// ========== STL example =========

```
#include <set>
//差别在与 set 中不允许有重复元素，multiset 中允许有重复元素。
int main() {
multiset<int> myset;
myset.clear();
printf("%d\n", myset.empty());
for (int i=10; i; i--)
    myset.insert(i*10);
// 10 20 30 40 50 60 70 80 90
multiset<int>::iterator itlow, itup, it;
itlow=myset.lower_bound (30);
itup=myset.upper_bound (60);
myset.erase(itlow,itup);// 10 20 70 80 90
// map<int,int>::iterator it
// cout >> it->first >> it->second
printf("size == %d\n", (int)myset.size());
myset.erase(10);
//20 70 80 90
it = myset.find(70);

printf("count == %d\n", (int)myset.count(80)); //返回容器中元素等于 key 的元素的个数
}
```

// ========== DSU 并查集 ==========

```
int p[maxn], Rank[maxn];
//p 记录祖先, Rank 记录秩
void init(int n){
    for(int i=1; i<=n; i++)
        p[i]=i, Rank[i]=0;
}
int Find(int x){//路径压缩找祖先
return p[x]==x?x:p[x]=Find(p[x]); }
void Union(int x, int y){
    int xr=Find(x), yr=Find(y);
    if(xr==yr) return;
    //如果祖先相同直接退出
    if(Rank[xr]>Rank[yr]) p[yr]=xr;
    //启发式合并
    else{
        p[xr]=yr;
        if(Rank[xr]==Rank[yr]) Rank[yr]++;
    }
}
```

// ========== RMQ ==========

```
// d[i][j]: 从 i 位开始 长度为 2^j 的一段元素
// 所有 max 直接改为 min 也可以直接用
void RMQ_init(const vector<int>& A) {
  for(int i = 0; i < A.size(); i++)
     d_max[i][0] = A[i];
  for (int j=1; (1<<j) <= n; j++)
  for (int i=0; i+(1<<j)-1 < n; i++)
      d_max[i][j]=max( d_max[i][j-1],
      d_max[i+(1<<(j-1))][j-1] );
}
int RMQ_Min(int L, int R) {
  int k = 0;
  while((1<<(k+1)) <= R-L+1) k++;
   return max( d_max[L][k],
   d_max[R-(1<<k)+1][k] );
}
```

// ========== 莫队算法 ==========

莫队 （不带区间修改）

```
// 左端点所在分块作为第一关键字 右端点大小作为第二关键字
struct Cmd {   int l, r, id;
friend bool operator < (const Cmd &a, const Cmd &b)      {
if (belong[a.l] == belong[b.l])
return a.r < b.r;
else return belong[a.l] < belong[b.l];  }
} cmd[maxm];
int ans[maxm], belong[maxn];
int cnt[maxk];  // cnt[i] = j 表示当前区间内有 j 个颜色为 i 的东西
inline void upd(int &now, int pos, int v) {   // 更新 now
    // 维护 now -= cnt[pos];
    //         cnt[pos] += v;
    //         now += cnt[pos];          }
inline void solve(void)  {
int L=1,R=0; //[L,R]为当前维护好的区间
int now = 0;  // now 为当前区间的答案
for (int i = 1; i <= M; i++)  {
for (; L < cmd[i].l; L++) upd(now, L, -1);
for (; R > cmd[i].r; R--) upd(now, R, -1);
for (; L > cmd[i].l; L--) upd(now, L - 1, 1);
for (; R < cmd[i].r; R++) upd(now, R + 1, 1);
    if (cmd[i].l == cmd[i].r) {
            ans[cmd[i].id] =…; continue;  }
ans[cmd[i].id] = now;
} } // end of solve()
int main() {
int blocksize = sqrt(N);
for (int i = 1; i <= N; i++)   // [1, N]
    belong[i] = (i - 1) / blocksize + 1;
for (int i = 1; i <= M; i++) {
    read(cmd[i].l), read(cmd[i].r);
    cmd[i].id = i;  }
sort(cmd + 1, cmd + M + 1); solve();
for (int i = 1; i <= M; i++)
            printf("%d\n", ans[i]);
}
```

// ========== 树状数组 ==========

```
int n,m, bit[600005]; // size == maxn
```

```
int lowbit(int u){return u&(-u);}
//最后一位 1 在的地方
void edit(int u,int v) { //a[u]的值增加 v
  for(int j=u;j<=n;j+=lowbit(j))
    bit[j]+=v;
}
int query(int p) { //区间和 a[1]+...+a[n]
  int ans=0,i;
  for(i=p;i>0;i-=lowbit(i))
    ans+=bit[i];
  return ans;
}
// a[1~n]
int main() {
  for(i=1;i<=n;i++) {
    scanf("%d",&val);
    edit(i,val);
  }
  for(i=1;i<=m;i++) {
    scanf("%d%d%d",&t,&a,&b);
    if(t==1)//单点修改
      edit(a, b);
    if(t==2)//区间查询[]
    printf("%d\n", query(b)-query(a-1));
  }
  return 0;
}
```

// ======== STL 名次树 ========

```
vector<int> tree;
int find(int x) { // x 的排名
   return lower_bound(tree.begin(),tree.end(),x)
   -tree.begin()+1;
}
int main() {
    scanf("%d", &n);
    tree.reserve(maxn);
    for (int i=1; i<=n; i++) {
        scanf("%d%d", &opt, &x);
        switch(opt) {
        case 1:
tree.insert(upper_bound(tree.begin(),
tree.end(),x),x); break;
        case 2:
        tree.erase(lower_bound(tree.begin(),tree.e
    nd(),x)); break;
        case 3:printf("%d\n",find(x));break;
         case 4: // 输出排名为 x 的数
         printf("%d\n",tree[x-1]);break;
         case 5: // 找 x 的前驱
printf("%d\n",
*--lower_bound(tree.begin(),tree.end(),x))
break;
         case 6: // 后继
         printf("%d\n",*upper_bound(tree.begin(),
tree.end(),x));break;
        }
    }
}
```

// ========= 替罪羊树 =========

```
namespace Scapegoat_Tree {
#define MAXN (100000 + 10)
  const double alpha = 0.75;
  struct Node {
    Node * ch[2]; //ch[0]=left, ch[1]=right
    int key, size, cover; // size 为有效节点的数
量，cover 为节点总数量
    bool exist;  // 是否存在（是否被删除,不是
真正删除 只 invalid）
    void PushUp() {
      size = ch[0]->size + ch[1]->size + (int)exist;
      cover = ch[0]->cover + ch[1]->cover + 1;
    }
    bool isBad() { // 判断是否需要重构
      return ((ch[0]->cover > cover * alpha + 5) ||
(ch[1]->cover > cover * alpha + 5));
    }
  };
  struct STree {
  protected:
    Node mem_pool[MAXN];    //内存池，直接
分配好避免动态分配内存占用时间
    Node *tail, *root, *null;  // 用 null 表示 NULL
的指针更方便，tail 为内存分配指针，root 为根
    Node *bc[MAXN]; int bc_top; // 储存被删除
的节点的内存地址，分配时可以再利用这些地
址

    Node * NewNode(int key) {
      Node * p = bc_top ? bc[--bc_top] : tail++;
      p->ch[0] = p->ch[1] = null;
      p->size = p->cover = 1; p->exist = true;
      p->key = key;
      return p;
    }
    void Travel(Node * p, vector<Node *>&v) {
      if (p == null) return;
      Travel(p->ch[0], v);
      if (p->exist) v.push_back(p); // 构建序列
      else bc[bc_top++] = p; // 回收
      Travel(p->ch[1], v);
    }
    Node * Divide(vector<Node *>&v, int l, int r) {
      if (l >= r) return null;
      int mid = (l + r) >> 1;
      Node * p = v[mid];
      p->ch[0] = Divide(v, l, mid);
      p->ch[1] = Divide(v, mid + 1, r);
      p->PushUp(); // 自底向上维护，先维护子
树
      return p;
```

```
    }
    void Rebuild(Node * &p) {
      static vector<Node *>v; v.clear();
      Travel(p, v); p = Divide(v, 0, v.size());
    }
    Node ** Insert(Node *&p, int val) {
      if (p == null) {
        p = NewNode(val);
        return &null;
      }
      else {
        p->size++; p->cover++;
        // 返回值储存需要重构的位置，若子树也需要重构，本节点开始也需要重构，以本节点为根重构
        Node ** res = Insert(p->ch[val >= p->key], val);
        if (p->isBad()) res = &p;
        return res;
      }
    }
    void Erase(Node *p, int id) {
      p->size--;
      int offset = p->ch[0]->size + p->exist;
      if (p->exist && id == offset) {
        p->exist = false;
        return;
      }
      else {
        if (id <= offset) Erase(p->ch[0], id);
        else Erase(p->ch[1], id - offset);
      }
    }
  public:
    void Init() {
      tail = mem_pool;
      null = tail++;
      null->ch[0] = null->ch[1] = null;
      null->cover = null->size = null->key = 0;
      root = null; bc_top = 0;
    }
    STree() { Init(); }
    void Insert(int val) {
      Node ** p = Insert(root, val);
      if (*p != null) Rebuild(*p);
    }
    int Rank(int val) {
      Node * now = root;
      int ans = 1;
      while (now != null) { // 非递归求排名
        if (now->key >= val) now = now->ch[0];
        else {
          ans += now->ch[0]->size + now->exist;
//判断 now 是否 valid
          now = now->ch[1];
        }
      }
      return ans; // ans >= 1
    } // 若 val 属于(1th,2th) 则 Rank(val)=2
    int Kth(int k) {
      Node * now = root;
      while (now != null) { // 非递归求第 K 大
        if (now->ch[0]->size + 1 == k && now->exist) return now->key;
        else if (now->ch[0]->size >= k) now = now->ch[0];
        else k -= now->ch[0]->size + now->exist, now = now->ch[1];
      }
      return -1; // k 非法
    }
    void Erase(int val) {
      Erase(root, Rank(val));
      if (root->size < alpha * root->cover)
        Rebuild(root);
    }
    void Erase_kth(int k) {
      Erase(root, k);
      if (root->size < alpha * root->cover)
        Rebuild(root);
    }
  };
#undef MAXN
}
int main() {
  using namespace Scapegoat_Tree;
  STree solver; solver.Init();
  int T; cin >> T;
  while (T--) {
    int opt, x; scanf("%d%d", &opt, &x);
    switch(opt) {
      case 1: solver.Insert(x);break;
      case 2: solver.Erase(x);break;
      case 3:
      printf("%d\n", solver.Rank(x));break;
      case 4:
      printf("%d\n", solver.Kth(x));break;
      case 5:
printf("%d\n", solver.Kth(solver.Rank(x) -1));break;
      case 6: printf("%d\n",
solver.Kth(solver.Rank(x+1)));break;
    }
  }
  return 0;
}
```

// ============ 线段树 ============

```
ll n, m; // index 1~n 一共 m 次操作
ll op, qL, qR, v;
// 每次 update 或 query 前 都必须 clarify
// 对于 set: v >= 0 !!!
ll _sum, _min, _max; // 每次 query 前都要 init
const ll maxnode = 1<<17;
```

```
const ll INF = 0x3f3f3f3f3f3f3f3f;

struct IntervalTree{
ll addv[maxnode*4],setv[maxnode*4];
ll sumv[maxnode*4],minv[maxnode*4];
ll maxv[maxnode*4];

  void maintain(ll o, ll L, ll R){
    ll lc = o*2, rc = o*2+1;
    sumv[o] = maxv[o] = minv[o] = 0;
    if(L < R){
      sumv[o] = sumv[lc] + sumv[rc];
      maxv[o] = max(maxv[lc], maxv[rc]);
      minv[o] = min(minv[lc], minv[rc]);
    }
    if(setv[o] >= 0){
      //when set included
      minv[o] = maxv[o] = setv[o];
      sumv[o] = setv[o] * (R-L+1);
    }
    if(addv[o]){
      minv[o] += addv[o];
      maxv[o] += addv[o];
      sumv[o] += addv[o] * (R-L+1);
    }
  }
  void pushdown(ll o){  // when set
    ll lc = o*2, rc = o*2+1;
    if(setv[o] >= 0){
      setv[lc] = setv[rc] = setv[o];
      addv[lc] = addv[rc] = 0;
      setv[o] = -1;
    }
    if(addv[o]){
      addv[lc] += addv[o];
      addv[rc] += addv[o];
      addv[o] = 0;
    }
  }
  void update(ll o, ll L, ll R){
    ll lc = o*2, rc = o*2+1;
    if(qL <= L && qR >= R){
      if(op == 2) { // set
        setv[o] = v;
        addv[o] = 0;
      }
      else { //op==1 :Add
        addv[o] += v;
      }
    }
    else{
      pushdown(o);  //when set
      ll M = L + (R-L)/2;
      if(qL <= M) update(lc, L, M);
      else maintain(lc, L, M); //when set
      if(qR > M) update(rc, M+1, R);
      else maintain(rc, M+1, R);//when set
    }
    maintain(o, L, R);
  }
  void query(ll o, ll L, ll R, ll add) {
    //只需要 set 时可以删去第四个参数
    if(setv[o] >= 0){ // when set included
      ll v = setv[o] + addv[o] + add;
      _sum += v * (min(R, qR)-max(L, qL)+1);
      _max = max(_max, v);
      _min = min(_min, v);
    }
    else if(qL <= L && qR >= R){
      //当前区间完全包含于询问中
      _sum += sumv[o] + add*(R-L+1);
      _max = max(_max, maxv[o]+add);
      _min = min(_min, minv[o]+add);
    }
    else{ // 递归统计 累加参数 add
      ll lc = o*2, rc = o*2+1;
      ll M = L + (R-L)/2;
      if(qL <= M) query(lc, L, M, add+addv[o]);
      if(qR > M) query(rc, M+1, R, add+addv[o]);
    }
  }
} tree;

int main(){
  scanf("%lld%lld",&n,&m);
  memset(&tree, 0, sizeof(tree)); // important!!

  for (ll i=1; i<=n; i++) {
    scanf("%lld", &v);
    qL = qR = i;
    op = 1;
    tree.update(1, 1, n);
  }
  if (s == "add") {
    scanf("%lld%lld%lld",&qL,&qR,&v);
    op = 1;
    tree.update(1, 1, n);
  }
  if (s == "set") {
    scanf("%lld%lld%lld",&qL,&qR,&v);
    op = 2;
    tree.update(1, 1, n);
  }
  if (s == "sum") {
    scanf("%lld%lld",&qL,&qR);
    _sum = 0; _max = -INF; _min = INF;
    tree.query(1, 1, n, 0);
    printf("%lld\n", _sum);
  }
}
```