx = s[ i ] ;  **if** ( next[ now ][ idx ] == -1 ) next[ now ][ idx ] = New () ;  now = next[ now ][ idx ] ;  }  end[ now ] = id ;  }    **void** Build () {  head = tail = 0 ;  fail[ root ] = root ;  **for** ( **int** i = 0 ; i < maxW ; ++ i ) {  **if** ( next[ root ][ i ] == -1 ) {  next[ root ][ i ] = root ;  }  **else** {  fail[ next[ root ][ i ] ] = root ;  Q[ tail ++ ] = next[ root ][ i ] ;  }  }  **while** ( head != tail ) {  **int** now = Q[ head ++ ] ;  **for** ( **int** i = 0 ; i < maxW ; ++ i ) {  **if** ( next[ now ][ i ] == -1 ) {  next[ now ][ i ] = next[ fail[ now ] ][ i ] ;  }  **else** {  fail[ next[ now ][ i ] ] = next[ fail[ now ] ][ i ] ;  Q[ tail ++ ] = next[ now ][ i ] ;  }  }  }  }    **int** Query ( **unsigned** **char** s[] , **int** len , **int** n ) {  **int** now = root , res = 0 ;  memset ( hash , 0 , **sizeof** hash ) ;  **for** ( **int** i = 0 ; i < len ; ++ i ) {  now = next[ now ][ s[i] ] ;  **int** tmp = now ;  **while** ( tmp != root ) {  **if** ( ~end[ tmp ] ) hash[ end[ tmp ] ] = 1 ;  tmp = fail[ tmp ] ;  }  }  **for** ( **int** i = 0 ; i < n ; ++ i ) **if** ( hash[ i ] ) ++ res ;  **return** res ;  }  } ;    Trie AC ;  **unsigned** **char** str[ maxN ] ;  **char** s[ maxN ] ;  **unsigned** **char** ss[ maxN ] ;    **unsigned** **char** Get ( **char** x ) {  **if** ( x >= 'A' && x <= 'Z' ) **return** x - 'A' + 0 ;  **if** ( x >= 'a' && x <= 'z' ) **return** x - 'a' + 26 ;  **if** ( x >= '0' && x <= '9' ) **return** x - '0' + 52 ;  **if** ( x == '+' ) **return** 62 ;  **return** 63 ;  }    **int** Encode ( **unsigned** **char** s[] , **int** len ) {  **int** num = 0 ;  **for** ( **int** i = 0 ; i < len ; i += 4 ) {  str[ num ++ ] = ( s[ i ] << 2 ) | ( s[ i + 1 ] >> 4 ) ;  **if** ( i + 2 < len ) str[ num ++ ] = ( s[ i + 1 ] << 4 ) | ( s[ i + 2 ] >> 2 ) ;  **if** ( i + 3 < len ) str[ num ++ ] = ( s[ i + 2 ] << 6 ) | s[ i + 3 ] ;  }  **return** num ;  }    **void** work () {  **int** n , m ;  **while** ( ~scanf ( "%d" , &n ) ) {  AC.Init () ;  **for** ( **int** i = 0 ; i < n ; ++ i ) {  scanf ( "%s" , s ) ;  **int** len = strlen ( s ) ;  **while** ( s[ len - 1 ] == '=' ) -- len ;  **for** ( **int** j = 0 ; j < len ; ++ j ) ss[ j ] = Get ( s[ j ] ) ;  **int** num = Encode ( ss , len ) ;  AC.Insert ( str , num , i ) ;  }  AC.Build () ;  scanf ( "%d" , &m ) ;  **for** ( **int** i = 0 ; i < m ; ++ i ) {  scanf ( "%s" , s ) ;  **int** len = strlen ( s ) ;  **while** ( s[ len - 1 ] == '=' ) -- len ;  **for** ( **int** j = 0 ; j < len ; ++ j ) ss[ j ] = Get ( s[ j ] ) ;  **int** num = Encode ( ss , len ) ;  printf ( "%d\n" , AC.Query ( str , num , n ) ) ;  }  printf ( "\n" ) ;  }  }    **int** main () {  work () ;  **return** 0 ;  } |

### AC自动机-CF\_EDU16F\_分块\_指针版

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| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <assert.h>  **#include** <bitset>  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**, **int**> PII;  **const** **int** mod = 2012;  **const** **int** N = 300010;  **const** **int** SN = sqrt(N);  **//const int SN = 1101;**  **struct** Trie{  **int** ch[26];  **int** val;  **int** pre;  **int** last;  }pl[N\*20];  **int** tot;  Trie\* newnode()  {  memset(pl[tot].ch, 0, **sizeof**(pl[tot].ch));  pl[tot].val = pl[tot].pre = pl[tot].last = 0;  **return** &pl[tot++];  }  **struct** ACam{  **int** sum;  Trie \*lt;**//包含Trie数组上的某段区间**  **void** init()  {  sum = 0;  **this** -> lt = ::pl+tot;**//为了让每个自动机的Trie编号都从0开始，方便处理**  newnode();  }  **void** insert(**char** \*s, **int** n, **int** v)  {  **int** rt = 0;  **for**(**int** i = 0; i < n; i++)  {  **int** id = s[i] - 'a';  **if**(lt[rt].ch[id] == 0) lt[rt].ch[id] = newnode()-lt;  rt = lt[rt].ch[id];  }  lt[rt].val += v;  }  **void** print(**int** j, **int**& ans)  {  **if**(j)  {  ans += lt[j].val;  print(lt[j].last, ans);  }  }  **int** findStr(**char** \*s, **int** n)  {  **int** ans = 0;  **int** rt = 0;  **for**(**int** i = 0; i < n; i++)  {  **int** id = s[i] - 'a';  **while**(rt && !lt[rt].ch[id]) rt = lt[rt].pre;  rt = lt[rt].ch[id];  **if**(lt[rt].val) print(rt, ans);  **else** **if**(lt[rt].last) print(lt[rt].last, ans);  }  **return** ans;  }  **void** getFail()  {  queue<**int**> q;  lt[0].pre = 0;  **for**(**int** i = 0; i < 26; i++)  {  **int** u = lt[0].ch[i];  **if**(u) { lt[u].pre = 0; q.push(u); lt[u].last = 0; }  }  **while**(!q.empty())  {  **int** r = q.front(); q.pop();  **for**(**int** c = 0; c < 26; c ++)  {  **int** u = lt[r].ch[c];  **if**(!u){  **// lt[r].ch[c] = lt[lt[r].pre].ch[c];**  **continue**;  }  q.push(u);  **int** v = lt[r].pre;  **while**(v && !lt[v].ch[c]) v = lt[v].pre;  lt[u].pre = lt[v].ch[c];  lt[u].last = lt[lt[u].pre].val ? lt[u].pre : lt[lt[u].pre].last;  }  }  }  }ac[SN];  **int** act;  **void** init()  {  tot = 0;  act = 0;  }  **char** s[N];  **char** s2[N];  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  **// cout<<SN<<endl;**  init();  **int** q;  scanf("%d", &q);  ac[0].init();  **while**(q--)  {  **int** ty;  scanf("%d%s", &ty, s);  **int** n = strlen(s);  **if**(ty == 3){  LL ans = 0;  **for**(**int** i = 0; i <= act; i++)  {  ans += ac[i].findStr(s, n);  }  cout<<ans<<endl;  }**else**{  **if**(ac[act].sum > SN) ac[++act].init();  ac[act].sum += n;  ac[act].insert(s, n, ty==1?1:-1);  ac[act].getFail();  }  }  **return** 0;  } |

### manacher马拉车回文子串

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| **//len[i] 记录的是回文串中心(i/2)到两端的最小距离**  **// 如果回文串长度为偶数，则回文中心为偏左的位置。**  **int** len[N];  **void** manacher(**char** str[], **int** len[], **int** n)  {  len[0] = 1;  **for**(**int** i = 1, j = 0; i < (n<<1)-1; i++)  {  **int** p = i >> 1, q = i-p, r = ((j+1)>>1) + len[j] - 1;  len[i] = r < q ? 0 : min(r-q+1, len[(j<<1)-i]);  **while**(p > len[i]-1 && q + len[i] < n && str[p-len[i]] == str[q+len[i]])  ++len[i];  **if**(q + len[i] - 1 > r)  j = i;  }  }  **//可以得到以idx/2为中心的串的左右端点。**  PII getLR(**int** idx)  {  **int** val = len[idx];  **if**(idx&1){  **return** PII(idx/2-val+1, idx/2+val);  }**else**{  **return** PII(idx/2-val+1, idx/2+val-1);  }  } |

### 字符串的最小表示法(环串中的最小字典序)

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| **//HDU 5442**  **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** smallestRepresation(**char** s[], **int** n, **bool** kind)  {  **for**(**int** tt = 0; tt < n; tt++) s[n + tt] = s[tt];  s[n \* 2] = '\0';  **int** i, j, k ,l;  **for**(i = 0, j = 1; j < n;){  **for**(k = 0; k < n && s[i+k] == s[j+k]; k++);  **if**(k >= n) {  **if**(kind) **//求相同字典序的出现的最小坐标**  **break**;  i = j;j ++; **//求相同字典序的出现的最大坐标..**  **//不过这里效率并不高，效率比较高的方法还是找出符合串之后用字符串匹配算法求出最大坐标比较好**  **continue**;  }  **if**(s[i+k] > s[j+k]) j += k + 1;**//这里是最大表示法(即字典序最大， 最小只需要将大于改为小于即可)**  **else** {  l = i+k;  i = j;  j = max(l, j) + 1;  }  }  **return** i;  }  **char** s[42222], s1[42222], s2[42222];  **int** main()  {  Open();  **int** T;scanf("%d", &T);  **while**(T--){  **int** n;  scanf("%d", &n);  scanf("%s", s);  strcpy(s1, s);  strcpy(s2, s);  **int** shunidx = smallestRepresation(s1, n, 1);  reverse(s2, s2+n);  **int** liidx = smallestRepresation(s2, n, 0);  liidx = n - liidx - 1;  **int** kind = -1;  **int** cnt = 0;  **for**(**int** i = shunidx, j = liidx; cnt < n; cnt++){  **if**(s[i] != s[j]){  kind = (s[i] < s[j]);  **break**;  }  i++, j--;  i = i % n;  j = (j + n) % n;  }  **if**(kind == -1){  **if**(shunidx <= liidx){  printf("%d 0\n", shunidx+1);  }**else** **if**(shunidx > liidx){  printf("%d 1\n", liidx+1);  }  }**else**{  **if**(kind == 0) printf("%d %d\n", shunidx+1, kind);  **else** printf("%d %d\n", liidx+1, kind);  }  }  **return** 0;  } |

### 扩展KMP

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| //求S的所有后缀与T的最长公共前缀（存储在extand中）  **void** GetNext(**const** **char**\* T, **int**\* nxt)  {  **int** len = strlen(T), a = 0;  nxt[0] = len;  **while**(a<len-1 && T[a] == T[a+1]) a++;  nxt[1] = a;  a = 1;  **for**(**int** k=2;k<len;k++){  **int** p = a + nxt[a] - 1, L = nxt[k - a];  **if**(k - 1 + L >= p){  **int** j = max(0, p-k+1);  **while**(k+j<len && T[k+j] == T[j]) j++;  nxt[k] = j;a = k;  }**else** nxt[k] = L;  }  }  **void** GetExtand(**const** **char**\* S, **const** **char**\* T, **int**\* nxt, **int**\* extand)  {  GetNext(T, nxt);  **int** slen = strlen(S), tlen = strlen(T), a = 0;  **int** Minlen = min(slen, tlen);  **while**(a < Minlen && S[a] == T[a]) a++;  extand[0] = a;  a = 0;  **for**(**int** k=1;k<slen;k++){  **int** p = a + extand[a] - 1, L = nxt[k-a];  **if**(k-1+L >= p){  **int** j = max(0, p-k+1);  **while**(k+j < slen && j < tlen && S[k+j] == T[j]) j++;  extand[k] = j; a = k;  }**else** extand[k] = L;  }  } |

### 快速hash值计算

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| **//快速hash值计算**  **//一般修改为unsigned long long会比较准确**  **//一定要记得将模数从自然溢出修改为模质数，常用的大质数：1125899839733759LL， base/MAGIC：9987**  **//这个质数太大了，下面会乘爆LL，还是换成一个int的模数比较好**  **//998244353**  **//1004535809**  **//985661441**  **//880803841**  **//786433**  **//100000007**  **//200000033**  **//300000007**  **//400000009**  **//500000009**  **//600000007**  **//699999953**  **//799999999**  **//900000053**  **//1000000007**  **inline** **void** init\_hash(**char** \*s, **unsigned** **int** \*h, **int** l)  {  h[0]= 0;  **for**(**int** i = 1; i <= l;++i)  h[i] = h[i-1] \* MAGIC + s[i-1];  base[0] = 1;  **for**(**int** i = 1; i <= l; ++i)  base[i] = base[i-1] \* MAGIC;  }  **inline** **unsigned** **int** string\_hash(**unsigned** \*h, **int** l, **int** r) **//[0-base)**  {  **return** h[r] - h[l]\* base[r-l];  }  **//快速hash值计算**  **//快速hash值计算**  **//一般修改为unsigned long long会比较准确**  **//一定要记得将模数从自然溢出修改为模质数，常用的大质数：1125899839733759LL， base/MAGIC：9987**  **const** LL MOD = 1e9+7.5;  **const** LL MAGIC = 9987;  LL h[N], base[N];  **inline** **void** init\_hash(**char** \*s, LL \*h, **int** l)  {  h[0]= 0;  **for**(**int** i = 1; i <= l;++i)  h[i] = (h[i-1] \* MAGIC % MOD + s[i-1])%MOD;  base[0] = 1;  **for**(**int** i = 1; i <= l; ++i)  base[i] = base[i-1] \* MAGIC % MOD;  }  **inline** LL string\_hash(LL \*h, **int** l, **int** r) **//[0-base)**  {  **return** (h[r] - h[l]\* base[r-l]%MOD+MOD)%MOD;  } |

### 可持久化字典树HDU4757

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| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("F:/in.txt","r",stdin);  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **struct** node{  **int** go[2];  **int** cnt;  }pool[N\*20];  **int** tot;**//**  vector<**int**> G[N];**//**  **int** pa[20][N];**//**  **int** w[N];**//**  **int** dep[N];**//**  **int** n,m;  **int** root[N];**//**  **int** insert(**int** pre, **int** val)  {  **int** p = ++tot, ret = p;  pool[p] = pool[pre];  **for**(**int** i = 15; i >= 0; i--)  {  **int** tmp = (val>>i)&1;  **int** cur = ++tot;  pool[cur] = pool[pool[p].go[tmp]];  pool[cur].cnt++;  pool[p].go[tmp] = cur;  p = cur;  }  **return** ret;  }  **void** dfs(**int** v, **int** p, **int** d)  {  root[v] = insert(root[max(0, p)], w[v]);  pa[0][v] = p;  dep[v] = d;  **for**(**int** i = 0; i < G[v].size(); i ++)  **if**(G[v][i] != p) dfs(G[v][i], v, d+1);  }  **void** init()  {  tot = 0;  root[0] = 0;  memset(pool, 0, **sizeof**(pool));  dfs(1, -1, 0);  **for**(**int** k = 0; k + 1 < 20; k++)  **for**(**int** v = 1; v <= n; v++)  **if**(pa[k][v] < 0) pa[k+1][v] = -1;  **else** pa[k+1][v] = pa[k][pa[k][v]];  }  **int** lca(**int** u, **int** v)  {  **if**(dep[u] > dep[v]) swap(u, v);  **for**(**int** k = 0; k < 20; k++)  **if**((dep[v] - dep[u]) >> k & 1)  v = pa[k][v];  **if**(u == v) **return** u;  **for**(**int** k = 19; k >= 0; k--)  **if**(pa[k][u] != pa[k][v])  u = pa[k][u], v = pa[k][v];  **return** pa[0][u];  }  **int** getans(**int** u, **int** v, **int** val)  {  **int** LCA = lca(u, v);  **int** pu = root[u], pv = root[v], pl = root[LCA];  **int** ans = 0;  **for**(**int** i = 15; i >= 0; i--)  {  **int** tmp = (val >> i)&1;  **int** sum = pool[pool[pu].go[!tmp]].cnt + pool[pool[pv].go[!tmp]].cnt - 2 \* pool[pool[pl].go[!tmp]].cnt;  **if**(sum > 0){  pu = pool[pu].go[!tmp];  pv = pool[pv].go[!tmp];  pl = pool[pl].go[!tmp];  ans += 1<<i;  }**else**{  pu = pool[pu].go[tmp];  pv = pool[pv].go[tmp];  pl = pool[pl].go[tmp];  }  }  **return** max(val ^ w[LCA], ans);  }  **int** main()  {  **// Open();**  **while**(~scanf("%d%d", &n, &m))  {  **for**(**int** i = 1; i <= n; i++)  scanf("%d", &w[i]), G[i].clear();  **for**(**int** i = 1; i < n; i++)  {  **int** u, v;scanf("%d%d", &u, &v);  G[u].push\_back(v);  G[v].push\_back(u);  }  init();  **while**(m--)  {  **int** u, v, z;  scanf("%d%d%d", &u, &v, &z);  printf("%d\n", getans(u, v, z));  }  }  **return** 0;  } |

### 回文树

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| **const** **int** MAXN = 100005 ;  **const** **int** N = 26 ;    **struct** Palindromic\_Tree {  **int** next[MAXN][N] ;//next指针，next指针和字典树类似，指向的串为当前串两端加上同一个字符构成  **int** fail[MAXN] ;//fail指针，失配后跳转到fail指针指向的节点  **int** cnt[MAXN] ;  **int** num[MAXN] ;  **int** len[MAXN] ;//len[i]表示节点i表示的回文串的长度  **int** S[MAXN] ;//存放添加的字符  **int** last ;//指向上一个字符所在的节点，方便下一次add  **int** n ;//字符数组指针  **int** p ;//节点指针    **int** newnode ( **int** l ) {//新建节点  **for** ( **int** i = 0 ; i < N ; ++ i ) next[p][i] = 0 ;  cnt[p] = 0 ;  num[p] = 0 ;  len[p] = l ;  **return** p ++ ;  }    **void** init () {//初始化  p = 0 ;  newnode ( 0 ) ;  newnode ( -1 ) ;  last = 0 ;  n = 0 ;  S[n] = -1 ;//开头放一个字符集中没有的字符，减少特判  fail[0] = 1 ;  }    **int** get\_fail ( **int** x ) {//和KMP一样，失配后找一个尽量最长的  **while** ( S[n - len[x] - 1] != S[n] ) x = fail[x] ;  **return** x ;  }    **void** add ( **int** c ) {  c -= 'a' ;  S[++ n] = c ;  **int** cur = get\_fail ( last ) ;//通过上一个回文串找这个回文串的匹配位置  **if** ( !next[cur][c] ) {//如果这个回文串没有出现过，说明出现了一个新的本质不同的回文串  **int** now = newnode ( len[cur] + 2 ) ;//新建节点  fail[now] = next[get\_fail ( fail[cur] )][c] ;//和AC自动机一样建立fail指针，以便失配后跳转  next[cur][c] = now ;  num[now] = num[fail[now]] + 1 ;  }  last = next[cur][c] ;  cnt[last] ++ ;  }    **void** count () {  **for** ( **int** i = p - 1 ; i >= 0 ; -- i ) cnt[fail[i]] += cnt[i] ;  //父亲累加儿子的cnt，因为如果fail[v]=u，则u一定是v的子回文串！  }  } ; |

### 后缀数组

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| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <bitset>  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**, **int**> PII;  **const** **int** N = 200010;  **char** ss[N], st[N];  **int** sa[N], t[N], t2[N], c[N];**//**  **int** rk[N], height[N];**//**  **//注意要在字符串最后增加一个最小值**  **//sa[i] 表示字典序第i个后缀的起始位置**  **//rk[i] 表示str第i个位置的后缀在字典序中的排位，rk从1开始计数**  **//height[i] 表示字典序排序中i和i-1后缀的最长公共前缀,从[2,len]有意义,左闭右闭**  **//调用的时候，build\_sa(a, n+1, m), getHeight(a, n), markrmq的时候，长度也是n+1;!!!!!!!!!!!!!!!!!!!!!!!!!!**  **void** getHeight(**char** \*s, **int** n)  {  **int** i, k = 0;  **for**(i = 1; i <= n; i++) rk[sa[i]] = i;  **for**(i = 0; i < n; i++)  {  **if**(k)k--;  **if**(rk[i] == 0) **continue**;  **int** j = sa[rk[i]-1];  **while**(i+k < n && j+k < n && s[i+k] == s[j+k]) k++;  height[rk[i]] = k;  }  }  **void** build\_sa(**char** \*s, **int** n, **int** m)  {  **int** i, \*x = t, \*y = t2;  **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**(**int** k = 1; k <= n; k <<= 1){  **int** p = 0;  **for**(i = n-k; i < n; i++) y[p++] = i;  **for**(i = 0; i < n; i++) **if**(sa[i] >= k) y[p++] = sa[i]-k;  **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];  swap(x, y);  p = 1; x[sa[0]] = 0;  **for**(i = 1; i < n; i++)  x[sa[i]] = y[sa[i-1]]== y[sa[i]] && y[sa[i-1]+k] == y[sa[i]+k] ? p-1 : p++;  **if**(p >= n) **break**;  m = p;  }  }  **int** dp[N][22];**//**  **int** mm[N];**//**  **void** makermqmi(**int** n,**int** b[],**int** dp[][22])  {  **int** i,j;  mm[0] = -1;  **for**(i=0;i<n;i++)  mm[i+1] = ((i&(i+1)) == 0)?mm[i]+1:mm[i], dp[i][0]=b[i];  **for**(j=1;(1<<j)<=n;j++)  **for**(i=0;i+(1<<j)-1<n;i++)  dp[i][j]=min(dp[i][j-1],dp[i+(1<<(j-1))][j-1]);  }  **int** rmq(**int** x,**int** y)**//[x, y]**  {  **int** k = mm[y-x+1];  **return** min(dp[x][k],dp[y-(1<<k)+1][k]);  }  **int** lcp(**int** a, **int** b)  {  **if**(a > b) swap(a, b);  a++;  **return** rmq(a, b);  }  **int** getOtherLcp(**char** s[], **char** t[], **int** n, **int** m)  {  **int** id = 0;  **while**(id < n && id < m && s[id] == t[id]) id++;  **return** id;  }  **//int sum[N];**  **int** nxt[N];**//**  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  **int** T;scanf("%d",&T);  **for**(**int** cas=1;cas<=T;cas++){  printf("Case #%d:\n", cas);  memset(ss, 0, **sizeof**(ss));  memset(height,0, **sizeof**(height));  **int** n, m;  scanf("%d%d", &n, &m);  **int** len = 0;  ss[len++] = '#';  **for**(**int** i = 0; i < n; i++)  {  scanf("%s", ss+len);  **while**(ss[len] != 0) len++;  ss[len++] = '#';  }  ss[--len] = '\0';  reverse(ss, ss+len);  len--;  ss[len] = '#';  **// cout<<ss<<endl;**  build\_sa(ss, len+1, 222);  getHeight(ss, len);  nxt[len] = len;  **for**(**int** i = len-1; i >= 0; i--)  {  **if**(ss[i] == '#') nxt[i] = i;  **else** nxt[i] = nxt[i+1];  }  makermqmi(len+1, height, dp);  **// sum[0] = 0;**  **// for(int i = 1; i <= len; i++)**  **// {**  **// int sid = sa[i];**  **// int res = nxt[sid] - sid;**  **// res -= height[i];**  **// sum[i] = sum[i-1] + res;**  **// }**  **while**(m--)  {  scanf("%s", st);  **int** tlen = strlen(st);  reverse(st, st+tlen);  **int** lb = -1, ub = len+1;  **int** up = -1, down = -1;  **while**(lb + 1 < ub)  {  **int** mid = lb + ub >> 1;  **if**(strcmp(ss+sa[mid], st) >= 0) up = ub = mid;  **else** lb = mid;  }  **if**(ub == len+1) {  printf("0\n");  **continue**;  }  **int** res = 0;  **if**(getOtherLcp(ss+sa[up], st, len-sa[up], tlen) == tlen) {  lb = up, down = ub = len+1;  **while**(lb + 1 < ub)  {  **int** mid = lb + ub >> 1;  **if**(lcp(up, mid) >= tlen) lb = mid;  **else** down = ub = mid;  }  res += tlen - max(height[up], height[down]);  **int** uid = sa[up];  **if**(up + 1 != down) res += max(0, min(nxt[uid] - uid, lcp(up, down-1)) - tlen);  **else** res += nxt[uid] - uid - tlen;  **// res += sum[down-1] - sum[up];**  }  printf("%d\n", res);  }  }  **return** 0;  } |

### 后缀数组DC3 O(n) – 慎用

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| **int** wsf[N],wa[N],wb[N],wv[N],sa[N],rank[N],height[N],f[N];  **int** s[N],a[N];  **char** str[N],str1[N],str2[N];  **//sa:字典序中排第i位的起始位置在str中第sa[i]**  **//rank:就是str第i个位置的后缀是在字典序排第几**  **//height：字典序排i和i-1的后缀的最长公共前缀**  **int** c0(**int** \*r,**int** a,**int** b)  {  **return** r[a]==r[b]&&r[a+1]==r[b+1]&&r[a+2]==r[b+2];  }  **int** c12(**int** k,**int** \*r,**int** a,**int** b)  {  **if**(k==2) **return** r[a]<r[b]||r[a]==r[b]&&c12(1,r,a+1,b+1);  **else** **return** r[a]<r[b]||r[a]==r[b]&&wv[a+1]<wv[b+1];  }  **void** sort(**int** \*r,**int** \*a,**int** \*b,**int** n,**int** m)  {  **int** i;  **for**(i=0; i<n; i++) wv[i]=r[a[i]];  **for**(i=0; i<m; i++) wsf[i]=0;  **for**(i=0; i<n; i++) wsf[wv[i]]++;  **for**(i=1; i<m; i++) wsf[i]+=wsf[i-1];  **for**(i=n-1; i>=0; i--) b[--wsf[wv[i]]]=a[i];  **return**;  }  **void** dc3(**int** \*r,**int** \*sa,**int** n,**int** m)  {  **int** i,j,\*rn=r+n,\*san=sa+n,ta=0,tb=(n+1)/3,tbc=0,p;  r[n]=r[n+1]=0;  **for**(i=0; i<n; i++) **if**(i%3!=0) wa[tbc++]=i;  sort(r+2,wa,wb,tbc,m);  sort(r+1,wb,wa,tbc,m);  sort(r,wa,wb,tbc,m);  **for**(p=1,rn[F(wb[0])]=0,i=1; i<tbc; i++)  rn[F(wb[i])]=c0(r,wb[i-1],wb[i])?p-1:p++;  **if**(p<tbc) dc3(rn,san,tbc,p);  **else** **for**(i=0; i<tbc; i++) san[rn[i]]=i;  **for**(i=0; i<tbc; i++) **if**(san[i]<tb) wb[ta++]=san[i]\*3;  **if**(n%3==1) wb[ta++]=n-1;  sort(r,wb,wa,ta,m);  **for**(i=0; i<tbc; i++) wv[wb[i]=G(san[i])]=i;  **for**(i=0,j=0,p=0; i<ta && j<tbc; p++)  sa[p]=c12(wb[j]%3,r,wa[i],wb[j])?wa[i++]:wb[j++];  **for**(; i<ta; p++) sa[p]=wa[i++];  **for**(; j<tbc; p++) sa[p]=wb[j++];  **return**;  }  **void** getheight(**int** \*r,**int** n)**//n不保存最后的0**  {  **int** i,j,k=0;  **for**(i=1; i<=n; i++) rank[sa[i]]=i;  **for**(i=0; i<n; i++)  {  **if**(k)  k--;  **else**  k=0;  j=sa[rank[i]-1];  **while**(r[i+k]==r[j+k])  k++;  height[rank[i]]=k;  }  } |

### 后缀自动机

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| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <assert.h>  **#include** <bitset>  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**, **int**> PII;  **const** **int** mod = 2012;  **const** **int** N = 2000010;  **struct** node{  **int** stp, cnt, sum;  **int** rtn; **//number of right set**  **int** flag; **// 标记该点应该被加多少次**  node \*nxt[52], \*pre;  **void** clear()  {  pre = 0;  cnt = sum = stp = 0;  flag = rtn = 0;  memset(nxt, 0, **sizeof**(nxt));  }  }\*root, \*last, lt[N], \*cur;  **//第0号点为root点，不需要计算答案**  **//root -> 根节点**  **//last -> 当前字符串尾巴的节点/状态机的终结状态**  **//cur -> node池中的下一个点**  **//指针往回跳的时候，一定要注意指针为空的情况**  **void** init()  {  cur = lt;  root = last = cur++;  root->clear();  }  **void** insert(**int** w)  {  node \*p = last;  node \*np = cur++;np->clear();  np->stp = p->stp+1;  **while**(p && !p->nxt[w]) p->nxt[w] = np, p = p->pre;  **if**(p == 0) np->pre = root;  **else** {  node \*q = p->nxt[w];  **if**(p->stp + 1 == q->stp) np -> pre = q;  **else** {  node \*nq = cur++;  nq->clear();  memcpy(nq->nxt, q->nxt, **sizeof**(q->nxt));  nq->stp = p->stp+1;  nq->pre = q->pre;  np->pre = q->pre = nq;  **while**(p && p->nxt[w] == q) p->nxt[w] = nq, p = p->pre;  }  }  last = np;  }  **int** c[N];  **int** idx[N];  **void** Sort(**int** tot)  {  **for**(**int** i = 0; i < tot; i++) c[i] = 0;  **for**(**int** i = 0; i < tot; i++) c[lt[i].stp]++;  **for**(**int** i = 1; i < tot; i++) c[i] += c[i-1];  **for**(**int** i = 0; i < tot; i++) idx[--c[lt[i].stp]] = i;  }  **//得到每个集合right集合的大小**  **///需要先调用Sort函数**  **void** getright(**char** s[], **int** n)  {  node \*rt = root;  **for**(**int** i = 0; i < n; i++)  {  **int** id = s[i] - 'a';  rt = rt->nxt[id];  rt -> rtn++;  }  **for**(**int** i = cur-lt-1; i >= 1; i--)  {  rt = &lt[idx[i]];  rt -> pre -> rtn += rt -> rtn;  }  }  **char** s[N];  **char** s2[N];  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  init();  scanf("%s", s);  **int** len = strlen(s);  **for**(**int** i = 0; i < len; i++) insert(s[i]-'a');  **int** tot = cur - lt;  Sort(tot);  getright(s, len);  **int** q;  scanf("%d", &q);  **while**(q--)  {  scanf("%s", s2);  **int** n = strlen(s2);  node \*t = root;  **int** l = 0;  **int** ans = 0;  **for**(**int** i = 0; i < n ;i++)  {  **int** id = s2[i]-'a';  **if**(t->nxt[id]) t = t->nxt[id], l++;  **else**{  **while**(t && !t->nxt[id]) t = t->pre;  **if**(!t) t = root, l = 0;  **else** l = t->stp;  **if**(t->nxt[id]) t = t->nxt[id], l++;  **else** l = 0;  }  }  **for**(**int** i = 0; i < n ;i++)  {  **int** id = s2[i]-'a';  **if**(t->nxt[id]) t = t->nxt[id], l++;  **else**{  **while**(t && !t->nxt[id]) t = t->pre;  **if**(!t) t = root, l = 0;  **else** l = t->stp;  **if**(t->nxt[id]) t = t->nxt[id], l++;  **else** l = 0;  }  **while**(l >= n && t->pre->stp >= n) t = t -> pre;  **if**(l >= n && t->stp >= n && t->flag != q + len)  {  t->flag = q + len;  ans += t->rtn;  }  }  printf("%d\n", ans);  }  **return** 0;  } |

### Trie树

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| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <cstring>  **#define** N 100010  **using** **namespace** std;  **struct** node  {  **long** **long** nxt[2];**//存储nxt节点在数组中的下标**  }trie[N\*40];  **long** **long** all\_idx,bit[42],num[N],n;  **long** **long** createNode()  {  memset(trie[all\_idx].nxt,-1,**sizeof**(trie[all\_idx].nxt));**//没有访问过的置为-1**  **return** all\_idx++;  }  **void** insert\_Node(**long** **long** root,**long** **long** cur)  {  memset(bit,0,**sizeof**(bit));**//存储cur的二进制数**  **long** **long** len=0;  **while**(cur)  {  bit[len++]=cur&1;  cur>>=1;  }  **long** **long** idx=root;  **//将40位全部存进去**  **for**(len=40;len>=0;len--)  {  **long** **long** k=bit[len];  **if**(trie[idx].nxt[k]==-1)  trie[idx].nxt[k]=createNode();  idx=trie[idx].nxt[k];  }  }  **long** **long** running(**long** **long** root,**long** **long** cur)  {  **long** **long** sum=0;  memset(bit,0,**sizeof**(bit));  **long** **long** len=0;  **while**(cur)  {  bit[len++]=cur&1;  cur>>=1;  }  **long** **long** idx=root;  **for**(len=40;len>=0;len--)  {  **long** **long** k=!bit[len];**/////两个数不相同，异或结果为1**  **if**(trie[idx].nxt[k]!=-1) {  sum+=(1LL<<len);**///////一定要加LL，被坑了好久。。。也是无语了**  idx=trie[idx].nxt[k];  }  **else** idx=trie[idx].nxt[!k];**//如果不存在这样的数，只能取0，并且从这边走下去。**  }  **return** sum;  }  **int** main()  {  scanf("%I64d",&n);  **long** **long** pre=0,post=0;  **long** **long** ans=0;  **for**(**long** **long** i=0;i<n;i++)  scanf("%I64d",num+i),pre^=num[i];  **long** **long** root=createNode();  **for**(**long** **long** i=n-1;i>=0;pre^=num[i],post^=num[i],i--)  {  insert\_Node(root,post);  ans=max(ans,running(root,pre));  }  ans=max(ans,running(root,pre));**//判断取0个前缀的时候的值**  cout<<ans<<endl;  **return** 0;  } |

### KMP算法

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| --- |
| **//KMP算法**  **void** GetNextval(**char**\* T, **int** nxt[])  {  nxt[0] = -1;  **int** tlen = strlen(T), j=0, k=-1;  **while**(j<tlen)  **if**(k == -1 || T[j] == T[k]) nxt[++j] = ++k;  **else** k = nxt[k];  }  **int** KmpSearch(**char**\* s, **char**\* p)  {  **int** i = 0;  **int** j = 0;  **int** sLen = strlen(s);  **int** pLen = strlen(p);  **while** (i < sLen && j < pLen)  {  **//①如果j = -1，或者当前字符匹配成功（即S[i] == P[j]），都令i++，j++**  **if** (j == -1 || s[i] == p[j])  {  i++;  j++;  }  **else**  j = next[j];  }  **if** (j == pLen)  **return** i - j;  **else**  **return** -1;  }  **//KMP算法**  **//统计次数：**  **void** GetNextval(**int**\* p, **int** n, **int** nxt[])  {  **int** pLen = n;  nxt[0] = -1;  **int** k = -1;  **int** j = 0;  **while** (j < pLen )  {  **//p[k]表示前缀，p[j]表示后缀**  **if** (k == -1 || p[j] == p[k])  {  ++j;  ++k;  **//较之前next数组求法，改动在下面4行**  **if** (p[j] != p[k] || j==pLen)  nxt[j] = k; **//之前只有这一行**  **else**  **//因为不能出现p[j] = p[nxt[j]]，所以当出现时需要继续递归，k = nxt[k] = nxt[nxt[k]]**  nxt[j] = nxt[k];  }  **else**  {  k = nxt[k];  }  }  }  **int** KmpSearch(**int**\* s, **int** ns, **int**\* p, **int** ps)  {  **if**(ns < ps) **return** 0;  **int** i = 0;  **int** j = 0;  **int** sLen = ns;  **int** pLen = ps;  **int** cnt=0;  **int** tmp=0;  **while** (i < sLen)  {  **//①如果j = -1，或者当前字符匹配成功（即S[i] == P[j]），都令i++，j++**  **if** (j == -1 || s[i] == p[j])  {  i++;  j++;  }  **else**  {  **//②如果j != -1，且当前字符匹配失败（即S[i] != P[j]），则令 i 不变，j = nxt[j]**  **//nxt[j]即为j所对应的next值**  j = nxt[j];  }  **if** (j == pLen)  {  cnt++;  j = nxt[j];  }  }  **return** cnt;  }  **//统计次数(int)**  **int** nxt[N];  **char** s[N];  **char** t[N];  **int** vis[N];  **int** sum[N];    **void** GetNextval(**char**\* p, **int** nxt[])  {  **int** pLen = strlen(p);  nxt[0] = -1;  **int** k = -1;  **int** j = 0;  **while** (j < pLen )  {  **//p[k]表示前缀，p[j]表示后缀**  **if** (k == -1 || p[j] == p[k])  {  ++j;  ++k;  **//较之前next数组求法，改动在下面4行**  **if** (p[j] != p[k])  nxt[j] = k; **//之前只有这一行**  **else**  **//因为不能出现p[j] = p[nxt[j]]，所以当出现时需要继续递归，k = nxt[k] = nxt[nxt[k]]**  nxt[j] = nxt[k];  }  **else**  {  k = nxt[k];  }  }  }  **void** KmpSearch(**char**\* s, **char**\* p)  {  **int** i = 0;  **int** j = 0;  **int** sLen = strlen(s);  **int** pLen = strlen(p);  **while** (i < sLen )  {  **//①如果j = -1，或者当前字符匹配成功（即S[i] == P[j]），都令i++，j++**  **if** (j == -1 || s[i] == p[j])  {  i++;  j++;  }  **else**  {  **//②如果j != -1，且当前字符匹配失败（即S[i] != P[j]），则令 i 不变，j = nxt[j]**  **//nxt[j]即为j所对应的next值**  j = nxt[j];  }  **if**(j==pLen)  {  vis[i-pLen]=**true**;  j=nxt[j];  }  }  }  **//统计数目（char）** |

## 杂板子

### 魔方各种旋转

基于红书上面的板子

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| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <algorithm>  **#include** <queue>  **#include** <cstring>  **#include** <string>  **#include** <cmath>  **#include** <set>  **#include** <map>  **#include** <vector>  **#include** <climits>  **#include** <bitset>  **using** **namespace** std;  **#define** pb push\_back  **#define** ALL(x) x.begin(),x.end()  **#define** PII pair<**int**,**int**>  **#define** MP(x,y) make\_pair((x),(y))  **#define** ll **long** **long**  **#define** ull **unsigned** ll  **#define** scan(x) scanf("%d",&(x))  **#define** scan2(x,y) scanf("%d%d",&(x),&(y))  **#define** scan3(x,y,z) scanf("%d%d%d",&(x),&(y),&(z))  **#define** scan4(x,y,z,k) scanf("%d%d%d%d",&(x),&(y),&(z),&(k))  **#define** Max(a,b) a=max(a,b)  **#define** Min(a,b) a=min(a,b)  **#define** fuck(x) cout<<#x<<" "<<x<<endl  **typedef** **long** **long** LL;  **int** rf[9], rb[9], ru[9], rd[9], rl[9], rr[9];  **int** f[9], b[9], u[9], d[9], l[9], r[9], tmp[9], ch;  **//int ddidx;**  **int** ror(**int** a[9]){  **for**(**int** i=0;i<9;i++) tmp[i] = a[i];  **for**(**int** i=0;i<3;i++) **for**(**int** j=0;j<3;j++) a[i\*3 + j] = tmp[3\*(2-j) + i];  }  **//L面顺时针旋转90度**  **void** L(**int** cnt=1){  **for**(;cnt>0;cnt--){  ror(l);  ch=u[0], u[0]=b[8], b[8] = d[0], d[0]=f[0], f[0] = ch;  ch=u[3], u[3]=b[5], b[5] = d[3], d[3]=f[3], f[3] = ch;  ch=u[6], u[6]=b[2], b[2] = d[6], d[6]=f[6], f[6] = ch;  }  }  **//R面顺时针旋转90度，后面的一样**  **void** R(**int** cnt=1){  **for**(;cnt>0;cnt--){  ror(r);  ch=u[2], u[2]=f[2], f[2] = d[2], d[2]=b[6], b[6] = ch;  ch=u[5], u[5]=f[5], f[5] = d[5], d[5]=b[3], b[3] = ch;  ch=u[8], u[8]=f[8], f[8] = d[8], d[8]=b[0], b[0] = ch;  }  }  **void** U(**int** cnt=1){  **for**(;cnt>0;cnt--){  ror(u);  ch=f[0], f[0]=r[0], r[0] = b[0], b[0]=l[0], l[0] = ch;  ch=f[1], f[1]=r[1], r[1] = b[1], b[1]=l[1], l[1] = ch;  ch=f[2], f[2]=r[2], r[2] = b[2], b[2]=l[2], l[2] = ch;  }  }  **void** D(**int** cnt=1){  **for**(;cnt>0;cnt--){  ror(d);  ch=f[6], f[6]=l[6], l[6] = b[6], b[6]=r[6], r[6] = ch;  ch=f[7], f[7]=l[7], l[7] = b[7], b[7]=r[7], r[7] = ch;  ch=f[8], f[8]=l[8], l[8] = b[8], b[8]=r[8], r[8] = ch;  }  }  **void** F(**int** cnt=1){  **for**(;cnt>0;cnt--){  ror(f);  ch=u[6], u[6]=l[8], l[8] = d[2], d[2]=r[0], r[0] = ch;  ch=u[7], u[7]=l[5], l[5] = d[1], d[1]=r[3], r[3] = ch;  ch=u[8], u[8]=l[2], l[2] = d[0], d[0]=r[6], r[6] = ch;  }  }  **void** B(**int** cnt=1){  **for**(;cnt>0;cnt--){  ror(b);  ch=u[0], u[0]=r[2], r[2] = d[8], d[8]=l[6], l[6] = ch;  ch=u[1], u[1]=r[5], r[5] = d[7], d[7]=l[3], l[3] = ch;  ch=u[2], u[2]=r[8], r[8] = d[6], d[6]=l[0], l[0] = ch;  }  }  **//顺时针旋转某个面**  **void** shun(**int** x[])  {  **int** tmp = x[0];  x[0] = x[6];  x[6] = x[8];  x[8] = x[2];  x[2] = tmp;  tmp = x[1];  x[1] = x[3];  x[3] = x[7];  x[7] = x[5];  x[5] = tmp;  }  **//逆时针旋转某个面**  **void** lis(**int** x[])  {  **int** tmp = x[0];  x[0] = x[2];  x[2] = x[8];  x[8] = x[6];  x[6] = tmp;  tmp = x[1];  x[1] = x[5];  x[5] = x[7];  x[7] = x[3];  x[3] = tmp;  }  **//将整个魔方绕Y轴顺时针旋转90度（朝Y轴正方向）**  **void** RY()  {  **int** tmp[9];  memcpy(tmp, u, **sizeof**(**int**)\*9);  shun(l); **for**(**int** i = 0; i < 9; i++) u[i] = l[i];  shun(d); **for**(**int** i = 0; i < 9; i++) l[i] = d[i];  shun(r); **for**(**int** i = 0; i < 9; i++) d[i] = r[i];  shun(tmp); **for**(**int** i=0; i < 9; i++) r[i] = tmp[i];  shun(f);  lis(b);  }  **//将整个魔方绕Z轴顺时针旋转90度（朝Z轴负方向）**  **void** RZ()  {  **int** tmp[9];  memcpy(tmp, b, **sizeof**(**int**)\*9);  **for**(**int** i = 0; i < 9; i++) b[i] = l[i];  **for**(**int** i = 0; i < 9; i++) l[i] = f[i];  **for**(**int** i = 0; i < 9; i++) f[i] = r[i];  **for**(**int** i = 0; i < 9; i++) r[i] = tmp[i];  shun(u);  lis(d);  }  **//将整个魔方绕X轴顺时针旋转90度（朝Z轴负方向）**  **void** RX()  {  **int** tmp[9];  memcpy(tmp, u, **sizeof**(**int**)\*9);  **for**(**int** i = 0; i < 9; i++) u[i] = f[i];  **for**(**int** i = 0; i < 9; i++) f[i] = d[i];  **for**(**int** i = 0; i < 9; i++) d[i] = b[8-i];  **for**(**int** i = 0; i < 9; i++) b[i] = tmp[8-i];  shun(r);  lis(l);  }  **//给每个格子编号**  **void** init(){  ru[0] = 0, ru[8] = 8;  rl[0] = 9, rl[8] = 17;  rf[0] = 18, rf[8] = 26;  rr[0] = 27, rr[8] = 35;  rb[0] = 36, rb[8] = 44;  rd[0] = 45, rf[8] = 53;  **for**(**int** i = 1; i <= 8; i++) ru[i] = ru[i-1]+1;  **for**(**int** i = 1; i <= 8; i++) rl[i] = rl[i-1]+1;  **for**(**int** i = 1; i <= 8; i++) rf[i] = rf[i-1]+1;  **for**(**int** i = 1; i <= 8; i++) rr[i] = rr[i-1]+1;  **for**(**int** i = 1; i <= 8; i++) rb[i] = rb[i-1]+1;  **for**(**int** i = 1; i <= 8; i++) rd[i] = rd[i-1]+1;  **for**(**int** i = 0; i <= 8; i++) f[i] = rf[i];  **for**(**int** i = 0; i <= 8; i++) u[i] = ru[i];  **for**(**int** i = 0; i <= 8; i++) d[i] = rd[i];  **for**(**int** i = 0; i <= 8; i++) r[i] = rr[i];  **for**(**int** i = 0; i <= 8; i++) l[i] = rl[i];  **for**(**int** i = 0; i <= 8; i++) b[i] = rb[i];  }  **//24种角度查看魔方的映射**  **//虽然存储了32种映射，应为有冗余，只有24种不同的映射**  **int** rflct[66][35];  LL hs(**int** qqq[], **int** tl)  {  LL res = 0;  sort(qqq, qqq+tl);  **for**(**int** i = 0; i < tl; i++)  res = res \* 54 + qqq[i];  **return** res;  }  **int** t;  set<LL> st;  **int** sta[66];  **int** qqq[66];  **int** ans;  **void** dfs(){  **int** tl=0;  **for**(**int** i = 0; i <= 8; i++) **if**(f[i] == -1) qqq[tl++] = rf[i];  **for**(**int** i = 0; i <= 8; i++) **if**(u[i] == -1) qqq[tl++] = ru[i];  **for**(**int** i = 0; i <= 8; i++) **if**(d[i] == -1) qqq[tl++] = rd[i];  **for**(**int** i = 0; i <= 8; i++) **if**(r[i] == -1) qqq[tl++] = rr[i];  **for**(**int** i = 0; i <= 8; i++) **if**(l[i] == -1) qqq[tl++] = rl[i];  **for**(**int** i = 0; i <= 8; i++) **if**(b[i] == -1) qqq[tl++] = rb[i];  **bool** flag = **true**;  **for**(**int** i = 0; i < t; i++)  {  **for**(**int** j = 0; j < tl; j++)  sta[j] = rflct[qqq[j]][i];  LL res = hs(sta, tl);  **if**(flag && st.find(res) != st.end()) **return**;  flag = **false**;  st.insert(res);  }  ans++;  L();  dfs();  L(3);  R();  dfs();  R(3);  U();  dfs();  U(3);  D();  dfs();  D(3);  F();  dfs();  F(3);  B();  dfs();  B(3);  }  **int** main(){  **// freopen("/home/qingping/in.txt","r",stdin);**  **// freopen("/home/qingping/out.txt","w",stdout);**  init();  t = 0;  **for**(**int** i = 0; i < 4; i++)  {  RX();  **for**(**int** j = 0; j < 4; j++)  {  RY();  **for**(**int** i = 0; i <= 8; i++) rflct[rf[i]][t] = f[i];  **for**(**int** i = 0; i <= 8; i++) rflct[ru[i]][t] = u[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rd[i]][t] = d[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rr[i]][t] = r[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rl[i]][t] = l[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rb[i]][t] = b[i];  t++;  }  }  **for**(**int** i = 0; i < 4; i++)  {  RZ();  **for**(**int** j = 0; j < 4; j++)  {  RY();  **for**(**int** i = 0; i <= 8; i++) rflct[rf[i]][t] = f[i];  **for**(**int** i = 0; i <= 8; i++) rflct[ru[i]][t] = u[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rd[i]][t] = d[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rr[i]][t] = r[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rl[i]][t] = l[i];  **for**(**int** i = 0; i <= 8; i++) rflct[rb[i]][t] = b[i];  t++;  }  }  **int** T;scanf("%d",&T);  **for**(**int** cas=1;cas<=T;cas++){  init();  printf("Case #%d: ", cas);  **int** n;scanf("%d",&n);  **for**(**int** i=0;i<n;i++){  **int** x;  scanf("%d",&x);  **for**(**int** i = 0; i <= 8; i++) **if**(rf[i] == x) f[i] = -1;  **for**(**int** i = 0; i <= 8; i++) **if**(ru[i] == x) u[i] = -1;  **for**(**int** i = 0; i <= 8; i++) **if**(rd[i] == x) d[i] = -1;  **for**(**int** i = 0; i <= 8; i++) **if**(rr[i] == x) r[i] = -1;  **for**(**int** i = 0; i <= 8; i++) **if**(rl[i] == x) l[i] = -1;  **for**(**int** i = 0; i <= 8; i++) **if**(rb[i] == x) b[i] = -1;  }  st.clear();  ans = 0;  dfs();  **// int sz = st.size();**  printf("%d\n",ans);  }  **return** 0;  } |

### 枚举二进制状态的所有子集

|  |
| --- |
| **for**(**int** x = s; x; x = (x-1)&s)  {  **//每一个x都是s的一个子集**  } |

### 三分

|  |
| --- |
| **double** Calc(Type a)  {  /\* 根据题目的意思计算 \*/  }  **void** Solve(**void**)  {  **double** Left, Right;  **double** mid, midmid;  **double** mid\_value, midmid\_value;  Left = MIN; Right = MAX;  **while** (Left + EPS < Right)  {  mid = (Left + Right) / 2;  midmid = (mid + Right) / 2;  mid\_area = Calc(mid);  midmid\_area = Calc(midmid);  // 假设求解最大极值.  **if** (mid\_area >= midmid\_area) Right = midmid;  **else** Left = mid;  }  } |

### 手写递归栈

|  |
| --- |
| **void** dfs(){  stack<pair<**int**,pair<**int**,**int**> > >s;  s.push(mp(1,mp(0,0)));  **while**(!s.empty()){  pair<**int**,pair<**int**,**int**> >now=s.top();s.pop();  **int** u=now.first,pre=now.second.first,i=now.second.second;  **if**(i==0){  **int** t=++depth;  b[++tot]=t;  f[t]=u;  p[u]=tot;  }  **if**(i<edge[u].size()){ //重点是这里  **int** v=edge[u][i].first,w=edge[u][i].second;  s.push(mp(u,mp(pre,i+1)));  **if**(v==pre) **continue**;  dist[v]=dist[u]+w;  s.push(mp(v,mp(u,0)));  }  **else**  b[++tot]=b[p[pre]];  }  }  //大概是一个用bfs求图中各个点的dfs序的代码。 |

### 数位DP

|  |
| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 22  **using** **namespace** std;  **typedef** pair<**long** **long**,**long** **long**> PII;  **const** **long** **long** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **long** **long** dit[N];  **long** **long** dp[N][3][3][3];  **long** **long** dfs(**long** **long** idx,**bool** ppre,**long** **long** pre,**bool** limit,**long** **long** edidx)  {  **if**(dp[idx][ppre][pre][limit]!=-1)  **return** dp[idx][ppre][pre][limit];  **if**(idx==edidx+1)  {  **if**(ppre && pre == 1)  {  **return** dp[idx][ppre][pre][limit]=1;  }  **return** dp[idx][ppre][pre][limit]=0;  }  **if**(ppre && pre == 1)  {  **long** **long** cur=10;  **if**(limit){  **int** tmpidx=idx;  cur=dit[edidx-idx];  **while**(++tmpidx<=edidx)  {  cur\*=10;  cur+=dit[edidx-tmpidx];  }  }**else**{  **int** tmpidx=idx;  **while**(++tmpidx<=edidx)  {  cur\*=10;  }  }  **return** dp[idx][ppre][pre][limit]=cur;  }  **long** **long** ret=0;  **for**(**long** **long** i=0;i <= (limit?dit[edidx-idx]:9);i++)  {  **long** **long** flag=0;  **if**(i==4) flag=2;  **if**(i==9) flag=1;  ret+=dfs(idx+1,pre==2,flag,limit && i==dit[edidx-idx],edidx);  **//ret+=dfs(idx+1,pre,i,limit && i==dit[edidx-idx],edidx);**  }  **return** dp[idx][ppre][pre][limit]=ret;  }  **long** **long** getval(**long** **long** x)  {  **long** **long** ditnum=0;  memset(dp,-1,**sizeof** dp);  **while**(x)  {  dit[ditnum++]=x%10;  x/=10;  }  **return** dfs(1,0,0,1,ditnum);  }  **int** main()  {  Open();  **long** **long** T;  scanf("%I64d",&T);  **while**(T--)  {  **long** **long** a;  scanf("%I64d",&a);  printf("%I64d\n",getval(a));  }  **return** 0;  } |

### 五子棋判断某个位置是否连成5个

|  |
| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **#define** ID(x, y) ((x)\*m+(y))  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **typedef** pair<PII, **int**> PIII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** g[22][22];  **int** n = 15, m = 15;  **bool** judge(**int** play , **int** xp, **int** yp){  **int** n0=0 , n1=0 ,n2=0,n3=0,n4=0,n5=0,n6=0,n7=0;  **for**(**int** x=xp , y=yp+1 ; CHECK(x,y) && g[x][y]==play ; n0++ , y++);  **for**(**int** x=xp+1 , y=yp+1 ; CHECK(x,y) && g[x][y]==play ; n1++ ,x++, y++);  **for**(**int** x=xp+1 , y=yp ; CHECK(x,y) && g[x][y]==play ; n2++ , x++);  **for**(**int** x=xp+1 , y=yp-1 ; CHECK(x,y) && g[x][y]==play ; n3++ ,x++, y--);  **for**(**int** x=xp , y=yp-1 ; CHECK(x,y) && g[x][y]==play ; n4++ , y--);  **for**(**int** x=xp-1 , y=yp-1 ; CHECK(x,y) && g[x][y]==play ; n5++ ,x--, y--);  **for**(**int** x=xp-1 , y=yp ; CHECK(x,y) && g[x][y]==play ; n6++ , x--);  **for**(**int** x=xp-1 , y=yp+1 ; CHECK(x,y) && g[x][y]==play ; n7++ , x--,y++);  **int** a0 = n0+n4+1 , a1 = n1+n5+1 , a2=n2+n6+1, a3=n3+n7+1;  **return** a0>=5 || a1>=5 || a2>=5 || a3>=5;  } |

### 一些大质数

100000007

200000033

300000007

400000009

500000009

600000007

699999953

799999999

900000053

1000000007

### C++各个类型输入符控制

符号属性  长度属性 基本型 所占位数    取值范围           输入符举例    输出符举例

--          --      **char**     8      -2^7 ~ 2^7-1            %c         %c %d %u

signed      --      **char**     8      -2^7 ~ 2^7-1            %c         %c %d %u

unsigned    --      **char**     8      0 ~ 2^8-1               %c         %c %d %u

signed     **short**    **int**     16     -2^15 ~ 2^15-1          %hd

unsigned  **short**    **int**      16     0 ~ 2^16-1          %hu %ho  %hx

signed      --      **int**      32     -2^31 ~ 2^31-1          %d

unsigned    --      **int**      32     0 ~ 2^32-1           %u %o %x

signed     **long**     **int**      32     -2^31 ~ 2^31-1         %ld

unsigned   **long**     **int**      32     0 ~ 2^32-1         %lu %lo %lx

signed     **long**     **int**      64     -2^63 ~ 2^63-1        %I64d

unsigned   **long**     **int**      64     0 ~ 2^64-1      %I64u %I64o %I64x

 --         --     **float**     32    +/- 3.40282e+038    %f %e %g

--         --     **double**  64    +/- 1.79769e+308   %lf %le %lg     %f %e %g

--        **long**    **double**  96    +/- 1.79769e+308 %Lf、%Le、%Lg

### C++扩栈

#pragma comment(linker, "/STACK:102400000,102400000")

### Cin取消同步

std::ios::sync\_with\_stdio(**false**);

cin.tie(0);

//注意取消同步之后cin,cout不能和scanf,printf混用

### G++扩栈

|  |
| --- |
| //亲测HDU可用  //zoj扩栈内存会算到总内存中，需要小心一些  **int** main2() {  //your code  **return** 0;//博客上说这里换成exit(0),不过我在hdu上面提交这个也没有问题//ZOJ上也可用，不过的确得改为exit(0)  }  extern **int** main2(**void**) \_\_asm\_\_ ("\_main2");  **int** main()  {  **int** size = 256 << 20; // 256Mb  **char** \*p = (**char** \*)malloc(size) + size;  \_\_asm\_\_ \_\_volatile\_\_(  "mov %0, %%rsp\n" //这里很多时候会报错“bad register name '%rsp'”此时只需要将rsp换成esp就行了(原理就是两个不同的寄存器，在某些平台上名字不同)  "push $\_exit\n"  "jmp \_main2\n"  :: "r"(p));  **return** 0;  }  //博客中的扩栈代码：  //Win 32位MinGW 4.7.2环境  extern **int** main2(**void**) \_\_asm\_\_ ("\_main2");    **int** main2() {  **char** test[255 << 20];  memset(test, 42, sizeof(test));  printf(":)\n");  exit(0);  }    **int** main() {  **int** size = 256 << 20; // 256Mb  **char** \*p = (**char** \*)malloc(size) + size;  \_\_asm\_\_ \_\_volatile\_\_(  "movl %0, %%esp\n"  "pushl $\_exit\n"  "jmp \_main2\n"  :: "r"(p));  }  //Linux 64位gcc 4.8.1环境  extern **int** main2(**void**) \_\_asm\_\_ ("main2");    **int** main2() {  **char** test[255 << 20];  memset(test, 42, sizeof(test));  printf(":)\n");  exit(0);  }    **int** main() {  **int** size = 256 << 20; // 256Mb  **char** \*p = (**char** \*)malloc(size) + size;  \_\_asm\_\_ \_\_volatile\_\_(  "movq %0, %%rsp\n"  "pushq $exit\n"  "jmp main2\n"  :: "r"(p));  } |

### Headfile

|  |
| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#include <unordered\_map>**  **#define** N 100010  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **//#define CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)**  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("D:/in.txt","r",stdin);  **//freopen("D:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **int** main()  {  **//Open();**  **return** 0;  } |

### Unordered\_map

|  |
| --- |
| **struct** Node  {  string str;  **int** idx;  bool operator==(**const** Node& o)**const**  {  **return** str==o.str && idx == o.idx;  }  };  **struct** Node\_hash  {  size\_t operator()(**const** Node& o)**const**  {  **return** hash<string>()(o.str) ^ (hash<**int**>()(o.idx) >> 1);  }  };  unordered\_map<Node,**int**,Node\_hash> vis;  //我们需要重载==符号，以及另外在另一个结构体里面写hash函数，格式如上： |

### Unordermap简化版

|  |
| --- |
| **struct** Item{  **int** key,val,nxt;  };  **struct** UMP{  Item item[555555];  **int** itnum;  **int** head[999997];  **int** MOD;  UMP(){  MOD=999997;  clear();  }  **void** clear(){  memset(head,-1,sizeof(head));  itnum=0;  }  bool find(**int** x)  {  **int** idx=x%MOD;  **for**(**int** i=head[idx]; i!=-1; i=item[i].nxt)  {  **if**(item[i].key==x) **return** item[i].val;  }  **return** -1;//没找到  }  **int**& operator[](**int** x){  **int** idx=x%MOD;  //cerr<<idx<<endl;  **for**(**int** i=head[idx];i!=-1;i=item[i].nxt){  **if**(item[i].key==x) **return** item[i].val;  }  item[itnum]=(Item){x,0,head[idx]};  head[idx]=itnum;  **return** item[itnum++].val;  }  }; |

### 读入挂

|  |
| --- |
| inline **long** **long** Scan() //输入外挂  {  **long** **long** res=0,ch,flag=0;  **if**((ch=getchar())=='-')  flag=1;  **else** **if**(ch>='0'&&ch<='9')  res=ch-'0';  **while**((ch=getchar())>='0'&&ch<='9')  res=res\*10+ch-'0';  **return** flag?-res:res;  }  inline **void** Out(**long** **long** a) //输出外挂  {  **if**(a>9)  Out(a/10);  putchar(a%10+'0');  }  template<**class** T>  inline bool read(T &n){  T x = 0, tmp = 1; **char** c = getchar();  **while** ((c < '0' || c > '9') && c != '-' && c != EOF) c = getchar();  **if** (c == EOF) **return** **false**;  **if** (c == '-') c = getchar(), tmp = -1;  **while** (c >= '0' && c <= '9') x \*= 10, x += (c - '0'), c = getchar();  n = x\*tmp;  **return** **true**;  }  template <**class** T>  inline **void** write(T n) {  **if** (n < 0) {  putchar('-');  n = -n;  }  **int** len = 0, data[20];  **while** (n) {  data[len++] = n % 10;  n /= 10;  }  **if** (!len) data[len++] = 0;  **while** (len--) putchar(data[len] + 48);  }  ///////////////////////////////fread加速!!!!!!!!///////////////  **char** \*ch1, buf1[40\*1024000+5];  **char** \*ch, buf[40\*1024000+5];  template <**class** T>  **void** read(T &x) {  **for** (++ch; \*ch <= 32; ++ch);  **for** (x = 0; '0' <= \*ch; ch++) x = x \* 10 + \*ch - '0';  }  **void** out(**int** x) {  **if** (!x) \*(++ch1) = '0';  **else** {  **char** \*ch0 = ch1, \*ch = ch1 + 1;  **while** (x) {  \*(++ch0) = x % 10 + '0';  x /= 10;  }  ch1 = ch0;  **while** (ch <= ch0) swap(\*(ch++), \*(ch0--));  }  \*(++ch1) = '\n';  }  **void** out(**long** **long** x) {  **if** (!x) \*(++ch1) = '0';  **else** {  **char** \*ch0 = ch1, \*ch = ch1 + 1;  **while** (x) {  \*(++ch0) = x % 10 + '0';  x /= 10;  }  ch1 = ch0;  **while** (ch <= ch0) swap(\*(ch++), \*(ch0--));  }  \*(++ch1) = '\n';  }  **int** main(){  Open();//freopen  ch = buf - 1;  ch1 = buf1 - 1;  fread(buf, 1, 1000 \* 35 \* 1024, stdin);        // fwrite(buf1, 1, ch1 - buf1 + 1, stdout);//输出，放在main函数的最后一行  }  //----------------------比较规整的版本，注意内存消耗比较大-------------  **struct** Reader{  **static** **const** **int** MSIZE = 1000 \* 8 \* 1024;  **char** buf[MSIZE], \*pt = buf, \*o = buf;  **void** init(){  fread(buf, 1, MSIZE, stdin);  }  **char** getch()  {  **char** ch;  **while**((\*pt < 'A' || \*pt > 'Z') && (\*pt < 'a' || \*pt > 'z')) pt++;  ch = \*pt;pt++;  **return** ch;  }  **int** getint()  {  **int** f = 1, x = 0;  **while**(\*pt != '-' && !isdigit(\*pt)) pt++;  **if**(\*pt == '-') f = -1, pt++;  **else** x = \*pt++ - 48;  **while**(isdigit(\*pt)) x = x \* 10 + \*pt++ - 48;  **return** x \* f;  }  }frd; |

### 多重背包二进制

|  |
| --- |
| **for**(**int** i = 0; i < K; ++i){  **int** num = ev[i].c;  **for**(**int** k = 1; num; k <<= 1){  **int** mul = min(k,num);  **for**(**int** j = ev[i].a ; j >= mul \* ev[i].h; --j)  **if**(dp[j- ev[i].h\*mul]) dp[j] = 1,ans = max(j,ans);  num -= mul;  }  }  **for**(**int** d = 0; d < w[i]; d++) { // 对于所有余数 d [0, w[i])  // 窗口大小为 c[i]  **int** sum = 0, st = 0, ed = -1; //st,ed 单调队列的开始和结尾, sum 队列中是否有一个 true  **for**(**int** v = d; v <= m; v+= w[i]) { // 完全背包 model, 但步长是 w[i]  **if**(ed - st == c[i]) { // 窗口大小为0, 移除队首元素, 队首后移一位  sum -= queue[st++];  }  queue[++ed] = dp[v];  sum += dp[v];  **if**(!dp[v] && sum)  dp[v] = 1;  }  } |

### 矩阵快速幂

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| --- |
| **#include** <iostream>  **#include** <cstdio>  **#include** <stack>  **#include** <cstring>  **#include** <queue>  **#include** <algorithm>  **#include** <cmath>  **//#define lson x<<1**  **//#define rson x<<1|1**  **//#define mid ((lt[x].l+lt[x].r)/2)**  **//#define ID(x, y) ((x)\*m+(y))**  **#define** CHECK(x, y) ((x)>=0 && (x)<n && (y)>=0 && (y)<m)  **using** **namespace** std;  **typedef** **long** **long** LL;  **typedef** **unsigned** **long** **long** ULL;  **typedef** pair<**int**,**int**> PII;  **const** **int** INF=0x3f3f3f3f;  **void** Open()  {  **#ifndef** ONLINE\_JUDGE  freopen("/home/qingping/in.txt","r",stdin);  **// freopen("/home/qingping/out.txt","w",stdout);**  **//freopen("F:/my.txt","w",stdout);**  **#endif** **// ONLINE\_JUDGE**  }  **const** **int** MN = 110;  **///该快速幂板子运算前一定要记得将矩阵的初始化**  **struct** Mat{  **int** n, m;  LL mat[MN][MN];  Mat(**int** \_n = MN, **int** \_m = MN){n = \_n, m = \_m;}  **void** resize(**int** \_n, **int** \_m){n = \_n, m = \_m;memset(mat, 0, **sizeof**(mat));}  **void** unit(**int** \_n, **int** \_m)  {  n = \_n, m = \_m;memset(mat, 0, **sizeof**(mat));  **for**(**int** i = 0; i < n; i++) mat[i][i] = 1;  }  **void** print()  {  **for**(**int** i = 0; i < n; i++, printf("\n"))  **for**(**int** j = 0; j < m; j++)  printf("%d ", mat[i][j]);  }  };  Mat **operator**\*(Mat a, Mat b)  {  **int** n = a.n, m = a.m, k = b.m;  Mat c;  c.resize(n, k);  **for**(**int** i = 0; i < n; i++)  **for**(**int** j = 0; j < k; j++)  **for**(**int** l = 0; l < m; l++)  {  **if**(a.mat[i][l] && b.mat[l][j])  c.mat[i][j] += a.mat[i][l]\*b.mat[l][j];  }  **return** c;  }  Mat **operator**^(Mat A, **int** x)  {  Mat c;  c.unit(A.n, A.m);  **while**(x)  {  **if**(x & 1) c = c\*A;  A = A\*A;  x >>= 1;  }  **return** c;  }  **char** op[3];  **int** main()  {  **// Open();**  **int** n, m, k;  **while**(~scanf("%d%d%d", &n, &m, &k))  {  **if**(n+m+k == 0) **break**;  Mat res, tmp, ini;  res.unit(n+1, n+1);  **while**(k--)  {  scanf("%s", op);  **int** x, y;  **if**(op[0] == 'g')  {  scanf("%d", &x);  x--;  **for**(**int** i = 0; i < n+1; i++)  {  res.mat[i][x]+=res.mat[i][n];  }  }  **if**(op[0] == 's')  {  scanf("%d%d", &x, &y);  **if**(x == y) **continue**;  x--, y--;  **for**(**int** i = 0; i < n+1; i++)  swap(res.mat[i][x], res.mat[i][y]);  }  **if**(op[0] == 'e')  {  scanf("%d", &x);  x--;  **for**(**int** i = 0; i < n+1; i++)  res.mat[i][x] = 0;  }  }  ini.resize(1, n+1);  ini.mat[0][n] = 1;  res = res^m;  ini = ini\*res;  **for**(**int** i = 0; i < n; i++)  {  printf("%lld%c", ini.mat[0][i], " \n"[i == n-1]);  }  }  **return** 0;  }  **#include** <iostream>  **#include** <cstdio>  **#include** <cstring>  **#include** <cstdlib>  **#include** <cmath>  **#include** <algorithm>  **#define** N 6  **using** **namespace** std;  **const** **int** mod=1e9+7;  **void** printfm(**int** A[N][N],**int** n,**int** m)  {  **for**(**int** i=0;i<n;i++)  **for**(**int** j=0;j<m;j++)  {  printf("%d%c",A[i][j],(j==m-1)?'\n':' ');  }  printf("\n");  }  **void** mul(**int** A[N][N],**int** B[N][N],**int** t[N][N],**int** n,**int** m,**int** l)**//A 为n\*m的矩阵，B为m\*l的矩阵,t为结果矩阵**  {  **int** tmp[N][N];**//为了防止冲突**  **for**(**int** i=0;i<n;i++)  **for**(**int** j=0;j<l;j++){  tmp[i][j]=0;  **for**(**int** k=0;k<m;k++)  tmp[i][j]=(tmp[i][j]+A[i][k]\*B[k][j])%mod;  }  **for**(**int** i=0;i<n;i++) **for**(**int** j=0;j<l;j++) t[i][j]=tmp[i][j];  }  **void** expo(**int** p[N][N],**int** e[N][N],**int** k,**int** n)**//P为n\*n的矩阵，k为计算k次幂，e为结果矩阵**  {  **for**(**int** i = 0; i < n; ++i) **for**(**int** j = 0; j < n; ++j) e[i][j] = (i == j);  **while**(k) {  **if**(k&1) mul(e,p,e,n,n,n);  mul(p,p,p,n,n,n);  k>>=1;  }  }  **int** a[N][N];  **int** b[N][N];  **int** c[N][N];  **int** main()  {  **#ifndef** ONLINE\_JUDGE  **//freopen("E:/in.txt","r",stdin);**  **//freopen("E:/my.txt","w",stdout);**  **#endif**  **int** n,a0,ax,ay,b0,bx,by;  **while**(~scanf("%d%d%d%d%d%d%d",&n,&a0,&ax,&ay,&b0,&bx,&by))  {  memset(a,0,**sizeof**(a));  memset(b,0,**sizeof**(b));  memset(c,0,**sizeof**(c));  a[0][0]=0,a[0][1]=a0\*b0%mod,a[0][2]=a0,a[0][3]=b0,a[0][4]=1;  b[0][0]=1,b[1][0]=1,b[1][1]=ax\*bx%mod,b[2][1]=ax\*by%mod,b[2][2]=ax,b[3][1]=bx\*ay%mod;  b[3][3]=bx,b[4][1]=ay\*by%mod,b[4][2]=ay,b[4][3]=by,b[4][4]=1;  **//printfm(a,1,5);**  **//printfm(b,5,5);**  expo(b,c,n,5);  mul(a,c,c,1,5,5);  printf("%d\n",c[0][0]);  }  **return** 0;  } |

### 离散化

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| cnt = 0;  **int** len = 1;  **for**(**int** i=1;i<=n;i++)  {  **int** a, b;  scanf("%d%d", &a, &b);  // read(a);read(b);  **if**(a == 0){  q[i] = node(a, b, b+len);  mp[cnt++] = b, mp[cnt++] = b+len;  idx[len] = i;  len++;  }**else**{  q[i] = node(a, q[idx[b]].l, q[idx[b]].r);  }  }  sort(mp, mp+cnt);  cnt = unique(mp, mp+cnt) - mp;  **for**(**int** i=1;i<=n;i++)  {  q[i].l = lower\_bound(mp, mp+cnt, q[i].l) - mp + 1;  q[i].r = lower\_bound(mp, mp+cnt, q[i].r) - mp + 1;  } |

## 计算几何

### 最近点对问题

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| **//最近点对问题**  **#include** <iostream>  **#include** <cstdio>  **#include** <cstring>  **#include** <cmath>  **#include** <algorithm>  **using** **namespace** std;  **const** **double** INF = 1e20;  **const** **int** N = 100005;    **struct** Point  {  **double** x;  **double** y;  }point[N];  **int** n;  **int** tmpt[N];    **bool** cmpxy(**const** Point& a, **const** Point& b)  {  **if**(a.x != b.x)  **return** a.x < b.x;  **return** a.y < b.y;  }    **bool** cmpy(**const** **int**& a, **const** **int**& b)  {  **return** point[a].y < point[b].y;  }    **double** min(**double** a, **double** b)  {  **return** a < b ? a : b;  }    **double** dis(**int** i, **int** j)  {  **return** sqrt((point[i].x-point[j].x)\*(point[i].x-point[j].x)  + (point[i].y-point[j].y)\*(point[i].y-point[j].y));  }    **double** Closest\_Pair(**int** left, **int** right)  {  **double** d = INF;  **if**(left==right)  **return** d;  **if**(left + 1 == right)  **return** dis(left, right);  **int** mid = (left+right)>>1;  **double** d1 = Closest\_Pair(left,mid);  **double** d2 = Closest\_Pair(mid+1,right);  d = min(d1,d2);  **int** i,j,k=0;  **//分离出宽度为d的区间**  **for**(i = left; i <= right; i++)  {  **if**(fabs(point[mid].x-point[i].x) <= d)  tmpt[k++] = i;  }  sort(tmpt,tmpt+k,cmpy);  **//线性扫描**  **for**(i = 0; i < k; i++)  {  **for**(j = i+1; j < k && point[tmpt[j]].y-point[tmpt[i]].y<d; j++)  {  **double** d3 = dis(tmpt[i],tmpt[j]);  **if**(d > d3)  d = d3;  }  }  **return** d;  }  **//最近点对问题** |

### 凸包

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| /\*  \* 计算凸包，输入点数组为p，个数为n，输出点数组为ch，返回凸包顶点数  \* 输入不能有重复点。函数执行完之后，sort，会破坏顺序  \* 如果不希望在凸包的边上有输入点，把两个 <= 改为 <  \*/  **int** ConvexHull(Point\* p, **int** n, Point\* ch)  {  sort(p, p+n);  **int** m = 0;  **for**(**int** i=0;i<n;i++){  **while**(m > 1 && Cross(ch[m-1] - ch[m-2], p[i] - ch[m-2]) <= 0) m--;  ch[m++] = p[i];  }  **int** k=m;  **for**(**int** i=n-2;i>=0;i--){  **while**(m>k && Cross(ch[m-1] - ch[m-2], p[i] - ch[m-2]) <= 0) m--;  ch[m++] = p[i];  }  **if**(n>1) m--;  **return** m;  }  /\*  \* 用法：  \* for(int i=0;i<n;i++)  \* {  \* double x,y;  \* scanf("%lf%lf",&x,&y);  \* p[i] = (Point){x,y};  \* }  \* int bagNum=ConvexHull(p,n,tubag);  \*/ |

### 求多边形重心

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| Point MassCenter(Point a[] , **int** n){  Point ans = Point(0,0);  **double** area = AREA(a, n);  **if**(dcmp(area) == 0) **return** ans;  a[n] = a[0];  **for**(**int** i=0;i<n;i++) ans = ans+(a[i] + a[i+1])\*Cross(a[i+1] , a[i]);  **return** ans /area /6.0;  } |

### 计算几何常规模板

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| **#include** <cstdio>  **#include** <cmath>  **#include** <iostream>  **#include** <algorithm>  **#include** <vector>  **using** **namespace** std;  **const** **int** N = 100010;  **struct** Point  {  **double** x, y;  **Point**(**double** x = 0, **double** y = 0) :x(x), y(y) {}  **void** **read**()  {  scanf("%lf%lf", &x, &y);  }  }pa[N], pb[N];  **const** **double** eps = 1e-10;  **const** **double** PI = acos(-1.0);  **typedef** Point Vector;  **int** **dcmp**(**double** x) { **if** (fabs(x) < eps) **return** 0; **else** **return** x<0 ? -1 : 1; }  **int** **dcmp**(**double** x)  {  **return** (x>eps) - (x<-eps);  }  Vector **operator+**(Vector A, Vector B) { **return** Vector(A.x + B.x, A.y + B.y); }  Vector **operator-**(Point A, Point B) { **return** Vector(A.x - B.x, A.y - B.y); }  Vector **operator\***(Vector A, **double** p) { **return** Vector(A.x\*p, A.y\*p); }  Vector **operator/**(Vector A, **double** p) { **return** Vector(A.x / p, A.y / p); }  **bool** **operator<**(**const** Point& a, **const** Point& b) { **return** a.x<b.x || (a.x == b.x && a.y < b.y); }  **bool** **operator==**(**const** Point& a, **const** Point& b) { **return** dcmp(a.x - b.x) == 0 && dcmp(a.y - b.y) == 0; }  //返回值(-PI, PI]  **double** **angle**(Vector A) { **return** atan2(A.y, A.x); }//返回A向量的极角atan2(y,x)所表达的意思是坐标原点为起点，指向(x,y)的射线在坐标平面上与x轴正方向之间的角的角度。  **double** **Dot**(Vector A, Vector B) { **return** A.x\*B.x + A.y\*B.y; }  **double** **Length**(Vector A) { **return** sqrt(Dot(A, A)); }  **double** **Angle**(Vector A, Vector B) { **return** acos(Dot(A, B) / Length(A) / Length(B)); }//A到B的逆时针转的角  **double** **Cross**(Vector A, Vector B) { **return** A.x\*B.y - A.y\*B.x; }  Vector **Rotata**(Vector A, **double** rad) { **return** Vector(A.x\*cos(rad) - A.y\*sin(rad), A.x\*sin(rad) + A.y\*cos(rad)); }//A逆时针转ang弧度  **double** **torad**(**double** ang) { **return** ang / 180 \* PI; }  Vector **Normal**(Vector A) { **double** L = Length(A); **return** Vector(-A.y / L, A.x / L); }//需要确保A不是0向量，左转90度  //非规范相交，端点上视为在线段上  **bool** **OnSegment**(Point p, Point a, Point b) { **return** dcmp(Length(p - a) + Length(p - b) - Length(a - b)) == 0; }//精度也很高的！  **double** **NormalAng**(**double** x)//将弧度x通过+-2\*PI的方式约束到[-PI,PI];  {  **if** (x > 0) {  **while** (x > PI) x -= 2.0 \* PI;  }  **else** {  **while** (x < -PI) x += 2.0 \* PI;  }  **return** x;  }  **struct** Line {  Point p, v;  **double** a, b, c;//得到一般式的参数  **double** ang;  **Line**() {}  **Line**(Point p = Point(0, 0), Vector v = Vector(0, 0)) :p(p), v(v) { a = v.y - p.y; b = p.x - v.x; c = p.y\*v.x - v.y\*p.x; ang = angle(v); }  Point **point**(**double** t) { **return** p + v\*t; }//只能在点斜式中用  **bool** **operator <** (**const** Line& L)**const** {  **return** ang < L.ang;  }  }L[N];  **struct** Circle  {  Point c;  **double** r;  **Circle**() {}  **Circle**(Point c, **double** r) :c(c), r(r) {}  Point **point**(**double** a)  {  **return** Point(c.x + cos(a)\*r, c.y + sin(a)\*r);  }  };  **bool** **OnSegment**(Point p, Point a1, Point a2) { **return** dcmp(Cross(a1 - p, a2 - p)) == 0 && dcmp(Dot(a1 - p, a2 - p)) < 0; }  **bool** **OnSegment**(Point p, Point a, Point b)//精度较高的判断  {  Point v1, v2;  v1 = p - a;  v2 = p - b;  **if** (dcmp(Cross(v1, v2)) != 0) //叉积不为0 就不在直线上  **return** 0;  **else**  {  **if** (dcmp(min(a.x, b.x) - p.x) <= 0 && dcmp(p.x - max(a.x, b.x)) <= 0 && dcmp(min(a.y, b.y) - p.y) <= 0 && dcmp(p.y - max(a.y, b.y)) <= 0)  **return** 1;  **else**  **return** 0;  }  }  //根据一个极角，返回相应极角的向量  Vector **getVFromAngle**(**double** ang)  {  Vector V;  **if** (dcmp(ang - PI / 2) == 0) V = Vector(1, 1);  **else** **if** (dcmp(ang + PI / 2) == 0) V = Vector(1, -1);  **else** {  V = Vector(1, tan(ang));  }  **return** V;  }  //两直线相交  Point **GetLineIntersection**(Point P, Vector v, Point Q, Vector w)  {  Vector u = P - Q;  **double** t = Cross(w, u) / Cross(v, w);  **return** P + v\*t;  }  //点到线段距离  **double** **DistanceToSegment**(Point P, Point A, Point B)  {  **if** (A == B) **return** Length(P - A);  Vector v1 = B - A, v2 = P - A, v3 = P - B;  **if** (dcmp(Dot(v1, v2)) < 0) **return** Length(v2);  **else** **if** (dcmp(Dot(v1, v3)) > 0) **return** Length(Length(v3));  **else** **return** fabs(Cross(v1, v2)) / Length(v1);  }  //点到直线距离  **double** **DistanceToLine**(Point P, Point A, Point B)  {  Vector v1 = B - A, v2 = P - A;  **return** fabs(Cross(v1, v2)) / Length(v1);  }  //线段是否规范相交  **bool** **SegmentProperIntersection**(Point a1, Point a2, Point b1, Point b2)  {  **double** c1 = Cross(a2 - a1, b1 - a1), c2 = Cross(a2 - a1, b2 - a1);  **double** c3 = Cross(b2 - b1, a1 - b1), c4 = Cross(b2 - b1, a2 - b1);  **return** dcmp(c1)\*dcmp(c2)<0 && dcmp(c3)\*dcmp(c4)<0;  }  //过点P的圆C的切线  **int** **getTangents**(Point P, Circle C, Vector\* v)  {  Vector u = C.c - P;  **double** dist = Length(u);  **if** (dist < C.r) **return** 0;  **if** (dcmp(dist - C.r) == 0) {  v[0] = Rotata(u, PI / 2);  **return** 1;  }  **double** ang = asin(C.r / dist);  v[0] = Rotata(u, -ang);  v[1] = Rotata(u, ang);  **return** 2;  }  //圆圆相交  **int** **getCircleCircleIntersection**(Circle C1, Circle C2, vector<Point>& sol)  {  **double** d = Length(C1.c - C2.c);  **if** (dcmp(d) == 0)  {  **if** (dcmp(C1.r - C2.r) == 0) **return** -1;  **return** 0;  }  **if** (dcmp(C1.r + C2.r - d) < 0) **return** 0;  **if** (dcmp(fabs(C1.r - C2.r) - d) > 0) **return** 0;  **double** a = angle(C2.c - C1.c);  **double** da = acos((C1.r\*C1.r + d\*d - C2.r\*C2.r) / (2 \* C1.r\*d));  Point P1 = C1.point(a - da), P2 = C1.point(a + da);  sol.push\_back(P1);  **if** (P1 == P2) **return** 1;  sol.push\_back(P2);  **return** 2;  }  //直线与圆相交,直线必须是点斜式,如果是线段的话，需要检查t1,t2是否在[0,1]之间。  **int** **getLineCircleIntersection**(Line L, Circle C, vector<Point >& sol)  {  **double** a = L.v.x, b = L.p.x - C.c.x, c = L.v.y, d = L.p.y - C.c.y;  **double** e = a\*a + c\*c, f = 2 \* (a \* b + c \* d), g = b\*b + d\*d - C.r\*C.r;  **double** delta = f\*f - 4 \* e\*g;  **double** dist = DistanceToLine(C.c, L.p, L.p + L.v);  **double** t1, t2;  **if** (dcmp(dist - C.r) > 0) **return** 0;  **if** (dcmp(dist - C.r) == 0) {  t1 = t2 = -f / (2 \* e); sol.push\_back(L.point(t1));  **return** 1;  }  t1 = (-f - sqrt(delta)) / (2 \* e); sol.push\_back(L.point(t1));  t2 = (-f + sqrt(delta)) / (2 \* e); sol.push\_back(L.point(t2));  **return** 2;  }  //计算多边形的有向面积  **double** **PolygonArea**(Point\* p, **int** n)  {  **double** area = 0;  **for** (**int** i = 1; i<n - 1; i++) area += Cross(p[i] - p[0], p[i + 1] - p[0]);  **return** area / 2;  }  //判断点是否在多边形（可以是凹多边形）的内部  **int** **isPointInPolygon**(Point p, Point\* poly, **int** n)  {  **int** wn = 0;  **for** (**int** i = 0; i<n; i++)  {  **if** (OnSegment(p, poly[i], poly[(i + 1) % n])) **return** -1;//边界  **int** k = dcmp(Cross(poly[(i + 1) % n] - poly[i], p - poly[i]));  **int** d1 = dcmp(poly[i].y - p.y);  **int** d2 = dcmp(poly[(i + 1) % n].y - p.y);  **if** (k>0 && d1 <= 0 && d2 > 0) wn++;  **if** (k<0 && d2 <= 0 && d1 > 0) wn--;  }  **if** (wn != 0) **return** 1;//内部  **return** 0;//外部  }  //点是否在凸多边形内  **bool** **isPointInConvexPolygon**(Point p, Point\* poly, **int** n)  {  **for** (**int** i = 0; i<n; i++)  **if** (dcmp(Cross(poly[(i + 1) % n] - poly[i], p - poly[i])) <= 0) **return** 0;  **return** 1;  }  //两圆交面积  **const** **long** **double** eps = 1e-13;  **const** **long** **double** PI = acos(-1.0);  **int** **dcmp**(**long** **double** x)  {  **return** (x > 0) - (x < 0);  }  **long** **double** **solve**(Point c1, **long** **double** r1, Point c2, **long** **double** r2)  {  **long** **double** a = Length(c1-c2), b = r1, c = r2;  **if** (dcmp(a - r1 - r2) >= 0) **return** 0;  **if** (dcmp(a + r1 - r2) <= 0) **return** r1\*r1\*PI;  **if** (dcmp(a + r2 - r1) <= 0) **return** r2\*r2\*PI;  **long** **double** cta1 = acos((a\*a + b\*b - c\*c) / 2 / (a\*b));  **long** **double** cta2 = acos((a\*a + c\*c - b\*b) / 2 / (a\*c));  **long** **double** s1 = r1\*r1\*cta1 - r1\*r1\*sin(cta1)\*(a\*a + b\*b - c\*c) / 2 / (a\*b);  **long** **double** s2 = r2\*r2\*cta2 - r2\*r2\*sin(cta2)\*(a\*a + c\*c - b\*b) / 2 / (a\*c);  **return** s1 + s2;  } |

### 多边形圆交面积

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| **struct** CPIArea  {  Circle cir;  **double** Scir;  Point p[MAXN];  **int** tail;  CPIArea()  {  tail=0;  }  CPIArea(Circle cir):cir(cir)  {  Scir = PI\*cir.r\*cir.r;  tail=0;  }  //tp[]是多边形的点集，n是点的个数。tp[]必须满足点是按顺时针或者逆时针排序的  **double** solve(Point tp[],**int** n)  {  tail = 0;  **for**(**int** i=0; i<n; i++)  {  p[tail++]=tp[i];//p[]是囊括了圆和多边形交点的点集，也是按顺时针或者逆时针排序的  Line line = Line(tp[i],tp[(i+1)%n] - tp[i]);  **double** t1,t2;  vector<Point > sol;  sol.clear();  getLineCircleIntersection(line , cir , t1,t2,sol);  **for**(**int** j=0; j<sol.size(); j++)  {  p[tail++]=sol[j];  }  }  **double** res=0;  **for**(**int** i=0; i<tail; i++)  {  Point O = cir.c;  **double** ang = Angle(p[(i+1)%tail]-O , p[i]-O);  **if**( dcmp( Cross( p[i]-O , p[(i+1)%tail]-O)) > 0 ) ang\*=1;  **else** ang\*=-1;  **double** Sshan = ang/(2\*PI)\*Scir;  **double** Strian = Area(O , p[i] ,p[(i+1)%tail] );  **if**(dcmp( abs(Sshan) - abs(Strian))<=0 )  {  res += Sshan;  }  **else** res += Strian;  }  **return** abs(res);  }  }; |

### 点集的直径

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| **int** diameter2(Point\* points, **int** n, Point\* p)  {  n = ConvexHull(points, n, p);  **if**(n == 1) **return** 0;  **if**(n == 2) **return** Dot(p[1] - p[0], p[1] - p[0]);  p[n] = p[0];  **int** ans = 0;  **for**(**int** u = 0, v = 1; u<n; u++)  // 一条直线贴住边p[u]-p[u+1]  **while**(**true**)  {  // 当Area(p[u], p[u+1], p[v+1]) <= Area(p[u], p[u+1], p[v])时停止旋转  // 即Cross(p[u+1]-p[u], p[v+1]-p[u]) - Cross(p[u+1]-p[u], p[v]-p[u]) <= 0  // 根据Cross(A,B) - Cross(A,C) = Cross(A,B-C)  // 化简得Cross(p[u+1]-p[u], p[v+1]-p[v]) <= 0  **int** diff = Cross(p[u+1]-p[u], p[v+1]-p[v]);  **if**(diff <= 0)  {  ans = max(ans, (**int**)(Dot(p[u]-p[v], p[u]-p[v])+eps));//u和v是对踵点  **if**(diff == 0) ans = max(ans, (**int**)(Dot(p[u]-p[v+1], p[u]-p[v+1])+eps));// diff == 0时u和v+1也是对踵点  **break**;  }  v = (v+1)%n;  }  **return** ans;  } |

### 半平面交

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| **struct** line  {  Point P;  Vector v;  **double** ang;  line(){}  line(Point P, Vector v):P(P), v(v){ang = atan2(v.y, v.x);}//点和向量  line(**double** a, **double** b, **double** c)//从一般式转化过来  {  v = Vector(b, -a);  **if**(b != 0) P = Point(0, -c/b);  **else** P = Point(-c/a, 0);  Vector nor = Normal(v);  Point tmp = nor + P;  **if**(dcmp(a \* tmp.x + b \* tmp.y + c) > 0){//这里保证是ax+by+c <= 0的半平面  v = v\*-1;  }  ang = atan2(v.y, v.x);  }  bool operator<(**const** line &o)**const**{  **return** ang < o.ang;  }  }L[111];  bool OnLeft(line L, Point P)  {  **return** Cross(L.v, P - L.P) > 0;  }  Point GetIntersection(line a, line b)  {  Vector u = a.P - b.P;  **double** t = Cross(b.v, u) / Cross(a.v, b.v);  **return** a.P + a.v\*t;  }  //函数过后， L的顺序会改变。返回半平面交的凸包的节点数。  LL HalfPlaneIntersection(line\* L, LL n, Point\* poly)  {  sort(L, L+n);  LL first, last;  Point \*p = **new** Point[n];  line \*q = **new** line[n];  q[first = last = 0] = L[0];  **for**(LL i = 1; i < n ;i++)  {  **while**(first < last && !OnLeft(L[i], p[last - 1])) last--;  **while**(first < last && !OnLeft(L[i], p[first])) first++;  q[++last] = L[i];  **if**(fabs(Cross(q[last].v, q[last-1].v)) < eps){  last--;  **if**(OnLeft(q[last], L[i].P)) q[last] = L[i];  }  **if**(first < last) p[last - 1] = GetIntersection(q[last - 1], q[last]);  }  **while**(first < last && !OnLeft(q[first], p[last - 1])) last -- ;  **if**(last - first <= 1) **return** 0;  p[last] = GetIntersection(q[last], q[first]);  LL m = 0;  **for**(LL i = first; i <= last; i++) poly[m++] = p[i];  **return** m;  } |