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**数论**  
**(ex)CRT((扩展)中国剩余定理)**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
#include <numeric>  
using namespace std;  
#define int \_\_int128  
// 用于存储 \_\_int128 的字符串表示  
std::string to\_string(\_\_int128 value) {  
 std::string result;  
 bool isNegative = value < 0;  
 value = isNegative ? -value : value;  
  
 do {  
 result.push\_back(static\_cast<char>(value % 10) + '0');  
 value /= 10;  
 } while (value > 0);  
  
 if (isNegative) {  
 result.push\_back('-');  
 }  
  
 std::reverse(result.begin(), result.end());  
 return result;  
}  
  
// 从字符串转换为 \_\_int128  
\_\_int128 to\_int128(const std::string& str) {  
 \_\_int128 result = 0;  
 bool isNegative = str[0] == '-';  
 size\_t start = isNegative ? 1 : 0;  
  
 for (size\_t i = start; i < str.size(); ++i) {  
 result = result \* 10 + (str[i] - '0');  
 }  
  
 return isNegative ? -result : result;  
}  
  
// 重载 >> 操作符以支持 \_\_int128 输入  
std::istream& operator>>(std::istream& in, \_\_int128& value) {  
 std::string str;  
 in >> str;  
 value = to\_int128(str);  
 return in;  
}  
  
// 重载 << 操作符以支持 \_\_int128 输出  
std::ostream& operator<<(std::ostream& out, \_\_int128 value) {  
 out << to\_string(value);  
 return out;  
}  
class exCRT{  
   
 public:  
 exCRT(vector<int> r,vector<int> m){  
 this->r=r;  
 this->m=m;  
 n=r.size();  
 }  
 vector<int> r,m;  
 int x,n;  
 int exgcd(int a,int b,int &x,int &y)//扩展欧几里得  
 {  
 if(b==0)  
 {  
 x=1;y=0;  
 return a;  
 }  
 int d=exgcd(b,a%b,x,y),t=x;  
 x=y;y=t-a/b\*y;  
 return d;  
 }  
 int CRT()  
 {  
 int mul=accumulate(m.begin(),m.end(),1LL,  
 [](int a,int b){return a\*b;}),ans=0;  
 for(int i=0;i<n;i++)  
 {  
 int M=mul/m[i],b,y;  
 exgcd(M,m[i],b,y);  
 ans=(ans+r[i]\*M%mul\*b%mul+mul)%mul;  
 }  
 return (ans%mul+mul)%mul;  
 }  
 int \_exCRT()  
 {  
 int M=m[0],ans=r[0];  
 for(int i=1;i<n;i++)  
 {  
 int a=M,b=m[i];  
 int c=((r[i]-ans)%b+b)%b;  
 int x,y;  
 int gcd=exgcd(a,b,x,y);  
 int bg=b/gcd;  
 if(c%gcd!=0) return -1;  
 x=(x%bg+bg)%bg;  
 x=(x\*c/gcd%bg+bg)%bg;  
 ans+=x\*M;  
 M\*=bg;  
 ans=(ans%M+M)%M;  
 }  
 return (ans%M+M)%M;  
 }  
  
};  
signed main()  
{  
 int T\_start=clock();  
 int n;cin>>n;  
 vector<int> r(n),m(n);  
 for(int i=0;i<n;i++) cin>>m[i]>>r[i];  
 exCRT ex(r,m);  
 cout<<ex.CRT()<<endl;  
 return 0;  
}  
//exCRT 求解同余方程组  
//形式：x≡a1(mod m1),x≡a2(mod m2),...,x≡ak(mod mk)  
//其中m1,m2,...,mk互质(CRT)  
//其中m1,m2,...,mk不互质(\_exCRT)  
//时间复杂度：O(nln(amax))

**乘法逆元**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
using namespace std;  
long long ModQpow(long long a,long long b,long long m)//快速幂  
{  
 long long ans=1;  
 while(b)  
 {  
 if(b&1) ans=ans\*a%m;  
 a=a\*a%m;b>>=1;  
 }  
 return ans;  
}  
long long invMod1(int a,int m)//a在模m意义下的逆元（费马小定理，m为质数），即a^(m-2)  
{  
 return ModQpow(a,m-2,m);  
}  
long long exgcd(long long a,long long b,long long &x,long long &y)//扩展欧几里得  
{  
 if(b==0)  
 {  
 x=1;y=0;  
 return a;  
 }  
 long long d=exgcd(b,a%b,x,y),t=x;  
 x=y;y=t-a/b\*y;  
 return d;  
}  
long long invMod2(int a,int m)//a在模m意义下的逆元（扩展欧几里得）  
{  
 long long x,y;  
 exgcd(a,m,x,y);  
 return (x%m+m)%m;  
}  
int main()  
{  
 int T\_start=clock();  
   
 return 0;  
}

**矩阵快速幂**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
#include <numeric>  
using namespace std;  
#define int long long  
const int mod=1e9+7;  
class MaTQpow{  
 public:  
 vector<vector<int>> mat;  
 int \_mod;  
 MaTQpow(vector<vector<int>> \_mat,int mod):mat(\_mat),\_mod(mod){}  
 MaTQpow(int n,int mod):\_mod(mod)  
 {  
 mat.resize(n,vector<int>(n,0));  
 for(int i=0;i<n;i++) mat[i][i]=1;  
 \_mod=mod;  
 }  
 MaTQpow operator\*(const MaTQpow& other)const{  
 vector<vector<int>> res(mat.size(),vector<int>(other.mat[0].size(),0));  
 for(int i=0;i<mat.size();i++)  
 {  
 for(int j=0;j<other.mat[0].size();j++)  
 {  
 for(int k=0;k<other.mat.size();k++)  
 {  
 res[i][j]=(res[i][j]+mat[i][k]\*other.mat[k][j]&\_mod)%\_mod;  
 }  
 }  
 }  
 return MaTQpow(res,\_mod);  
 }  
 MaTQpow Qpow(int n){  
 MaTQpow res(mat.size(),\_mod);  
 MaTQpow base(mat,\_mod);  
 while(n)  
 {  
 if(n&1) res=res\*base;  
 base=base\*base;  
 n>>=1;  
 }  
 return res;  
 }  
 vector<vector<int>> get(int n){  
 return Qpow(n).mat;  
 }  
};  
signed main()  
{  
 int T\_start=clock();  
 //freopen("in.txt","r",stdin);  
 int n;cin>>n;  
 vector<int> a(n+1);  
 for(int i=1;i<=n;i++) cin>>a[i];  
 int c,m,k,t;cin>>c>>m>>k>>t;c%=m;  
 vector<int> dp(m,0);  
 for(int i=1;i<=n;i++)  
 {  
 vector<int> ndp(m,0);  
 ndp[a[i]%m]=1;  
 for(int j=0;j<m;j++)  
 {  
 if(dp[j])  
 {  
 ndp[(j+a[i])%m]=(ndp[(j+a[i])%m]+dp[j])%mod;  
 }  
 }  
 for(int j=0;j<m;j++) dp[j]=(dp[j]+ndp[j])%mod;  
 }  
 vector<vector<int>> p(m,vector<int>(m,0));  
 for(int i=0;i<m;i++)  
 {  
 for(int j=0;j<m;j++)  
 {  
 p[i][(i\*j)%m]=(p[i][(i\*j)%m]+dp[j])%mod;  
 }  
 }  
 MaTQpow mat(p,mod);  
 auto res=mat.Qpow(t);  
 cout<<res.mat[c][k]<<endl;  
 return 0;  
}  
//矩阵快速幂：处理快速形式变换  
//时间复杂度：O(n^3logk)

**整除分块**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#define int long long   
using namespace std;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
struct blocknode{  
 int l;  
 int r;  
 int val;  
};  
//对[l,r]的i,floor(n/i)相等  
//n%i=n-i\*floor(n/i)  
//首项n-l\*val 公差-val 项数r-l+1  
signed main()  
{  
 int T\_start=clock();  
 int n=read(),k=read();  
 vector<blocknode>a;  
 for(int l=1,r;l<=n;l=r+1)  
 {  
 blocknode tp;  
 r=min(n/(n/l),n);  
 tp.l=l;tp.r=r;  
 tp.val=n/l;  
 a.push\_back(tp);  
 }  
 //for(auto i:a)  
 //{  
 //cout<<i.l<<' '<<i.r<<' '<<i.val<<endl;  
 //}  
 return 0;  
}  
//整除分块：处理连续区间内满足条件的元素个数  
//时间复杂度：O(n^(1/2))

**DS**  
**BIT**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
class BIT{  
 private:  
 int n;  
 vector<int> tree;//tree[i] 是[i-lowbit(i)+1,i]的和,[1,n]存储  
 int lowbit(int x){  
 return x&(-x);  
 }  
 public:  
 BIT(int n): n(n),tree(n+1,0){}  
 void update(int i,int val)//单点修改 a[i]+=val  
 {  
 while(i<=n){   
 tree[i]+=val;  
 i+=lowbit(i);//跳到后一个lowbit(x)的位置  
 }  
 }  
 int query(int l,int r)//区间查询 [l,r]的和  
 {  
 int res=0;  
 while(r>=l){  
 res+=tree[r];  
 r-=lowbit(r);//跳到前一个lowbit(x)的位置  
 }  
 return res;  
 }  
 int query\_diff(int i)//单点查询 a\_diff[i] (维护差分数组)=sum[1,i]  
 {  
 return query(1,i);  
 }  
 void update\_diff(int l,int r,int val)//区间修改 (维护差分数组) a\_diff[l]+=val,a\_diff[r+1]-=val  
 {  
 update(l,val);  
 update(r+1,-val);  
 }  
 void init(vector<int> a)//初始化  
 {  
 vector<int> presum(a.size()+1,0);  
 for(int i=1;i<=a.size();i++)  
 {  
 presum[i]=presum[i-1]+a[i-1];  
 tree[i]=presum[i]-presum[i-lowbit(i)];//按定义  
 }   
 }  
};  
int main()  
{  
 int T\_start=clock();  
 //test  
 int n=10; vector<int> a={1,3,2,4,2,1,5,4,3,2},a\_diff={1,2,-1,2,-2,-1,4,-1,-1,-1};//a\_diff[i]=a[i]-a[i-1]  
 BIT bit(n),bit\_diff(n);  
 bit.init(a);bit\_diff.init(a\_diff);  
 cout<<bit.query(1,5)<<endl;  
 bit.update(1,5);  
 cout<<bit.query(1,5)<<endl;  
 bit\_diff.update\_diff(1,5,2);  
 cout<<bit\_diff.query\_diff(5)<<endl;  
 cout<<bit\_diff.query\_diff(6)<<endl;  
 //test end  
 return 0;  
}  
//进阶用法1.维护差分数组  
//进阶用法2.把数组离散化后按照值域建树状数组，可以用来求逆序对(第K大)  
//e.g.val[1,16,9,10,3]->dis[1,5,3,4,2]->bit[1,1,1,1,1]  
// BIT bit(5);  
// //bit.update(1,1);bit.update(2,1);bit.update(3,1);bit.update(4,1);bit.update(5,1);  
// val\_i[1,3]即更新为[1,0,1,0,1] 9即为第2大 即bit.query(1,3)=2  
//求逆序对，how to do? 即[1,r]中比a[r]大的数的个数

**st表**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class st{  
 public:  
 vector<vector<int>> dp;//dp[i][j]是[i,i+2^j-1]的min/max  
 int inf(int a,int b)  
 {  
 return max(a,b);  
 }  
 void init(vector<int>& nums,int siz)  
 {  
 int len=log2(siz)+1;  
 dp.resize(siz);  
 for(auto &i:dp) i.resize(len);  
 for(int i=0;i<siz;i++)  
 {  
 dp[i][0]=nums[i];  
 }  
 for(int j=1;j<=len;j++)  
 {  
 for(int i=0;i+(1<<j)-1<siz;i++)  
 {  
 dp[i][j]=inf(dp[i][j-1],dp[i+(1<<(j-1))][j-1]);  
 }  
 }  
 }  
 int query(int l,int r)  
 {  
 int k=log2(r-l+1);  
 return inf(dp[l][k],dp[r-(1<<k)+1][k]);  
 }  
 st(vector<int>& nums){  
 init(nums,nums.size());  
 }  
};  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read();  
 vector<int> nums(n);  
 for(int i=0;i<n;i++)  
 {  
 nums[i]=read();  
 }  
 st s(nums);  
 for(int i=0;i<m;i++)  
 {  
 int l=read(),r=read();  
 write(s.query(l-1,r-1));  
 putchar('\n');  
 }  
 return 0;  
}

**并查集**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class DSU{  
 public:  
 int n;vector<int> fa;  
 DSU(int n):n(n)  
 {  
 srand(time(NULL));  
 fa.resize(n+1);  
 for(int i=1;i<=n;i++)  
 {  
 fa[i]=i;  
 }  
 }  
 int find(int u){  
 return fa[u]==u?u:fa[u]=find(fa[u]);  
 }  
 void merge(int a,int b)  
 {  
 int op=rand()%2;  
 if(op==0) fa[find(a)]=find(b);  
 else fa[find(b)]=find(a);  
 }  
};  
int main()  
{  
 int T\_start=clock();  
 srand(time(NULL));  
 return 0;  
}

**FHQTreap**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class FHQTreap{  
 //无旋Treap：1.满足二叉搜索树性质(val) 2.满足堆性质（优先级）  
 //树堆：BST+Heap  
 public:  
 struct Node{  
 int val;  
 int size=0;  
 int priority;//随机数  
 Node \*left, \*right;  
 Node(int val):val(val),priority(rand()),left(NULL),right(NULL),size(1){}  
 Node(int val,int priority):val(val),priority(priority),left(NULL),right(NULL),size(1){}  
 };  
 bool cmp(Node a,Node b){  
 return a.val<b.val;  
 }  
 Node \*root;  
 FHQTreap():root(NULL){}  
 void merge(Node \*&root,Node \*a,Node \*b){  
 //val a<=val b(内部满足Treap)  
 if(!a)root=b;  
 else if(!b)root=a;  
 else{  
 if(a->priority>b->priority){//a的优先级大  
 root=a;//a作为根(为了满足Heap(大))  
 merge(a->right,a->right,b);//b合并到a的右子树（为了满足BST：a的右子树的所有节点都大于a)  
 }  
 else{  
 root=b;  
 merge(b->left,a,b->left);  
 }  
 }  
 if(root)  
 {  
 root->size=1;  
 if(root->left)root->size+=root->left->size;  
 if(root->right)root->size+=root->right->size;  
 //cout<<root->val<<' '<<root->size<<endl;  
 }  
 }  
 void split(Node \*root,Node \*&a,Node \*&b,int val){  
 //将root按照val分割为a,b两部分  
 //a的val都小于等于val，b的val都大于val  
 if(!root){  
 a=b=NULL;  
 return;  
 }  
 if(root->val<=val){  
 a=root;  
 split(root->right,a->right,b,val);  
 }  
 else{  
 b=root;  
 split(root->left,a,b->left,val);  
 }  
 if(root)  
 {  
 root->size=1;  
 if(root->left)root->size+=root->left->size;  
 if(root->right)root->size+=root->right->size;  
 //cout<<root->val<<' '<<root->size<<endl;  
 }  
 }  
 void insert(int val){  
 Node \*a,\*b;  
 split(root,a,b,val);//将root按照val分割为a,b两部分  
 merge(a,a,new Node(val));//将val插入到a中  
 merge(root,a,b);//将a,b合并为root  
 //偶还能这样  
 }  
 void erase(int val){  
 Node \*a,\*b,\*c;  
 split(root,a,b,val);//将root按照val分割为a,b两部分  
 split(a,a,c,val-1);//将a按照val-1分割为a,c两部分  
 if(c)  
 {  
 merge(a,a,c->right);//将c的右子树合并到a中(删除一个节点)  
 merge(a,a,c->left);//将c的左子树合并到a中(删除一个节点)  
 }  
 merge(root,a,b);//将a,b合并为root  
 }  
 void print(Node \*root){  
 if(!root)return;  
 print(root->left);  
 cout<<root->val<<" ";  
 print(root->right);  
 }  
 int findMax(Node \*root){  
 if(!root)return -1;  
 while(root->right)root=root->right;  
 return root->val;  
 }  
 int findMin(Node \*root){  
 if(!root)return -1;  
 while(root->left)root=root->left;  
 return root->val;  
 }  
 int pre(int val){  
 Node \*a,\*b;  
 split(root,a,b,val-1);//将root按照val-1分割为a,b两部分  
 int res=findMax(a);  
 merge(root,a,b);  
 return res;  
 }  
 int next(int val){  
 Node \*a,\*b;  
 split(root,a,b,val);//将root按照val分割为a,b两部分  
 int res=findMin(b);  
 merge(root,a,b);  
 return res;  
 }  
 int rank(int val){  
 Node \*a,\*b;  
 split(root,a,b,val-1);//将root按照val-1分割为a,b两部分  
 int res=(a?a->size:0)+1;  
 merge(root,a,b);  
 return res;  
 }  
 int QueryKth(int k){  
 return KthQuery(root,k);  
 }  
 int KthQuery(Node\* root,int k){  
 if(root==nullptr) return -1;  
 int leftsize=root->left?root->left->size:0;  
 if(k<=leftsize) return KthQuery(root->left,k);  
 else if(k==leftsize+1) return root->val;  
 else return KthQuery(root->right,k-leftsize-1);  
 }  
 bool find(int val){  
 Node \*a,\*b;  
 split(root,a,b,val);//将root按照val分割为a,b两部分  
 bool res=a&&findMax(a)==val;  
 merge(root,a,b);  
 return res;  
 }  
   
};  
int main()  
{  
 int T\_start=clock();  
 FHQTreap treap;  
 vector<int> test={1,2,3,4,5,6,7,8,9,10};  
 /\*for(int i=0;i<test.size();i++){  
 treap.insert(test[i]);  
 }  
 treap.print(treap.root);  
 cout<<endl;  
 treap.erase(5);  
 treap.print(treap.root);  
 cout<<endl;  
 treap.insert(5);  
 treap.insert(5);  
 treap.insert(5);  
 treap.insert(5);  
 treap.print(treap.root);  
 cout<<endl;  
 treap.erase(5);  
 treap.print(treap.root);  
 cout<<endl;\*/  
 cout<<treap.pre(5)<<endl;  
 cout<<treap.next(5)<<endl;  
 cout<<treap.rank(5)<<endl;  
 treap.erase(5);  
 treap.print(treap.root);  
 cout<<endl;  
 treap.insert(5);  
 treap.insert(5);  
 treap.insert(5);  
 treap.print(treap.root);  
 cout<<endl;  
 cout<<treap.rank(6)<<endl;  
 treap.erase(5);  
 treap.print(treap.root);  
 cout<<endl;  
 cout<<treap.rank(8)<<endl;  
 cout<<treap.QueryKth(7)<<endl;  
 return 0;  
}

**01trie**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class O1Tire{  
 public:  
 struct node  
 {  
 node\* ch[2];  
 int cnt;  
 node():ch{nullptr,nullptr},cnt(0){}  
 };  
 node\* root;  
 O1Tire():root(new node){}  
 void set(int x,int t)//从高到低建树  
 {  
 node\* p=root;  
 for(int i=31;i>=0;i--)  
 {  
 int d=(x>>i)&1;  
 if(!p->ch[d])  
 p->ch[d]=new node();  
 p->ch[d]->cnt+=t;  
 p=p->ch[d];  
 }  
 }  
 int findMax(int x)//从高到低找,贪心选择,求解x对tire中所有数的最大异或值  
 {  
 node\* p=root;  
 int res=0;  
 for(int i=31;i>=0;i--)  
 {  
 int d=(x>>i)&1;  
 if(p->ch[d^1]&&p->ch[d^1]->cnt)  
 p=p->ch[d^1],res+=(1<<i);  
 else  
 p=p->ch[d];  
 if(!p)  
 return res;  
 }  
 return res;  
 }  
   
};  
int main()  
{  
 int T\_start=clock();  
 int t;cin>>t;  
 while(t--)  
 {  
 int n,k;cin>>n>>k;  
 vector<int> a(n);  
 for(int i=0;i<n;i++)  
 cin>>a[i];  
 O1Tire tire;  
 int ans=0xfffffff;  
 for(int i=0,j=0;i<n;i++)  
 {  
 tire.set(a[i],1);  
 while(j<=i&&tire.findMax(a[i])>=k)  
 {  
 ans=min(ans,i-j+1);  
 tire.set(a[j],-1);  
 j++;  
 }  
 }  
 if(ans==0xfffffff) cout<<-1<<endl;  
 else cout<<ans<<endl;  
 }  
 return 0;  
}

**线段树**  
**case1:sum**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class SegTree{  
 public:  
 struct Node  
 {  
 int sum;  
 int s,e;  
 int lazy=0;  
 Node\* lt;  
 Node\* rt;  
 Node(int sum,int s,int e):s(s),e(e),sum(sum),lt(nullptr),rt(nullptr){}  
 };  
 Node\* root;  
 Node\* buildtree(vector<int> &nums,int l,int r)  
 {  
 if(l>r) return nullptr;  
 if(l==r) return new Node(nums[l],l,l);  
 int mid=(l+r)>>1;  
 Node\* root=new Node(0,l,r);  
 Node\* lc=buildtree(nums,l,mid);  
 Node\* rc=buildtree(nums,mid+1,r);  
 if(lc) root->lt=lc,root->sum+=lc->sum;  
 if(rc) root->rt=rc,root->sum+=rc->sum;  
 return root;  
 }  
 void init(vector<int>nums)  
 {  
 root=buildtree(nums,0,nums.size()-1);  
 return;  
 }  
 void taglazy(Node\* root,int val)  
 {  
 if(root==nullptr) return;  
 root->lazy+=val;  
 root->sum+=(root->e-root->s+1)\*val;  
 }  
 void pushdown(Node\* root)  
 {  
 if(!root) return ;  
 if(root->lazy)  
 {  
 taglazy(root->lt,root->lazy);  
 taglazy(root->rt,root->lazy);  
 root->lazy=0;  
 }  
 }  
 void update(Node\* root,int l,int r,int val)  
 {  
 if(!root) return ;  
 if(root->s>r||root->e<l) return ;  
 if(root->s>=l&&root->e<=r)  
 {  
 taglazy(root,val);  
 return;  
 }  
 pushdown(root);  
 update(root->lt,l,r,val);  
 update(root->rt,l,r,val);  
 root->sum=((root->lt?root->lt->sum:0)+(root->rt?root->rt->sum:0));  
 return ;  
 }  
 void update(int l,int r,int val)  
 {  
 update(root,l,r,val);  
 return ;  
 }  
 int query(Node\* root,int l,int r)  
 {  
 pushdown(root);  
 if(!root) return 0;  
 if(root->s>r||root->e<l) return 0;  
 if(root->s>=l&&root->e<=r) return root->sum;  
 return query(root->lt,l,r)+query(root->rt,l,r);  
 }  
 int query(int l,int r)  
 {  
 return query(root,l,r);  
 }  
};  
int main()  
{  
   
 return 0;  
}

**case2:max/min**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class SegTree{  
 public:  
 pair<int,int> error={-0x3f3f3f3f,0x3f3f3f3f};  
 struct Node{  
 int start;int end;  
 int high;int low;  
 int lazy=0;  
 Node\* left;  
 Node\* right;  
 Node(int start,int end,int high,int low)  
 :start(start),end(end),high(high),  
 low(low),left(nullptr),right(nullptr){}  
 };  
 Node\* root;  
 Node\* Build(vector<int>& nums,int start,int end)  
 {  
 if(start>end) return nullptr;  
 if(start==end) return new Node(start,end,nums[start],nums[start]);  
 int mid=(start+end)>>1;  
 Node\* root=new Node(start,end,-0x3f3f3f3f,0x3f3f3f3f);  
 Node\* leftchild=Build(nums,start,mid);  
 Node\* rightchild=Build(nums,mid+1,end);  
 if(leftchild)   
 {  
 root->left=leftchild;  
 root->high=max(root->high,leftchild->high);  
 root->low=min(root->low,leftchild->low);  
 }  
 if(rightchild)  
 {  
 root->right=rightchild;  
 root->high=max(root->high,rightchild->high);  
 root->low=min(root->low,rightchild->low);  
 }  
 return root;  
 }  
 void init(vector<int>& nums)  
 {  
 root=Build(nums,0,nums.size()-1);  
 return ;  
 }  
   
 void taglazy(Node\* root,int val)  
 {  
 if(root==nullptr) return ;  
 root->low+=val,root->high+=val;  
 root->lazy+=val;  
 }  
 void pushdown(Node\* root)  
 {  
 if(root==nullptr) return ;  
 if(root->lazy!=0)  
 {  
 taglazy(root->left,root->lazy);  
 taglazy(root->right,root->lazy);  
 root->lazy=0;  
 }  
 }  
 void update(Node\* root,int l,int r,int val)  
 {  
 if(root==nullptr) return;  
 if(root->end<l||root->start>r) return ;  
 if(root->start>=l&&root->end<=r)   
 {  
 taglazy(root,val);  
 return;  
 }  
 pushdown(root);  
 update(root->left,l,r,val);  
 update(root->right,l,r,val);  
 if(root->left)   
 {  
 root->high=max(root->left->high,root->high);  
 root->low=min(root->left->low,root->low);  
 }  
 if(root->right)  
 {  
 root->high=max(root->right->high,root->high);  
 root->low=min(root->right->low,root->low);  
 }  
 return ;  
 }  
 void update(int l,int r,int val) {update(root,l,r,val);}  
 pair<int,int> query(Node\* root,int l,int r)  
 {  
 pushdown(root);  
 if(root==nullptr) return error;  
 if(root->end<l||root->start>r) return error;  
 if(root->start>=l&&root->end<=r) return {root->high,root->low};  
 int tpmax=-0x3f3f3f3f,tpmin=0x3f3f3f3f;  
 if(root->left)   
 {  
 pair<int,int> tp1=query(root->left,l,r);  
 tpmax=max(tp1.first,tpmax);  
 tpmin=min(tp1.second,tpmin);  
 }  
 if(root->right)  
 {  
 pair<int,int> tp2=query(root->right,l,r);  
 tpmax=max(tp2.first,tpmax);  
 tpmin=min(tp2.second,tpmin);  
 }  
 return {tpmax,tpmin};  
 }  
 pair<int,int> query(int l,int r) {return query(root,l,r);}  
};  
int main()  
{  
   
 return 0;  
}

**case3:sum+upd+set**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
#define int long long  
using namespace std;  
class segtree{  
 public:  
 struct node  
 {  
 int sum;  
 int s;int e;  
 node\* lt;  
 node\* rt;  
 int lazysum=0;  
 int lazycover=0;  
 node(int sum,int s,int e):   
 sum(sum),s(s),e(e),lt(nullptr),  
 rt(nullptr),lazycover(0),lazysum(0){}  
 };  
 node\* root;  
 node\* build(vector<int>& nums,int l,int r)  
 {  
 if(l>r) return nullptr;  
 if(l==r) return new node(nums[l],l,l);  
 int mid=(l+r)>>1;  
 node\* root=new node(0,l,r);  
 node\* lc=build(nums,l,mid);  
 node\* rc=build(nums,mid+1,r);  
 root->lt=lc,root->rt=rc;  
 root->sum=(lc?lc->sum:0)+(rc?rc->sum:0);  
 return root;  
 }  
 void init(vector<int>& nums) {root=build(nums,0,nums.size()-1);}  
 void taglazy(node\* root,int val,int op){  
 //1:sum,2:cover  
 if(!root) return;  
 if(op==1)  
 {  
 root->lazysum+=val;  
 root->sum+=(val)\*(root->e-root->s+1);  
 }  
 else if(op==2)  
 {  
 root->lazycover=val;  
 root->lazysum=0;  
 root->sum=val\*(root->e-root->s+1);  
 }  
 }  
 void pushdown(node\* root)  
 {  
 if(root->lazycover){  
 taglazy(root->lt,root->lazycover,2);  
 taglazy(root->rt,root->lazycover,2);  
 root->lazycover=0;  
 }  
 if(root->lazysum){  
 taglazy(root->lt,root->lazysum,1);  
 taglazy(root->rt,root->lazysum,1);  
 root->lazysum=0;  
 }  
 }  
 int query(node\* root,int l,int r)  
 {  
 pushdown(root);  
 if(!root) return 0;  
 if(root->s>r||root->e<l) return 0;  
 if(root->s>=l&&root->e<=r) return root->sum;  
 return query(root->lt,l,r)+query(root->rt,l,r);  
 }  
 int query(int l,int r) {return query(root,l,r);}  
 void update(node\* root,int l,int r,int val,int op)  
 {  
   
 if(!root) return ;  
 if(root->s>r||root->e<l) return ;  
 if(root->s>=l&&root->e<=r)   
 {  
 taglazy(root,val,op);  
 return ;  
 }  
 pushdown(root);  
 update(root->lt,l,r,val,op);  
 update(root->rt,l,r,val,op);  
 root->sum=(root->lt?root->lt->sum:0)+(root->rt?root->rt->sum:0);  
 return ;  
 }  
 void update(int l,int r,int val,int op){  
 update(root,l,r,val,op);  
 }  
  
};  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
signed main()  
{  
   
 return 0;  
}

**case4:max/min+upd+set**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
#define int long long  
class segtree{  
 public:  
 const int H=-0xfffffffffffffff;   
 const int L=0xfffffffffffffff;  
 pair<int,int> error={H,L};  
 struct node{  
 int s;int e;  
 int lazyadd;  
 int lazycover;  
 int lazycoveradd;  
 int high,low;  
 node\* lt;  
 node\* rt;  
 node(int s,int e,int high,int low):  
 s(s),e(e),lazyadd(0),lazycover(0),  
 high(high),low(low),lazycoveradd(-1),  
 lt(nullptr),rt(nullptr){}  
 };  
 node\* root;  
 void inf(node\* a,node\* l,node\* r)  
 {  
 if(!a) return ;  
 if(!l&&r) a->low=r->low,a->high=r->high;  
 if(l&&!r) a->low=l->low,a->high=l->high;  
 if(l&&r) a->low=min(l->low,r->low),a->high=max(l->high,r->high);  
 }  
 node\* build(vector<int> &nums,int l,int r)  
 {  
 if(l>r) return nullptr;  
 if(l==r) return new node(l,r,nums[l],nums[l]);  
 int mid=(l+r)>>1;  
 node\* root=new node(l,r,H,L);  
 node\* lc=build(nums,l,mid);  
 node\* rc=build(nums,mid+1,r);  
 root->lt=lc,root->rt=rc;  
 inf(root,lc,rc);  
 return root;  
 }  
 void init(vector<int> &nums){root=build(nums,0,nums.size()-1);}  
 void taglazy(node\* root,int val,int op)  
 {  
 //op 1 add,2 cover  
 if(!root) return ;  
 if(op==1)  
 {  
 root->lazyadd+=val;  
 root->high+=val;  
 root->low+=val;  
 }  
 if(op==2)  
 {  
 root->lazycover=val;  
 root->lazycoveradd=1;  
 root->high=val;  
 root->low=val;  
 root->lazyadd=0;  
 }  
 }  
 void pushdown(node\* root)  
 {  
 if(!root) return ;  
 if(root->lazycoveradd==1)  
 {  
 taglazy(root->lt,root->lazycover,2);  
 taglazy(root->rt,root->lazycover,2);  
 root->lazycover=0;  
 root->lazycoveradd=-1;  
 }  
 if(root->lazyadd)  
 {  
 taglazy(root->lt,root->lazyadd,1);  
 taglazy(root->rt,root->lazyadd,1);  
 root->lazyadd=0;  
 }  
 }  
 pair<int,int> query(node\* root,int l,int r)  
 {  
 pushdown(root);  
 if(!root) return error;  
 if(root->s>r||root->e<l) return error;  
 if(l<=root->s&&root->e<=r)   
 {  
 //cout<<"query:"<<root->s<<' '<<root->e<<' '<<root->high<<' '<<root->low<<endl;  
 return {root->high,root->low};  
 }  
 pair<int,int> tplt=query(root->lt,l,r);  
 pair<int,int> tprt=query(root->rt,l,r);  
 int anshigh=max(tplt.first,tprt.first);  
 int anslow=min(tplt.second,tprt.second);  
 return {anshigh,anslow};  
 }  
 pair<int,int> query(int l,int r) {return query(root,l,r);}  
 void update(node\* root,int l,int r,int val,int op)  
 {  
 if(!root) return ;  
 if(root->s>r||root->e<l) return ;  
 if(l<=root->s&&root->e<=r)  
 {  
 //cout<<"taglazy:"<<root->s<<' '<<root->e<<' '<<val<<' '<<op<<endl;  
 taglazy(root,val,op);  
 return;  
 }  
 pushdown(root);  
 update(root->lt,l,r,val,op);  
 update(root->rt,l,r,val,op);  
 inf(root,root->lt,root->rt);  
 return ;  
 }  
 void update(int l,int r,int val,int op){  
 update(root,l,r,val,op);  
 }  
  
};  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
signed main()  
{  
 int T\_start=clock();  
 //freopen("in.txt","r",stdin);  
 //freopen("out.txt","w",stdout);  
 int n=read(),m=read();  
 vector<int>a(n);  
 for(auto&i:a) i=read();  
 segtree st;st.init(a);  
 while(m--)  
 {  
 int op=read(),l=read(),r=read();  
 if(op==1)  
 {  
 int x=read();  
 st.update(l-1,r-1,x,2);  
 }  
 else if(op==2)  
 {  
 int x=read();  
 st.update(l-1,r-1,x,1);  
 }  
 else printf("%lld\n",st.query(l-1,r-1).first);  
 // for(int i=0;i<n;i++)  
 // {  
 // cout<<st.query(i,i).first<<' ';  
 // }  
 // cout<<endl;  
 }   
 return 0;  
}

**笛卡尔树**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
struct DKRTreeNode{  
 int val;  
 int index;  
 DKRTreeNode \*left, \*right;  
 DKRTreeNode(int x,int i):val(x),index(i),left(NULL),right(NULL){}  
};  
//笛卡尔树具有一下性质：  
//1.二叉搜索树，2.堆  
//i:index,val:nums[i]  
//因为BST的中序遍历一定是原序列，所以新插入的节点一定在右边  
//需要调整最右边的纵向位置，使其满足堆的性质，用单调栈维护最右链  
//大根堆  
DKRTreeNode\* buildTree(vector<int> &nums){  
 stack<DKRTreeNode\*> s;  
 DKRTreeNode\* root=nullptr;  
 for(int i=0;i<nums.size();i++)  
 {  
 DKRTreeNode\* node=new DKRTreeNode(nums[i],i);  
 DKRTreeNode\* last=nullptr;  
 while(!s.empty()&&s.top()->val<node->val)  
 {  
 last=s.top();  
 s.pop();  
 }//单调栈维护  
 if(!s.empty()) s.top()->right=node;//栈顶元素的右子树为node  
 if(last) node->left=last;//栈弹出的元素为node的左子树  
 s.push(node);  
 }  
 while(!s.empty()) root=s.top(),s.pop();//最后一个元素为根节点  
 return root;  
}  
void printTree(DKRTreeNode\* root)  
{  
 if(root==nullptr) return;  
 printTree(root->left);  
 cout<<root->val<<" ";  
 printTree(root->right);  
}  
int main()  
{  
 int T\_start=clock();  
 vector<int> nums(10,0);  
 for(int i=0;i<nums.size();i++) nums[i]=rand()%100;  
 for(auto i:nums) cout<<i<<" ";  
 cout<<endl;  
 DKRTreeNode\* root=buildTree(nums);  
 printTree(root);  
 cout<<root->val<<endl;  
 return 0;  
}

**堆**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class Heap{//小根堆  
 public:  
 struct node{  
 int val;  
 };  
 vector<node> heap;  
 int n,size=0;  
 Heap(int n):n(n){  
 heap.resize(n+1);  
 }  
 bool cmp(node a,node b){//自定义比较函数  
 return a.val<b.val;  
 }  
 //1...n的完全二叉树,i的父亲为i/2,i的左孩子为2i,右孩子为2i+1  
 void push(int val){  
 heap[++size].val=val;  
 int i=size;  
 while(i>1&&cmp(heap[i],heap[i/2])){  
 swap(heap[i],heap[i/2]);  
 i/=2;//向上调整  
 }  
 }  
 void pop(){  
 heap[1]=heap[size--];//将最后一个元素放到第一个位置  
 int i=1;  
 while(i\*2<=size){  
 int j=i\*2;  
 if(j<size&&cmp(heap[j+1],heap[j])) j++;//找到左右孩子中较大的一个  
 if(cmp(heap[i],heap[j])) break;//如果父亲节点比孩子节点大,则不需要调整  
 swap(heap[i],heap[j]);  
 i=j;  
 }//向下调整  
 }  
 int top(){  
 return heap[1].val;  
 }  
   
};  
int main()  
{  
 int T\_start=clock();  
 int n;  
 cin>>n;  
 Heap h(n);  
 for(int i=0;i<n;i++){  
 int x;  
 cin>>x;  
 h.push(x);  
 }  
 while(h.size>1){  
 cout<<h.top()<<" ";  
 h.pop();  
 }  
 return 0;  
}

**莫队**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <unordered\_map>  
#include <array>  
using namespace std;  
class BIT{  
 private:  
 int n;  
 vector<int> tree;//tree[i] 是[i-lowbit(i)+1,i]的和,[1,n]存储  
 int lowbit(int x){  
 return x&(-x);  
 }  
 public:  
 BIT(int n): n(n),tree(n+1,0){}  
 void update(int i,int val)//单点修改 a[i]+=val  
 {  
 while(i<=n){   
 tree[i]+=val;  
 i+=lowbit(i);//跳到后一个lowbit(x)的位置  
 }  
 }  
 int query(int l,int r)//区间查询 [l,r]的和  
 {  
 int res=0;  
 while(r>=l){  
 res+=tree[r];  
 r-=lowbit(r);//跳到前一个lowbit(x)的位置  
 }  
 return res;  
 }  
 void init(vector<int> a)//初始化  
 {  
 vector<int> presum(a.size()+1,0);  
 for(int i=1;i<=a.size();i++)  
 {  
 presum[i]=presum[i-1]+a[i-1];  
 tree[i]=presum[i]-presum[i-lowbit(i)];//按定义  
 }   
 }  
};  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
unordered\_map<int,int> dis(vector<int> a)  
{  
 sort(a.begin(),a.end());  
 unordered\_map<int,int> mp;  
 for(int i=0;i<a.size();i++)  
 {  
 mp[a[i]]=i+1;  
 }  
 return mp;  
}  
int main()  
{  
 int t=read();  
 while(t--)  
 {  
 int n=read(),m=read();  
 vector<int> a(n+1);  
 for(int i=1;i<=n;i++)  
 {  
 a[i]=read();  
 }  
 vector<array<int,4>> q(m);  
 for(int i=0;i<m;i++)  
 {  
 q[i][0]=read();  
 q[i][1]=read();  
 q[i][2]=read();  
 q[i][3]=i;  
 }  
 int block=static\_cast<int>(sqrt(n))+1;//按值域分块  
 auto cmp=[block](array<int,4> a,array<int,4> b)  
 {  
 if(a[0]/block!=b[0]/block) return a[0]/block<b[0]/block;//按块排序  
 else{  
 if(a[0]/block%2==0) return a[1]<b[1];//按值排序  
 else return a[1]>b[1];//按块排序  
 }  
 };  
 sort(q.begin(),q.end(),cmp);  
 vector<int> ans(m,0);  
 int l=1,r=0;  
 BIT bit(n+1);  
 for(auto [ql,qr,x,idx]:q)//暴力  
 {  
 while(r<qr) bit.update(a[++r],1);  
 while(l>ql) bit.update(a[--l],1);  
 while(r>qr) bit.update(a[r--],-1);  
 while(l<ql) bit.update(a[l++],-1);  
 //cout<<l<<" "<<r<<endl;  
 ans[idx]=bit.query(1,a[x])+l-1;  
 }  
 for(auto i:ans) write(i),putchar('\n');  
 }  
 return 0;  
}

**图论**

**拓扑排序**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
#define MOD 80112002  
vector<int> edge[5005];  
int \_to[5005]={0},\_in[5005]={0};  
long long ans[5005]={0};queue<int> q;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read();  
 for(int i=0;i<m;i++)  
 {  
 int u=read(),v=read();  
 edge[v].push\_back(u);  
 \_to[u]++;\_in[v]++;  
 }  
 for(int i=1;i<=n;i++)  
 {  
 if(!\_to[i])   
 {  
 q.push(i);  
 ans[i]=1;  
 }  
 }  
 while(!q.empty())  
 {  
 int temp=q.front();  
 //cout<<temp<<endl;  
 q.pop();  
 for(int i=0;i<edge[temp].size();i++)  
 {  
 //cout<<temp<<' '<<edge[temp][i]<<' '<<ans[temp]<<' '<<ans[edge[temp][i]]<<endl;  
 ans[edge[temp][i]]=(ans[edge[temp][i]]+ans[temp])%MOD;  
 \_to[edge[temp][i]]--;  
 if(!\_to[edge[temp][i]]) q.push(edge[temp][i]);  
 }  
 }  
 long long res=0;  
 for(int i=1;i<=n;i++)  
 {  
 if(!\_in[i])   
 {  
 //cout<<i<<' '<<ans[i]<<endl;  
 res=(res+ans[i])%MOD;  
 }  
 }  
 write(res),putchar('\n');  
 return 0;  
}

**dfs/bfs**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
vector <int> edge[100000+5];  
queue <int> q;int vis[100000+5]={0},sum=0;  
int ans[100000+5];  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
void dfs(int x)  
{  
 write(x);putchar(' ');vis[x]=1;  
 for(int i=0;i<edge[x].size();i++)  
 {  
 if(!vis[edge[x][i]]) dfs(edge[x][i]);  
 }  
 return ;  
}  
int bfs(int x)  
{  
 q.push(x);  
 while(!q.empty())  
 {  
 int temp=q.front(); q.pop();  
 if(vis[temp]) continue;  
 else{  
 vis[temp]=1;sum++;  
 }  
 for(int i=0;i<edge[temp].size();i++)  
 {  
 q.push(edge[temp][i]);  
 if(!vis[edge[temp][i]]) ans[edge[temp][i]]=ans[temp];  
 }  
 // cout<<q.size()<<endl;  
 // for(int i=0;i<=q.size();i++)  
 // {  
 // cout<<q.front()<<" ";  
 // q.pop();  
 // }  
 }  
 return sum;  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read();  
 for(int i=0;i<m;i++)  
 {  
 int u=read(),v=read();  
 edge[v].push\_back(u);  
 }  
 for(int i=1;i<=n;i++)  
 {  
 ans[i]=i;  
 }  
 for(int i=n;i>=1;i--)  
 {  
 bfs(i);  
 if(sum==n) break;  
 }  
 for(int i=1;i<=n;i++)  
 {  
 write(ans[i]);putchar(' ');  
 }  
 putchar('\n');  
 return 0;  
}  
//preview:2024.12.29 23:01

**最短路（dijkstra）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
vector<int> dijkstra(int n,vector<vector<pair<int,int>>>mp,int s)  
{  
 vector<int> dis(n+1,0x7fffffff);//初始化距离为无穷大  
 dis[s]=0;//起点到起点的距离为0  
 priority\_queue<pair<int,int>,vector<pair<int,int>>,greater<pair<int,int>>> pq;  
 pq.push({0,s});//将起点加入优先队列  
 while(!pq.empty())  
 {  
 int u=pq.top().second;//取出当前距离最小的点  
 int d=pq.top().first;//取出当前距离最小的点的距离  
 pq.pop();  
 if(d>dis[u]) continue;//u已经被更新过  
 if(mp[u].empty()) continue;  
 for(auto it:mp[u])  
 {  
 int v=it.first;  
 int w=it.second;  
 if(dis[v]>dis[u]+w)//更新s->v的最短距离(min(s->v,s->u->v))  
 {  
 dis[v]=dis[u]+w;  
 pq.push({dis[v],v});  
 }  
 }  
 }  
 //正确性证明：  
 //假设目前更新s->t(=3),假设存在s->u->t(=2),则s->u<s->t,而s->u一定在之前被更新过，所以s->u->t一定在之前被更新过，与假设矛盾。  
 //单源最短路(正边权)  
 //时间复杂度O(ElogV),E为边数,V为点数(二叉堆)  
 //使用斐波那契堆的 Dijkstra 算法的时间复杂度为 O(E+VlogV)。  
 //不用堆优化：O(v^2+E)  
 //当E<<v^2时，使用堆优化  
 //当E~v^2时，不用堆优化  
 return dis;  
}  
int main()  
{  
 int T\_start=clock();  
 //freopen("in.txt","r",stdin);  
 int n=read(),m=read(),s=read();  
 vector<vector<pair<int,int>>> mp(n+1);  
 while(m--)  
 {  
 int u=read(),v=read(),w=read();  
 mp[u].push\_back({v,w});  
 }  
 vector<int> dis=dijkstra(n,mp,s);  
 for(int i=1;i<=n;i++)  
 write(dis[i]),putchar(' ');  
 int T\_end=clock();  
 return 0;  
}

**最短路（spfa）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
vector<int> Bellman\_Ford(vector<vector<pair<int,int>>>& mp,int s,int n)  
{  
 vector<int> dis(n+1,0x7fffffff);  
 dis[s]=0;  
 for(int i=1;i<=n-1;i++)  
 {  
 for(int j=1;j<=n;j++)  
 {  
 for(auto [u,w]:mp[j])  
 {  
 if(dis[j]!=0x7fffffff&&dis[j]+w<dis[u])  
 {  
 dis[u]=dis[j]+w;  
 }  
 }  
 }   
 }  
 for(int j=1;j<=n;j++)  
 {  
 for(auto [u,w]:mp[j])  
 {  
 if(dis[j]!=0x7fffffff&&dis[j]+w<dis[u])  
 {  
 cout<<"negative cycle!"<<endl;  
 }  
 }  
 }  
 return dis;  
 //Bellman\_Ford 对所有的边进行n-1次松弛操作，如果在进行第n次松弛操作时，仍然存在边可以松弛，则说明图中存在负权环（从s点出发存在负权环）  
 //时间复杂度：O(nm),形式上就是暴力）  
 //第i次循环，我们能找到经历i条边到达的点的最短距离  
 //所以第n次循环，我们能找到经历n条边到达的点的最短距离，如果存在负权环，那么一定能在第n次循环找到经历n条边到达的点的最短距离  
}  
vector<int> SPFA(vector<vector<pair<int,int>>>& mp,int s,int n)  
{  
 vector<int> dis(n+1,0x7fffffff);  
 vector<int> vis(n+1,0);  
 vector<int> cnt(n+1,0);  
 dis[s]=0;queue<int> q;  
 q.push(s);vis[s]=1;cnt[s]=0;  
 while(!q.empty())  
 {  
 int u=q.front();  
 q.pop();vis[u]=0;  
 for(auto [v,w]:mp[u])  
 {  
 if(dis[v]>dis[u]+w)//松弛  
 {  
 dis[v]=dis[u]+w;  
 cnt[v]=cnt[u]+1;  
 if(cnt[v]>n-1)//存在负权环  
 {  
 //1-n的节点，最短路最多经过n-1条边，如果经过n条边，说明存在负权环  
 cout<<"negative cycle!"<<endl;  
 return dis;  
 }  
 if(!vis[v])  
 {  
 q.push(v);  
 vis[v]=1;  
 }  
 }  
 }  
 }  
 return dis;  
 //SPFA: 形式上Bellman\_Ford是一棵树，很显然，只有上一次被松弛的节点u，才有可能对v进行松弛，所以可以采用SPFA  
 //为啥只有上一次被松弛的节点u，才有可能对v进行松弛？  
 //手玩一下就好了（悲  
 //考虑简单图，他可以是个递推的过程  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read();  
 vector<vector<pair<int,int>>> mp(n+1);  
 for(int i=0;i<m;i++)  
 {  
 int u=read(),v=read(),w=read();  
 mp[u].push\_back({v,w});  
 }  
 return 0;  
}

**最短路（floyd）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
const int MAXN=1e4;  
int Graph[MAXN][MAXN];  
int dp[MAXN][MAXN];  
int main()  
{  
 int T\_start=clock();  
 int T=10;  
 srand(time(NULL));  
 for(int i=1;i<=T;i++)  
 {  
 for(int j=1;j<=T;j++)  
 {  
 int op=rand()%3;  
 if(false) Graph[i][j]=0;  
 else if(op==1) Graph[i][j]=0x3f3f3f3f;  
 else Graph[i][j]=(rand()\*10+rand())%10;  
 //Graph[i][j]=(rand()\*10+rand())%10;  
 }  
 Graph[i][i]=0;  
 }  
  
   
 for(int i=1;i<=T;i++)  
 {  
 for(int j=1;j<=T;j++)  
 {  
 dp[i][j]=Graph[i][j];  
 }  
 }  
 for(int i=1;i<=T;i++)  
 {  
 for(int j=1;j<=T;j++)  
 {  
 cout<<dp[i][j]<<" ";  
 }  
 cout<<endl;  
 }  
 cout<<endl;  
 for(int i=1;i<=T;i++)  
 {  
 for(int j=1;j<=T;j++)  
 {  
 for(int k=1;k<=T;k++)  
 {  
 dp[j][k]=min(dp[j][k],dp[j][i]+dp[i][k]);  
 }  
 }  
 }  
  
 for(int i=1;i<=T;i++)  
 {  
 for(int j=1;j<=T;j++)  
 {  
 cout<<dp[i][j]<<" ";  
 }  
 cout<<endl;  
 }  
 int T\_end=clock();  
 return 0;  
}  
  
//Floyed 算法  
//处理任意两点之间的最短路径(无负环）  
//时间复杂度O(n^3)

**LCA（最近公共祖先,倍增）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
const int MAXN=5e5+5;  
const int LOG=25;//MAXN<=2^LOG  
vector<int> tree[MAXN];  
int dep[MAXN],st[MAXN][LOG];//节点深度，st表，st[i][j]=i的2^j级祖先  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
void init(int node,int parent)//用dfs预处理dep和st  
{  
 dep[node]=(parent==-1)?0:dep[parent]+1;  
 st[node][0]=parent;//一级祖先为自身  
 for(int i=1;i<LOG;i++)//更新node的祖先表  
 {  
 if(st[node][i-1]!=-1)  
 {  
 st[node][i]=st[st[node][i-1]][i-1];  
 //node的2^j级祖先为node的2^j-1祖先的2^j-1祖先  
 }  
 else st[node][i]=-1;//你的码的码没了，你还有码？（可删吗？）  
 }  
 for(auto child:tree[node])  
 {  
 if(child!=parent)  
 {  
 init(child,node);//从父节点向下dfs  
 }  
 }  
}  
int lca(int u,int v)  
{  
 if(dep[u]<dep[v]) swap(u,v);//确保u比v深  
 int diff=dep[u]-dep[v];  
 for(int i=0;i<LOG;i++)  
 {  
 if((diff>>i)&1)  
 {  
 u=st[u][i];//u向上跳转2^i,其中i为diff的二进制表示中第i位为一  
 }  
 }  
 if(u==v) return u;//深度相等，可能找到  
 //不相等，假设他们与lca(u,v)的距离为diff  
 //注意到5=4+1，5-4=1  
 //7=4+2+1,7-4-2=1  
 //6=4+2,6-4-1=1  
 //12=8+4,12-8-2-1  
 //做以下操作总能使diff=1  
 // for(int i=LOG-1;i>=0;i--)  
 // {  
 // if(st[u][i]!=st[v][i])  
 // {  
 // u=st[u][i];  
 // v=st[v][i];  
 // }  
 // }  
 // return st[u][0];  
 //优化版  
 for(int i=LOG-1;i>=0;i--)  
 {  
 if(st[u][i]!=st[v][i])  
 {  
 u=st[u][i];  
 v=st[v][i];  
 }  
 }  
 return st[u][0];  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read(),s=read();//n个点，n-1条边,m个询问，s为根  
 for(int i=0;i<n-1;i++)  
 {  
 int u=read(),v=read();  
 tree[u].push\_back(v);  
 tree[v].push\_back(u);//存树  
 }  
 for(int i=1;i<=n;i++)  
 {  
 dep[i]=-1;  
 for(int j=0;j<LOG;j++)  
 {  
 st[i][j]=-1;  
 }  
 }  
 init(s,-1);  
 while(m--)  
 {  
 write(lca(read(),read()));  
 putchar('\n');  
 }  
 return 0;  
}

**LCA（最近公共祖先,离线）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <unordered\_map>  
using namespace std;  
const int MaxN=5e5+5;  
vector<int> tree[MaxN];  
vector<pair<int,int>> q[MaxN];  
int vis[MaxN],ans[MaxN];  
int fa[MaxN];  
void prepare\_tree(int n)  
{  
 for(register int i=1;i<=n;i++)  
 {  
 fa[i]=i;  
 }  
}  
int find(int G)  
{  
 if(G==fa[G]) return G;  
 else  
 {  
 fa[G]=find(fa[G]);  
 return fa[G];  
 }  
 //return G==fa[G]? G:(fa[G]=find(fa[G]));  
}  
void merge(int a,int b)//合并  
{  
 fa[find(a)]=find(b);//有时路径压缩可能破坏rank'(rank->树深)  
 /\*register int x=find(a),y=find(b);  
 Rank[x]<=Rank[y]?fa[x]=y:fa[y]=x;  
 if(Rank[x]==Rank[y]&&x!=y) Rank[y]++;\*/  
  
}  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
void dfs(int node)  
{  
 vis[node]=1;  
 for(auto child:tree[node])  
 {  
 if(!vis[child])  
 {  
 dfs(child);  
 fa[child]=node;//调换顺序会使路径压缩到child的父节点，此时子树还没遍历完  
 }  
 }  
 for(auto i:q[node])  
 {  
 if(vis[i.first])//node及其子树已经dfs完了,如果此时i已经搜到，显然，根据dfs原则，find(i)是lca(i,node)  
 {  
 ans[i.second]=find(i.first);  
 }  
 }  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read(),s=read();  
 for(int i=0;i<n-1;i++)  
 {  
 int u=read(),v=read();  
 tree[v].push\_back(u);  
 tree[u].push\_back(v);  
 }  
 for(int i=0;i<m;i++)  
 {  
 int u=read(),v=read();  
 q[v].push\_back(make\_pair(u,i));  
 q[u].push\_back(make\_pair(v,i));  
 }  
 prepare\_tree(n);  
 for(int i=1;i<=n;i++)  
 {  
 vis[i]=0;  
 }  
 dfs(s);  
 for(int i=0;i<m;i++)  
 {  
 write(ans[i]);  
 putchar('\n');  
 }  
 return 0;  
}

**最小生成树（Kruskal）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
class BSU{  
 public:  
 int n;vector<int> fa;  
 BSU(int n):n(n)  
 {  
 fa.resize(n+1);  
 for(int i=1;i<=n;i++)  
 {  
 fa[i]=i;  
 }  
 }  
 int find(int u){  
 return fa[u]==u?u:fa[u]=find(fa[u]);  
 }  
 void merge(int a,int b)  
 {  
 int op=rand()%2;  
 if(op==0) fa[find(a)]=find(b);  
 else fa[find(b)]=find(a);  
 }  
};  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
int kruskal(vector<array<int,3>> &edge,int m,int n)  
{  
 sort(edge.begin(),edge.end(),[](auto a,auto b)->bool{  
 return a[2]<b[2];  
 });  
 BSU bsu(n);int cnt=0;int ans=0;  
 for(auto [u,v,w]:edge)  
 {  
 if(bsu.find(u)!=bsu.find(v))  
 {  
 bsu.merge(u,v);  
 cnt++;ans+=w;  
 //cout<<u<<" "<<v<<endl;  
 }  
 if(cnt==n-1) break;  
 }  
 return cnt==n-1?ans:-1;  
}  
//时间复杂度O(mlogm)，证明同prim  
int main()  
{  
 int T\_start=clock();  
 srand(time(NULL));  
 //freopen("in.txt","r",stdin);  
 int n=read(),m=read();  
 vector<array<int,3>> edge(m);  
 for(int i=0;i<m;i++)  
 {  
 int u=read(),v=read(),w=read();  
 edge[i]={u,v,w};  
 }  
 int ans=kruskal(edge,m,n);  
 if(ans==-1) puts("orz");  
 else cout<<ans<<endl;  
 return 0;  
}

**最小生成树（Prim）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
vector<int> prim(vector<vector<pair<int,int>>> &mp,int s,int n)  
{  
 vector<int> dis(n+1,0x7fffffff);//点离当前生成树的距离  
 vector<int> in(n+1,0);//点是否在生成树中  
 priority\_queue<pair<int,int>,vector<pair<int,int>>,greater<pair<int,int>>> pq;  
 dis[s]=0;pq.push({0,s});  
 while(!pq.empty())  
 {  
 auto [\_,u]=pq.top();//找到最小生成树连的边中未加入生成树的边权最小的边  
 pq.pop();  
 if(in[u]) continue;  
 in[u]=true;//进入最小生成树  
 for(auto [v,w]:mp[u])  
 {  
 if(dis[v]>w&&!in[v])//更新不在当前生成树中的点离生成树的距离  
 {  
 dis[v]=w;  
 pq.push({dis[v],v});  
 }  
 }  
 }  
 return dis;  
}  
//和dij一样，时间复杂度O((n+m)logn),暴力prim时间复杂度O(n^2),看看稀疏图和稠密图哪个更快  
//正确性证明：反证法：假设prim生成的不是最小生成树  
// 1).设prim生成的树为G0  
// 2).假设存在Gmin使得cost(Gmin)<cost(G0) 则在Gmin中存在<u,v>不属于G0  
// 3).将<u,v>加入G0中可得一个环，且<u,v>不是该环的最长边(这是因为<u,v>∈Gmin)  
// 4).这与prim每次生成最短边矛盾  
// 5).故假设不成立，命题得证.  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read();  
 vector<vector<pair<int,int>>> mp(n+1);  
 for(int i=1;i<=m;i++)  
 {  
 int u=read(),v=read(),w=read();  
 mp[u].push\_back({v,w});  
 mp[v].push\_back({u,w});  
 }  
 vector<int> ans=prim(mp,1,n);  
 int sum=0;  
 for(int i=1;i<=n;i++)  
 {  
 if(ans[i]==0x7fffffff)  
 {  
 puts("不连通！");  
 return 0;  
 }  
 sum+=ans[i];  
 }  
 cout<<sum<<endl;  
 return 0;  
}

**强连通分量（SCC）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
pair<vector<int>,int> tarjan(vector<vector<int>> &mp,int n)  
{  
 vector<int> bel(n+1,-1);//bel[i]:i属于哪个强连通分量  
 vector<int> dfn(n+1,-1),low(n+1,-1);  
 stack<int> st;int cnt=0,scc\_cnt=0;  
 auto dfs=[&](auto dfs,int u)->void{  
 dfn[u]=low[u]=++cnt; //时间戳+1  
 st.push(u); //inst[u]=1; //入栈  
 for(int v:mp[u])  
 {  
 if(dfn[v]==-1)//case1:u的邻接点v未被访问过  
 {  
 dfs(dfs,v);  
 low[u]=min(low[u],low[v]);  
 }  
 else if(bel[v]==-1)//v所属的强连通分量还未被确定（等价于case2）  
 {  
 low[u]=min(low[u],dfn[v]);  
 }  
 //case3:u的邻接点v不在栈中,且访问过  
 //说明v已经确定在某个强连通分量中，所以u的low不需要更新  
 }  
 if(dfn[u]==low[u])  
 {  
 scc\_cnt++;  
 while(true)  
 {  
 int v=st.top();  
 st.pop();  
 bel[v]=scc\_cnt;  
 if(v==u) break;  
 }  
 }  
 };  
 //图有可能不是强联通的  
 for(int i=1;i<=n;i++)  
 {  
 if(dfn[i]==-1)  
 {  
 dfs(dfs,i);  
 }  
 }  
 return {bel,scc\_cnt};  
}  
int main()  
{  
 int T\_start=clock();  
 int n,m;cin>>n>>m;  
 vector<vector<int>> mp(n+1);  
 vector<int> val(n+1);  
 for(int i=1;i<=n;i++) cin>>val[i];  
 for(int i=0;i<m;i++)  
 {  
 int u,v;cin>>u>>v;  
 mp[u].push\_back(v);  
 }  
 auto [bel,cnt]=tarjan(mp,n);  
 vector<vector<int>> mp2(cnt+1);  
 vector<int> val2(cnt+1,0);  
 vector<int> in(cnt+1,0);  
 vector<int> dp(cnt+1,0);  
 for(int i=1;i<=n;i++)  
 {  
 val2[bel[i]]+=val[i];  
 }  
 for(int i=1;i<=n;i++)  
 {  
 for(int v:mp[i])  
 {  
 if(bel[i]!=bel[v])  
 {  
 mp2[bel[i]].push\_back(bel[v]);  
 in[bel[v]]++;  
 }  
 }  
 }  
 queue<int> q;  
 for(int i=1;i<=cnt;i++)  
 {  
 if(in[i]==0) q.push(i),dp[i]=val2[i];  
 }  
 while(!q.empty())  
 {  
 int u=q.front();q.pop();  
 for(int v:mp2[u])  
 {  
 dp[v]=max(dp[v],dp[u]+val2[v]);  
 in[v]--;  
 if(in[v]==0) q.push(v);  
 }  
 }  
 cout<<\*max\_element(dp.begin()+1,dp.end())<<endl;  
 return 0;  
}

**点双联通分量（BCC）**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
vector<vector<int>> tarjan(vector<vector<int>> &mp,int n)  
{  
 //点双连通分量：无割点，且任意两点间至少有两条路径  
 vector<int> low(n+1,-1),dfn(n+1,-1);  
 //low:从当前点出发能到达的最早时间戳  
 //dfn:当前点的时间戳  
 vector<vector<int>> bccs;  
 stack<int> st;  
 int cnt=0;  
 auto dfs=[&](auto dfs,int u,int fa)->void{  
 int ch=0; //儿子数  
 dfn[u]=low[u]=++cnt;  
 st.push(u);  
 for(auto v:mp[u])  
 {  
 if(dfn[v]==-1)//case1:未访问  
 {  
 ch++;  
 dfs(dfs,v,u);  
 low[u]=min(low[u],low[v]);//更新low[u]  
 if((fa==-1&&ch>1)||(fa!=-1&&low[v]>=dfn[u]))//是割点,v以及他的被处理过的子树是一个bcc  
 {  
 vector<int> bcc;  
 while(1)  
 {  
 int x=st.top();st.pop();  
 bcc.push\_back(x);  
 if(x==v)break;//处理到v  
 }  
 bcc.push\_back(u);//把割点也加入bcc:割点有可能在多个bcc中  
 bccs.push\_back(bcc);  
 }  
 }  
 else if(v!=fa)//case2:已访问且不是父节点  
 {  
 low[u]=min(low[u],dfn[v]);//更新low[u]  
 }  
 }  
 // if(fa==-1&&ch==0) {  
 // bccs.push\_back({u});  
 // }  
 };  
 for(int i=1;i<=n;i++)  
 {  
 if(dfn[i]==-1)  
 {  
 dfs(dfs,i,-1);  
 //处理剩下的bcc  
 vector<int> bcc;  
 while(!st.empty())  
 {  
 int x=st.top();st.pop();  
 bcc.push\_back(x);  
 }  
 if(!bcc.empty()) bccs.push\_back(bcc);  
 }  
 }  
 return bccs;  
}  
//无向图中割点：删除该点后，图的bcc数增加  
//一个图中割点的判断  
//1.对于某个顶点 u，如果存在至少一个顶点 v（u 的儿子），使得low[v]>=dfn[u] ，即只能回到祖先（到不了dfn更早的点），那么 u 点为割点。  
//2.对于搜索的起始点，如果它的儿子数大于等于 2，那么它就是割点。  
int main()  
{  
 int T\_start=clock();  
 int n,m;cin>>n>>m;  
 vector<vector<int>> mp(n+1);  
 vector<int> val(n+1);  
 for(int i=0;i<m;i++)  
 {  
 int u,v;cin>>u>>v;  
 mp[u].push\_back(v);  
 mp[v].push\_back(u);  
 }  
 vector<vector<int>> bccs=tarjan(mp,n);  
 cout<<bccs.size()<<endl;  
 for(auto bcc: bccs)  
 {  
 cout<<bcc.size()<<' ';  
 for(auto x: bcc)  
 {  
 cout<<x<<" ";  
 }  
 cout<<endl;  
 }  
 return 0;  
}

**边双连通分量**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
vector<vector<int>> tarjan(vector<vector<pair<int,int>>> &mp,int n)  
{  
 //边双联通分量：无向图中，边双联通分量是指一个极大子图，删除该子图中的任意一条边，该子图仍然连通  
 //连接边双联通分量的边称为桥  
 vector<int> low(n+1,-1),dfn(n+1,-1);  
 //low:从当前点出发能到达的最早时间戳  
 //dfn:当前点的时间戳  
 vector<vector<int>> dccs;  
 stack<int> st; int cnt=0;  
 auto dfs=[&](auto dfs,int u,int fre)->void{  
 //fre:来时的边  
 dfn[u]=low[u]=++cnt;  
 st.push(u);  
 for(auto [v,rev]:mp[u])  
 {  
 if(dfn[v]==-1)//case1:未访问  
 {  
 dfs(dfs,v,rev);  
 low[u]=min(low[u],low[v]);//更新low[u]  
 }  
 else if(rev!=(fre^1))//case2:已访问且不是该边的反边  
 {  
 //阻断向父节点更新的可能  
 //多重边可能有一种特殊的组合让v!=fa失效  
 //eg.1-2,1-2,2-3,2-3  
 low[u]=min(low[u],dfn[v]);//更新low[u]  
 }  
 }  
 if(dfn[u]==low[u])//case3:u的子树中不存在能到达u的祖先的边  
 //u的子树全为dcc  
 {  
 vector<int> dcc;  
 while(true){  
 int t=st.top();st.pop();  
 dcc.push\_back(t);  
 if(t==u) break;  
 }  
 dccs.push\_back(dcc);  
 }  
 };  
 for(int i=1;i<=n;i++)  
 {  
 if(dfn[i]==-1)  
 {  
 dfs(dfs,i,-1);  
 }  
 }  
 return dccs;  
}  
int main()  
{  
 int T\_start=clock();  
 int n,m;cin>>n>>m;  
 vector<vector<pair<int,int>>> mp(n+1);  
 vector<int> val(n+1);  
 int tot=0;  
 for(int i=0;i<m;i++)  
 {  
 int u,v;cin>>u>>v;  
 if(u==v) continue;  
 mp[u].push\_back({v,tot+1});  
 mp[v].push\_back({u,tot});  
 tot+=2;//存各自的边的编号  
 }  
 vector<vector<int>> bccs=tarjan(mp,n);  
 cout<<bccs.size()<<endl;  
 for(auto bcc: bccs)  
 {  
 cout<<bcc.size()<<' ';  
 for(auto x: bcc)  
 {  
 cout<<x<<" ";  
 }  
 cout<<endl;  
 }  
 return 0;  
}

**树链剖分(+线段树)**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
#define int long long  
const int N=1e5+5;  
int dep[N],fa[N],hson[N],top[N],siz[N],dfn[N],rk[N],val[N];  
int mod;  
class SegTree{  
 public:  
 struct Node  
 {  
 int sum;  
 int s,e;  
 int lazy=0;  
 Node\* lt;  
 Node\* rt;  
 Node(int sum,int s,int e):s(s),e(e),sum(sum),lt(nullptr),rt(nullptr){}  
 };  
 Node\* root;  
 Node\* buildtree(vector<int> &nums,int l,int r)  
 {  
 if(l>r) return nullptr;  
 if(l==r) return new Node(nums[l],l,l);  
 int mid=(l+r)>>1;  
 Node\* root=new Node(0,l,r);  
 Node\* lc=buildtree(nums,l,mid);  
 Node\* rc=buildtree(nums,mid+1,r);  
 if(lc) root->lt=lc,root->sum=(root->sum+lc->sum)%mod;  
 if(rc) root->rt=rc,root->sum=(root->sum+rc->sum)%mod;  
 return root;  
 }  
 void init(vector<int>nums)  
 {  
 root=buildtree(nums,0,nums.size()-1);  
 return;  
 }  
 void taglazy(Node\* root,int val)  
 {  
 if(root==nullptr) return;  
 val%=mod;  
 root->lazy=(root->lazy+val)%mod;  
 root->sum=(root->sum+(root->e-root->s+1)%mod\*val)%mod;  
 }  
 void pushdown(Node\* root)  
 {  
 if(!root) return ;  
 if(root->lazy)  
 {  
 taglazy(root->lt,root->lazy);  
 taglazy(root->rt,root->lazy);  
 root->lazy=0;  
 }  
 }  
 void update(Node\* root,int l,int r,int val)  
 {  
 if(!root) return ;  
 if(root->s>r||root->e<l) return ;  
 if(root->s>=l&&root->e<=r)  
 {  
 taglazy(root,val);  
 return;  
 }  
 pushdown(root);  
 update(root->lt,l,r,val);  
 update(root->rt,l,r,val);  
 root->sum=((root->lt?root->lt->sum:0)+(root->rt?root->rt->sum:0))%mod;  
 return ;  
 }  
 void update(int l,int r,int val)  
 {  
 update(root,l,r,val);  
 return ;  
 }  
 int query(Node\* root,int l,int r)  
 {  
 pushdown(root);  
 if(!root) return 0;  
 if(root->s>r||root->e<l) return 0;  
 if(root->s>=l&&root->e<=r) return root->sum;  
 return query(root->lt,l,r)+query(root->rt,l,r);  
 }  
 int query(int l,int r)  
 {  
 return query(root,l,r);  
 }  
};  
class cutTree  
{  
 //树链剖分，把树剖分成若干条链，每条链上维护一个线段树  
 //可以支持链上修改和查询，也可以支持树上修改和查询  
 //还可以求lca  
 //重链剖分有一个重要的性质：对于节点数为n的树，从任意节点向上走到根节点，经过的轻边数量不超过logn。这是因为，如果一个节点连向父节点的边是轻边，  
 //就必然存在子树不小于它的兄弟节点，那么父节点对应子树的大小一定超过该节点的两倍(由dfs1可得)。每经过一条轻边，子树大小就翻倍，所以最多只能经过logn条。  
 public:  
 int n,tot,s;  
 //s:根节点  
 vector<vector<int>> tree;  
 //dep:树深,fa:父节点,hson:i的重儿子,top:重链顶端,siz:子树大小,dfn:dfs序,rk:dfs序对应的节点  
 SegTree seg;  
 void dfs1(int u,int f)  
 {  
 //cntt++;cout<<cntt<<endl;  
 dep[u]=dep[f]+1;//更新树深  
 fa[u]=f;siz[u]=1;  
 for(auto v:tree[u])  
 {  
 if(v==f)continue;  
 dfs1(v,u);  
 siz[u]+=siz[v];  
 if(hson[u]==-1||siz[v]>siz[hson[u]]) hson[u]=v;  
 //u的重儿子是所有子树大小最大的儿子  
 }  
 }  
 void dfs2(int u)  
 {  
 dfn[u]=++tot;rk[tot]=u;  
 //优先访问重儿子,保证重链顶端的dfn最小  
 if(hson[u]!=-1)  
 {  
 top[hson[u]]=top[u];  
 //重儿子的top是它所在重链的顶端  
 dfs2(hson[u]);  
 }  
 for(auto v:tree[u])  
 {  
 if(v==fa[u]||v==hson[u])//跳过父节点和重儿子  
 continue;  
 top[v]=v;//轻儿子的top是自己  
 dfs2(v);  
 }  
 }  
 void init()  
 {  
 tot=0;  
 dfs1(s,0);  
 dfs2(s);  
 }  
 int lca(int u,int v)  
 {  
 while(top[u]!=top[v])//不在同一条重链上  
 {  
 if(dep[top[u]]<dep[top[v]])swap(u,v);  
 u=fa[top[u]];  
 //链头深度大的往上跳  
 }  
 return dep[u]<dep[v]?u:v;  
 }  
 int queryPath(int u,int v)  
 {  
 int ans=0;  
 while(top[u]!=top[v])//遍历所有的边  
 {  
 if(dep[top[u]]<dep[top[v]])swap(u,v);  
 ans=(ans+seg.query(dfn[top[u]],dfn[u]))%mod;  
 u=fa[top[u]];  
 }  
 if(dep[u]>dep[v])swap(u,v);  
 ans=(ans+seg.query(dfn[u],dfn[v]))%mod;  
 return ans;  
 }  
 void updatePath(int u,int v,int val)  
 {  
 while(top[u]!=top[v])  
 {  
 if(dep[top[u]]<dep[top[v]])swap(u,v);  
 seg.update(dfn[top[u]],dfn[u],val);  
 u=fa[top[u]];  
 }  
 if(dep[u]>dep[v])swap(u,v);  
 seg.update(dfn[u],dfn[v],val);  
 }  
 void updateSub(int u,int val)  
 {  
 //子树的dfn一定是连续的  
 seg.update(dfn[u],dfn[u]+siz[u]-1,val);  
 }  
 int querySub(int u)  
 {  
 return seg.query(dfn[u],dfn[u]+siz[u]-1);  
 }  
 cutTree(int n,vector<vector<int>> tree,int s):n(n),tree(tree),s(s)  
 {  
 for(int i=0;i<=n;i++)  
 {  
 dep[i]=0;fa[i]=-1;hson[i]=-1;top[i]=-1;  
 siz[i]=0;dfn[i]=-1;rk[i]=-1;  
 }  
 top[s]=s;init(); vector<int> inf(n+1,0);  
 for(int i=1;i<=n;i++)inf[dfn[i]]=val[i]%mod;  
 seg.init(inf);  
 }  
};  
signed main()  
{  
 int T\_start=clock();  
 ios::sync\_with\_stdio(false);  
 cin.tie(0);  
 //freopen("in.txt","r",stdin);  
 //freopen("out.txt","w",stdout);  
 int n,m,s;  
 cin>>n>>m>>s>>mod;  
 vector<vector<int>> tree(n+1);  
 for(int i=1;i<=n;i++)  
 {  
 cin>>val[i];  
 }  
 for(int i=1;i<n;i++)  
 {  
 int u,v;  
 cin>>u>>v;  
 tree[u].push\_back(v);  
 tree[v].push\_back(u);  
 }  
 cutTree ct(n,tree,s);  
 while(m--)  
 {  
 int op,x,y,z;  
 cin>>op;  
 if(op==1)  
 {  
 cin>>x>>y>>z;  
 ct.updatePath(x,y,z);  
 }  
 else if(op==2)  
 {  
 cin>>x>>y;  
 cout<<ct.queryPath(x,y)%mod<<endl;  
 }  
 else if(op==3)  
 {  
 cin>>x>>y;  
 ct.updateSub(x,y);  
 }  
 else if(op==4)  
 {  
 cin>>x;  
 cout<<ct.querySub(x)%mod<<endl;  
 }  
 }  
 int T\_end=clock();  
 //cout<<"time: "<<(double)(T\_end-T\_start)/CLOCKS\_PER\_SEC<<"s"<<endl;  
 return 0;  
}

**分层图**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
int dij(vector<vector<pair<int,int>>>& mp,int s,int n,int t,int kk)  
{  
 vector<int> vis((kk+1)\*n+1,0x7fffffff);  
 vis[s]=0;  
 priority\_queue<pair<int,int>,vector<pair<int,int>>,greater<pair<int,int>>> pq;  
 pq.push({0,s});  
 while(!pq.empty())  
 {  
 auto [val,k]=pq.top();  
 pq.pop();  
 if(val>vis[k]) continue;  
 for(auto i:mp[k])  
 {  
 auto [v,w]=i;  
 if(vis[v]>vis[k]+w)  
 {  
 vis[v]=vis[k]+w;  
 pq.push({vis[v],v});  
 }  
 }  
 }  
 int ans=0x7fffffff;  
 for(int i=0;i<=kk;i++)  
 {  
 //i表示免费次数  
 ans=min(ans,vis[i\*n+t]);  
 }  
 return ans;  
}  
int main()  
{  
 //分层图：解决k次免费（有代价）最短路问题  
 int T\_start=clock();  
 int n=read(),m=read(),k=read();  
 int s=read(),t=read();  
 vector<vector<pair<int,int>>> mp((k+1)\*n+1);  
 while(m--)  
 {  
 int u,v,w;  
 u=read(),v=read(),w=read();  
 for(int i=0;i<=k;i++)  
 {  
 mp[i\*n+u].push\_back({i\*n+v,w});  
 mp[i\*n+v].push\_back({i\*n+u,w});  
 if(i!=k)   
 {  
 mp[i\*n+u].push\_back({(i+1)\*n+v,0});  
 mp[i\*n+v].push\_back({(i+1)\*n+u,0});//分层图连边  
 }  
 }  
 }  
 cout<<dij(mp,s,n,t,k)<<endl;  
 return 0;  
}

**2-sat**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
#include <numeric>  
using namespace std;  
pair<vector<int>,int> tarjan(vector<vector<int>> &mp,int n)  
{  
 vector<int> bel(n+1,-1);//bel[i]:i属于哪个强连通分量  
 vector<int> dfn(n+1,-1),low(n+1,-1);  
 stack<int> st;int cnt=0,scc\_cnt=0;  
 auto dfs=[&](auto dfs,int u)->void{  
 dfn[u]=low[u]=++cnt; //时间戳+1  
 st.push(u); //inst[u]=1; //入栈  
 for(int v:mp[u])  
 {  
 if(dfn[v]==-1)//case1:u的邻接点v未被访问过  
 {  
 dfs(dfs,v);  
 low[u]=min(low[u],low[v]);  
 }  
 else if(bel[v]==-1)//v所属的强连通分量还未被确定（等价于case2）  
 {  
 low[u]=min(low[u],dfn[v]);  
 }  
 //case3:u的邻接点v不在栈中,且访问过  
 //说明v已经确定在某个强连通分量中，所以u的low不需要更新  
 }  
 if(dfn[u]==low[u])  
 {  
 scc\_cnt++;  
 while(true)  
 {  
 int v=st.top();  
 st.pop();  
 bel[v]=scc\_cnt;  
 if(v==u) break;  
 }  
 }  
 };  
 //图有可能不是强联通的  
 for(int i=1;i<=n;i++)  
 {  
 if(dfn[i]==-1)  
 {  
 dfs(dfs,i);  
 }  
 }  
 return {bel,scc\_cnt};  
}  
int main()  
{  
 int T\_start=clock();  
 //freopen("in.txt","r",stdin);  
 int n,m;cin>>n>>m;  
 vector<vector<int>> mp(2\*n+1);  
 for(int i=0;i<m;i++)  
 {  
 int u,b1,v,b2;  
 cin>>u>>b1>>v>>b2;  
 //u=b1 or v=b2  
 //=>u!=b1->v=b2 and v!=b2->u=b1  
 mp[u+(!b1)\*n].push\_back(v+b2\*n);  
 mp[v+(!b2)\*n].push\_back(u+b1\*n);  
 //u=b1-> u+b1\*n x  
 }  
 auto [bel,scc\_cnt]=tarjan(mp,2\*n);  
 vector<int> ans(n+1,-1);  
 int flag=1;  
 for(int i=1;i<=n;i++)  
 {  
 if(bel[i]==bel[i+n]) {flag=0;break;}  
 else ans[i]=bel[i]>bel[i+n];  
 }  
 //此处处理的是i的正确性  
 //当bel[u==0]>bel[u==1]时,u==0的拓扑序小,i应当被赋值为false  
 //因为i->!i为永真式的前提为i=0  
 //此处i的含义是命题变元i的取值=0  
 //所以ans[i]=1  
 if(flag)  
 {  
 cout<<"POSSIBLE"<<endl;  
 for(int i=1;i<=n;i++)  
 {  
 cout<<ans[i]<<" ";  
 }  
 cout<<endl;  
 }  
 else cout<<"IMPOSSIBLE"<<endl;  
 return 0;  
}  
//2-sat  
//处理n个命题变元的赋值问题，形式上判断形如(p->q) and (!p->q)是否可永真赋值  
//即判断是否存在一种赋值使得p->q和!p->q同时为真  
//很显然若p->q,q->p均成立,则p,q在一个scc里

**差分约束**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
using namespace std;  
int flag=0;  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
vector<int> SPFA(vector<vector<pair<int,int>>>& mp,int s,int n)  
{  
 vector<int> dis(n+1,0x7fffffff);  
 vector<int> vis(n+1,0);  
 vector<int> cnt(n+1,0);  
 dis[s]=0;queue<int> q;  
 q.push(s);vis[s]=1;cnt[s]=1;  
 while(!q.empty())  
 {  
 int u=q.front();  
 q.pop();vis[u]=0;  
 for(auto [v,w]:mp[u])  
 {  
 if(dis[v]>dis[u]+w)//松弛  
 {  
 dis[v]=dis[u]+w;  
 cnt[v]=cnt[u]+1;  
 if(cnt[v]>=n+1)  
 {  
 flag=1;  
 return vector<int>(n+1,-1);  
 }  
 if(!vis[v])  
 {  
 q.push(v);  
 vis[v]=1;  
 }  
 }  
 }  
 }  
 return dis;  
}  
int main()  
{  
 int T\_start=clock();  
 int n=read(),m=read();  
 vector<vector<pair<int,int>>> mp(n+1);  
 for(int i=1;i<=m;i++)  
 {  
 int v=read(),u=read(),w=read();  
 mp[u].push\_back(make\_pair(v,w));  
 }  
 for(int i=1;i<=n;i++)  
 {  
 mp[0].push\_back(make\_pair(i,0));  
 }  
 vector<int>ans=SPFA(mp,0,n);  
 if(flag==1)  
 {  
 printf("NO\n");  
 }  
 else  
 {  
 //printf("YES\n");  
 for(int i=1;i<=n;i++)  
 {  
 printf("%d ",ans[i]);  
 }  
 printf("\n");  
 }  
 return 0;  
}  
//对一个差分约束系统，判断是否存在一组解，使得所有约束条件都成立。  
//ex. x1-x2<=3  
// x2-x3<=-2  
// x1-x3<=1  
//将xn看作超级源点（到所有点的权值为w=0）到n的最短路  
//那么第一个式子的意义就是x1<=x2+3,0到1的最短路<=3+0到2的最短路  
//在图上的意义就是建2->1的边权为3的边，0->1,0->2的边权为0的边  
//0->1,0->2的边权为0的边也是添加了以下条件  
//x1-x0<=0  
//x2-x0<=0  
//x0=0  
//那么整个系统就转化为了一张图  
//求xn即求0到n的最短路，如果存在负环，则无解，否则有解  
//负环还原的形式为  
//x1-x2<=-1...1  
//x2-x3<=-4...2  
//x3-x1<=-5...3  
//1+2+3->0<=-10,不成立  
//还有结论，设定w即求x1,x2..xn<=w的最大解  
//如果差分约束系统换换不等号，求最长路，spfa改一下即可  
  
//结论形式证明  
//假设X0是定死的；X1到Xn在满足所有约束的情况下可以取到的最大值分别为M1、M2、……、Mn（当然我们不知道它们的值是多少）；解出的源点到每个点的最短路径长度为D1、D2、……、Dn。  
//基本的Bellman-Ford算法是一开始初始化D1到Dn都是无穷大。然后检查所有的边对应的三角形不等式，一但发现有不满足三角形不等式的情况，则更新对应的D值。最后求出来的D1到Dn就是源点到每个点的最短路径长度。  
//如果我们一开始初始化D1、D2、……、Dn的值分别为M1、M2、……、Mn，则由于它们全都满足三角形不等式（我们刚才已经假设M1到Mn是一组合法的解），则Bellman-Ford算法不会再更新任合D值，则最后得出的解就是M1、M2、……、Mn。  
//好了，现在知道了，初始值无穷大时，算出来的是D1、D2、……、Dn；初始值比较小的时候算出来的则是M1、M2、……、Mn。大家用的是同样的算法，同样的计算过程，总不可能初始值大的算出来的结果反而小吧。所以D1、D2、……、Dn就是M1、M2、……、Mn。

**点分治**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
#include <array>  
#include <unordered\_map>  
#include <unordered\_set>  
#include <numeric>  
using namespace std;  
  
int main()  
{  
 int T\_start=clock();  
 //freopen("in.txt","r",stdin);  
 //freopen("out.txt","w",stdout);  
 int n,m;cin>>n>>m;  
 vector<vector<pair<int,int>>> tr(n+1);  
 for(int i=1;i<n;i++)  
 {  
 int u,v,w;  
 cin>>u>>v>>w;  
 tr[u].push\_back({v,w});  
 tr[v].push\_back({u,w});  
 }  
 vector<int> siz(n+1,0),q(m+1),vis(n+1,0),ans(m+1,0);  
 for(int i=1;i<=m;i++) cin>>q[i];  
 auto getsz=[&](auto getsz,int u,int p=-1)->int  
 {  
 siz[u]=1;  
 for(auto [v,w]:tr[u])  
 {  
 if(v==p||vis[v])continue;  
 siz[u]+=getsz(getsz,v,u);  
 }  
 return siz[u];  
 };//统计以u为根的子树大小  
 auto getrt=[&](auto getrt,int u,int p=-1,int sizrt)->int  
 {  
 for(auto [v,w]:tr[u])  
 {  
 if(v==p||vis[v])continue;  
 if(siz[v]>sizrt/2)return getrt(getrt,v,u,sizrt);  
 }  
 return u;  
 };//寻找重心  
 //重心：对于一棵树，如果存在一个顶点，其子树中最大的子树大小不超过整棵树大小的一半，则称该顶点为这棵树的重心。  
 auto clac=[&](auto clac,int uu,int dis,int p=-1,vector<int>& tpd)->void  
 {  
 tpd.push\_back(dis);  
 for(auto [vv,ww]:tr[uu])  
 {  
 if(vv==p||vis[vv])continue;  
 clac(clac,vv,dis+ww,uu,tpd);  
 }  
 };  
 auto div=[&](auto div,int u)->void{  
 vis[u]=1;  
 unordered\_set<int> s{0};  
 for(auto [v,w]:tr[u])  
 {  
 if(vis[v])continue;  
 vector<int> tpd;  
 clac(clac,v,w,u,tpd);  
 for(auto d:tpd)  
 {  
 for(int i=1;i<=m;i++)  
 {  
 if(!ans[i]&&d<=q[i]&&s.find(q[i]-d)!=s.end())  
 {  
 ans[i]=1;  
 }  
 }  
 }  
 for(auto d:tpd)s.insert(d);  
 }  
 for(auto [v,w]:tr[u])  
 {  
 //用重心划分u的子树  
 if(vis[v])continue;  
 getsz(getsz,v);  
 int subrt=getrt(getrt,v,-1,siz[v]);  
 div(div,subrt);  
 }  
 };//处理以u为根的子树  
 getsz(getsz,1);  
 int rt=getrt(getrt,1,-1,siz[1]);  
 div(div,rt);  
 for(int i=1;i<=m;i++)   
 {  
 if(ans[i])cout<<"AYE\n";  
 else cout<<"NAY\n";  
 }  
 return 0;  
}  
//淀粉质：把树上路径问题转化为子树分治问题  
//把树按重心划分，那么树高（或树的大小）不超过n/2，递归深度不超过logn(最坏：退化为链），于是可以暴力处理子树  
//根据实现方式的不同，时间复杂度可以做到O(nlogn)或O(nlog^2n)

**二分图染色**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
struct node{  
 int v;  
 int w;  
};  
vector<node> mp[20005];  
bool vis[20005]={false};  
int dyed[20005]={0};  
int Data[100005];  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0&&x!=-2147483648) {putchar('-');x=-x;}  
 if(x==-2147483648) {printf("-2147483648");return;}  
 do{  
 sta[top++]=x%10, x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
bool dye(int start,int mid)  
{  
 queue<int> q;  
 q.push(start);  
 vis[start]=1;dyed[start]=1;  
 while(!q.empty())  
 {  
 int temp=q.front();  
 q.pop();  
 for(auto i:mp[temp])  
 {  
 if(i.w>=mid)  
 {  
 if(!vis[i.v])  
 {  
 q.push(i.v);  
 vis[i.v]=true;  
 dyed[i.v]=3-dyed[temp];  
 }  
 else if(dyed[i.v]==dyed[temp]) return false;  
 }  
 }  
 }  
 return true;   
}  
bool isBinGraph(int n,int mid)  
{  
 memset(vis,0,sizeof(vis));  
 memset(dyed,0,sizeof(dyed));  
 for(int i=1;i<=n;i++)  
 {  
 if(!vis[i])  
 {  
 if(!dye(i,mid)) return false;  
 }  
 }  
 return true;  
}  
int main()  
{  
 int T\_start=clock();  
 freopen("in.txt","r",stdin);  
 // freopen("out.txt","w",stdout);  
 int n=read(),m=read();  
 for(int i=0;i<m;i++)  
 {  
 int u=read(),v=read(),w=read();  
 mp[u].push\_back({v,w});  
 mp[v].push\_back({u,w});  
 Data[i]=w;  
 }  
 sort(Data,Data+m);  
 // for(int i=0;i<m;i++)  
 // {  
 // cout<<Data[i]<<endl;  
 // }  
 if(isBinGraph(n,0))  
 {  
 cout<<"0"<<endl;  
 }  
 else  
 {  
 int l=0,r=m;  
 while(l<=r)  
 {  
 int mid=(l+r)>>1;  
 if(!isBinGraph(n,Data[mid])) l=mid+1;  
 else r=mid-1;  
 }  
 cout<<Data[r]<<endl;  
 }   
 return 0;  
}

**HASH**  
**双Hash**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
const int base1=27,base2=27;  
const int hash\_mod1=100663319,hash\_mod2=402653189;  
/\*hash mod number 53 97 193 389 769 1543 3079 6151 12289 24593 49157 98317 196613 393241 786433 1572869 3145739 6291469 12582917 25165843 50331653 100663319 402653189 805306457 1610612741 (1e9+7,1e9+9)\*/   
//char ss[10][10010];  
struct Data  
{  
 long long hash1;  
 long long hash2;  
}a[10005];  
long long make\_string\_hash1(char s[])  
{  
 register long long ans=0;  
 register int len=strlen(s);  
 for(register int i=0;i<len;i++)  
 {  
 ans=(ans\*base1+(long long)(s[i]))%hash\_mod1;  
 }  
 return ans;  
}  
long long make\_string\_hash2(char s[])  
{  
 register long long ans=0;  
 register int len=strlen(s);  
 for(register int i=0;i<len;i++)  
 {  
 ans=(ans\*base2+(long long)(s[i]))%hash\_mod2;  
 }  
 return ans;  
}//求子串哈希值hash=((hash[r]−hash[l−1]∗mod^(r−l+1))%mod+mod)%mod  
int main()  
{  
 int T\_start=clock();  
   
 return 0;  
}

**hash表**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
/\*hash mod number 53 97 193 389 769 1543 3079 6151 12289 24593 49157 98317 196613 393241 786433 1572869 3145739 6291469 12582917 25165843 50331653 100663319 402653189 805306457 1610612741 (1e9+7,1e9+9)\*/   
/\*prime such as 4k+3 (some)553963 553991 554003 554011 554051 554087 554123 554167 554171 554179 554207 554263 554299 554303 554347 554383 554419 554431 554447 554467 554503 554527 554531 554611 554627 554639 554663 554699 554707 554711 554731 554747 554759 554767 554779 554791 554803 554839 554843 554887 554891 554899 554923 554927 554951 554959 555043 555083 555091 555119 555143 555167 555251 555287 555307 555383 555391 555419 555439 555487 555491 555523 555671 555683 555691 555707 555739 555743 555767 555823 555827 555871 555931 555967 556007 556027 556043 556051 556067 556103 556123 556159 556211 556219 556243 556267 556271 556279 556327 556331 556343 556351 556399 556403 556459 556483 556487 556519 556559 556579 556583 556607 556627 556639 556651 556679 556687 556691 556723 556727 556763 556799 556811 556819 556823 556859 556867 556883 556891 556931 556939 556943 556967 556987 556999 557027 557059 557087 557159 557303 557339 557371 557423 557443 557483 557519 557551 557567 557591 557611 557639 557663 557671 557731 557743 557747 557759 557779 557803 557831 557863 557891 557899 557903 557927 557987 558007 558067 558083 558091 558139 558167 558179 558203 558223 558251 558287 558307 558319 558343 558427 558431 558479 558491 558499 558539 558563 558583 558587 558599 558611 558643 558683 558703 558731 558787 558791 558827 558863 558931 558947 558979 559051 559067 559099 559123 559183 559211 559219 559231 559243 559259 559319 559343 559367 559451 559459 559483 559511 559523 559547 559571 559583 559591 559631 559639 559667 559679 559687 559703 559739 559747 559799 559807 559831 559859 559883 559907 559939 559967 559991 560023 560039 560047 560083 560107 560123 560159 560171 560179 560191 560207 560227 560239 560243 560299 560311 560411 560447 560459 560471 560479 560491 560503 560531 560543 560551 560639 560683 560719 560767 560771 560783 560803 560827 560863 560887 560891 560939 561019 561047 561059 561079 561083 561091 561103 561191 561199 561251 561307 561343 561347 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572699 572707 572711 572791 572807 572827 572843 572867 572879 572903 572927 572939 572963 573007 573031 573047 573107 573119 573143 573163 573179 573247 573263 573299 573343 573371 573379 573383 573451 573479 573487 573511 573523 573527 573571 573647 573679 573691 573719 573739 573763 573787 573791 573847 573851 573863 573871 573883 573887 573899 573967 574003 574031 574051 574099 574127 574159 574163 574183 574219 574279 574283 574307 574363 574367 574423 574439 574507 574543 574547 574619 574627 574631 574643 574667 574687 574699 574703 574711 574723 574727 574799 574859 574907 574939 574963 574967 575027 575063 575087 575119 575123 575131 575203 575219 575231 575243 575251 575303 575359 575371 575431 575479 575503 575551 575579 575591 575611 575623 575647 575651 575699 575711 575723 575747 575791 575863 575867 575903 575923 575959 575963 575987 576019 576031 576119 576131 576151 576167 576179 576203 576211 576223 576227 576287 576299 576319 576379 576391 576427 576431 576439 576523 576539 576551 576647 576659 576671 576683 576703 576727 576731 576739 576743 576787 576791 576883 576899 576943 576967 577007 577043 577063 577067 577111 577123 577147 577151 577219 577259 577271 577279 577307 577327 577331 577351 577363 577387 577399 577427 577463 577471 577483 577523 577531 577547 577559 577627 577639 577667 577739 577751 577799 577807 577831 577867 577879 577919 577931 577939 577979 578047 578063 578131 578167 578183 578191 578203 578251 578267 578299 578311 578327 578363 578371 578399 578407 578419 578467 578483 578503 578563 578587 578603 578647 578659 578687 578719 578779 578803 578819 578827 578839 578843 578923 578959 578971 578999 579011 579023 579079 579083 579107 579119 579179 579199 579239 579251 579259 579263 579283 579287 579311 579331 579379 579407 579427 579451 579499 579503 579539 579563 579571 579583 579587 579611 579643 579707 579763 579779 579851 579883 579907 579947 579967 579983 580031 580079 580163 580183 580187 580219 580231 580259 580291 580303 580331 580339 580343 580379 580471 580487 580607 580627 580631 580639 580663 580687 580691 580711 580747 580759 580763 580787 580807 580843 580859 580871 580891 580919 580927 580939 581047 581071 581099 581143 581171 581183 581227 581239 581263 581303 581311 581323 581351 581407 581411 581443 581447 581459 581491 581527 581551 581599 581639 581663 581683 581687 581699 581731 581743 \*/  
const int MOD1=98317,MOD2=196613;  
vector <int> a[MOD1];  
vector <int> vis;  
bool \_find(int x)  
{  
 if(!a[(x%MOD1+MOD1)%MOD1].size()) return false;  
 for(int i=0;i<a[(x%MOD1+MOD1)%MOD1].size();i++)  
 {  
 if(a[(x%MOD1+MOD1)%MOD1][i]==x) return true;  
 }  
 return false;  
}  
void \_insert(int x)  
{  
 if(!\_find(x))   
 {  
 a[(x%MOD1+MOD1)%MOD1].push\_back(x);  
 vis.push\_back((x%MOD1+MOD1)%MOD1);  
 }  
 return ;  
}  
int read()  
{  
 int s=0,f=1;  
 char ch=getchar();  
 while(ch<'0'||ch>'9')  
 {  
 if(ch=='-') f=-1;  
 ch=getchar();  
 }  
 while(ch>='0'&&ch<='9')  
 {  
 s=(s<<3)+(s<<1)+ch-'0';  
 ch=getchar();  
 }  
 return s\*f;  
}  
inline void write(int x)   
{  
 static int sta[35];   
 int top=0;  
 if(x<0) {putchar('-');x=-x;}  
 do{  
 sta[top++]=x%10,x/=10;  
 }while(x);  
 while(top) putchar(sta[--top]+48);  
}  
int main()  
{  
 int T\_start=clock();  
 int t=read();  
 while(t--)  
 {  
 int n=read();  
 for(int i=0;i<n;i++)  
 {  
 int x=read();  
 if(!\_find(x))  
 {  
 \_insert(x);  
 write(x),putchar(' ');  
 }  
 }  
 putchar('\n');  
 for(auto i:vis)  
 {  
 a[i].clear();  
 }  
 vis.clear();  
 }  
   
   
 return 0;  
}

**String**

**KMP**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
vector<int> prefix\_init\_f(string s) //前缀函数初始化  
// 前缀函数就是，子串s[0..i]最长的相等的真前缀与真后缀的长度。  
// 在kmp算法中，前缀函数是核心，它决定了模式串（key）在匹配过程若不匹配应该跳转的位置。  
// e.g. abcabc的前缀函数为[0,0,0,1,2,3]  
{  
 int len=s.length();  
 vector<int> dp(len,0);  
 dp[0]=0;  
 for(int i=1;i<len;i++)  
 {  
 int j=dp[i-1];  
 while(j>0&&s[i]!=s[j]) j=dp[j-1];//如果s[i]和s[j]不相同，j跳到前一个符合的位置  
 if(s[i]==s[j]) j++; //如果s[i]和s[j]相同，j+1  
 dp[i]=j;  
 }  
 return dp;  
}   
void kmp(string s,string key)  
{  
 if(key.length()==0) return;  
 vector<int> dp=prefix\_init\_f(key);  
 int i=0,j=0;  
 while(i<s.length())  
 {  
 if(s[i]==key[j]) {i++;j++;} //如果匹配，接着匹配下一个字符  
 else if(j>0) j=dp[j-1]; //如果不匹配，j跳到前一个符合的位置  
 else i++;  
 if(j==key.length())  
 {  
 /\*some operation\*/  
 j=dp[j-1];//匹配成功后，j跳到前一个符合的位置  
 }  
 }  
}  
int main()  
{  
 int T\_start=clock();  
   
 return 0;  
}

**tiretree**

#include <algorithm>  
#include <bitset>  
#include <cmath>  
#include <cstdio>  
#include <cstdlib>  
#include <cstring>  
#include <ctime>  
#include <deque>  
#include <map>  
#include <iostream>  
#include <queue>  
#include <set>  
#include <stack>  
#include <vector>  
using namespace std;  
struct TiretreeNode{  
 vector<TiretreeNode\*> child;  
 bool isEnd;  
  
 TiretreeNode(): child(26,nullptr),isEnd(false) {}  
};  
void insert(string s,TiretreeNode\* root)  
{  
 for(auto ch:s)  
 {  
 int idx=ch-'a';  
 if(root->child[idx]==nullptr)  
 {  
 root->child[idx]=new TiretreeNode;  
 }  
 root=root->child[idx];  
 }  
 root->isEnd=true;  
}  
bool iscontain(string s,TiretreeNode\* root)  
{  
 for(auto ch:s)  
 {  
 int idx=ch-'a';  
 if(root->child[idx]==nullptr)  
 {  
 return false;  
 }  
 root=root->child[idx];  
 }  
 return root!=nullptr&&root->isEnd==true;  
}  
int main()  
{  
 int T\_start=clock();  
 vector<string> allsub={"hello","world","ld"};  
 TiretreeNode\* root=new TiretreeNode();  
 for(auto i:allsub)  
 {  
 insert(i,root);  
 }  
 vector<string> test={"hll","l","d","po","world"};  
 for(auto i:test)  
 {  
 cout<<i<<' '<<(iscontain(i,root)?"is in the tree":"is not in the tree")<<endl;  
 }  
 return 0;  
}