

Standard Code Library

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一切的开始

宏定义

- 需要 C++11

```
1  #include <bits/stdc++.h>
2  using namespace std;
3  using LL = long long;
4  #define FOR(i, x, y) for (decay<decltype(y)>::type i = (x), _##i = (y); i < _##i; ++i)
5  #define FORD(i, x, y) for (decay<decltype(x)>::type i = (x), _##i = (y); i > _##i; --i)
6  #ifdef zero1
7  #define dbg(x...) do { cout << "\033[32;1m" << #x << " -> "; err(x); } while (0)
8  void err() { cout << "\033[39;0m" << endl; }
9  template<template<typename...> class T, typename t, typename... A>
10 void err(T<t> a, A... x) { for (auto v: a) cout << v << ' '; err(x...); }
11 template<typename T, typename... A>
12 void err(T a, A... x) { cout << a << ' '; err(x...); }
13 #else
14 #define dbg(...)
15 #endif
16 // -----
```

数据结构

ST 表

```
1  struct ST{
2      int n;
3      std::vector<array<int,21>> st;
4      ST(int n):n(n),st(n + 1) {}
5      void init(vector<int>& a){
6          for(int i = 1;i <= n;i ++){
7              for(int j = 1;j <= 18;j ++){
8                  for(int i = 1;i + (1 << j) <= n + 1;i ++){
9                      st[i][j] = max(st[i][j - 1],st[i + (1 << (j - 1))][j - 1]);
10                 }
11             }
12         }
13         int rmq(int l,int r){
14             int j = log(r - l + 1)/log(2);
15             return max(st[l][j],st[r - (1 << j) + 1][j]);
16         }
17     };
18 }
```

线段树

```
1  struct SegTree {
2      int l, r;
3      SegTree *ls, *rs;
4      ll sum;
5      ll plus;
6      SegTree (const int L, const int R) : l(L), r(R) {
7          plus = 0;
8          if (L == R) {
9              /*Initial*/
10             ls = rs = nullptr;
11         } else {
12             int M = (L + R) >> 1;
13             ls = new SegTree (L, M);
14             rs = new SegTree (M + 1, R);
15             pushup();
16         }
17     }
18     void pushup() {
19         sum = ls->sum + rs->sum;
20         // std::cerr << "AAA" << l << ' ' << r << ' ' << sum;
21     }
22     void make_tag(long long w) {
23         sum += (r - l + 1) * w;
```

```

24     plus += w;
25 }
26 void pushdown() {
27     if (plus == 0) return;
28     ls->make_tag(plus);
29     rs->make_tag(plus);
30     plus = 0;
31 }
32 void upd(const int L, const int R, const int w) {
33     if ((L > r) || (l > R)) return;
34     if ((L <= l) && (r <= R)) {
35         make_tag(w);
36     } else {
37         pushdown();
38         ls->upd(L, R, w);
39         rs->upd(L, R, w);
40         pushup();
41     }
42 }
43 };

```

树状数组

```

1  template <typename T>
2  struct Fenwick {
3      int n;
4      std::vector<T> a;
5      Fenwick(int n) : n(n), a(n) {}
6      void add(int x, T v) {
7          for (int i = x + 1; i <= n; i += i & -i) {
8              a[i - 1] += v;
9          }
10     }
11     T sum(int x) {
12         T ans = 0;
13         for (int i = x; i > 0; i -= i & -i) {
14             ans += a[i - 1];
15         }
16         return ans;
17     }
18     T rangeSum(int l, int r) {
19         return sum(r) - sum(l);
20     }
21     int kth(T k) {
22         int x = 0;
23         // 先从高位开始取, 如果当前这一位可以取, 那么就考虑下一位是取 1 还是 0
24         // 到最后找到的就是最大的那个 pos 并且对应的 <=x 的
25         for (int i = 1 << std::_lg(n); i; i /= 2) {
26             if (x + i <= n && k >= a[x + i - 1]) {
27                 x += i;
28                 k -= a[x - 1];
29             }
30         }
31         return x;
32     } // 树状数组上倍增本质上是通过倍增来快速找出对应的区间
33 };

```

DSU

```

1  struct DSU {
2      std::vector<int> f, siz;
3      DSU(int n) : f(n), siz(n, 1) { std::iota(f.begin(), f.end(), 0); }
4      int leader(int x) {
5          while (x != f[x]) x = f[x] = f[f[x]];
6          return x;
7      }
8      bool same(int x, int y) { return leader(x) == leader(y); }
9      bool merge(int x, int y) {
10         x = leader(x);
11         y = leader(y);

```

```

12         if (x == y) return false;
13         siz[x] += siz[y];
14         f[y] = x;
15         return true;
16     }
17     int size(int x) { return siz[leader(x)]; }
18 };

```

Splay

```

1  struct Node {
2      int v, sz, sm;
3      Node *ch[2], *fa;
4
5      Node(const int V, Node *const f) : v(V), sz(1), sm(1), fa(f) {
6          ch[0] = ch[1] = nullptr;
7      }
8
9      inline int GetRela(const int x) { return (v == x) ? -1 : (x > v); }
10
11     void pushup() { sm = (ch[0] ? ch[0]->sm : 0) + (ch[1] ? ch[1]->sm : 0) + sz; }
12
13     inline void rotate(const int x) {
14         auto nrt = ch[x];
15         ch[x] = nrt->ch[x ^ 1];
16         nrt->ch[x ^ 1] = this;
17         if (ch[x]) ch[x]->fa = this;
18         nrt->fa = fa; fa = nrt;
19         if (nrt->fa) nrt->fa->ch[nrt->fa->GetRela(nrt->v)] = nrt;
20         pushup(); nrt->pushup();
21     }
22
23     void splay(const Node *p) {
24         while (fa != p) {
25             auto pa = fa->fa;
26             if (pa == p) {
27                 fa->rotate(fa->GetRela(v));
28             } else {
29                 int k1 = fa->GetRela(v), k2 = pa->GetRela(fa->v);
30                 if (k1 == k2) {
31                     pa->rotate(k1);
32                     fa->rotate(k1);
33                 } else {
34                     fa->rotate(k1);
35                     fa->rotate(k2);
36                 }
37             }
38         }
39     }
40 };

```

LCT

```

1  struct Node {
2      int v, s;
3      bool tag;
4      Node *ch[2], *fa;
5
6      inline void maketag() {
7          tag = !tag;
8          std::swap(ch[0], ch[1]);
9      }
10     inline void pushup() {
11         s = v;
12         for (auto u : ch) if (u != nullptr) {
13             s ^= u->s;
14         }
15     }
16     inline void pushdown() {
17         if (tag) {

```

```

18     for (auto u : ch) if (u != nullptr) {
19         u->maketag();
20     }
21     tag = false;
22 }
23 }
24
25 inline int Getson() { return fa->ch[1] == this; }
26
27 inline bool IsRoot() { return (fa == nullptr) || (fa->ch[Getson()] != this); }
28
29 void rotate(const int x) {
30     auto nt = ch[x];
31     ch[x] = nt->ch[x ^ 1];
32     nt->ch[x ^ 1] = this;
33     if (ch[x]) ch[x]->fa = this;
34     nt->fa = fa;
35     if (!IsRoot()) { fa->ch[Getson()] = nt; }
36     fa = nt;
37     pushup(); nt->pushup();
38 }
39
40 void splay() {
41     static Node* stk[maxn];
42     int top = 0;
43     stk[++top] = this;
44     for (auto u = this; !u->IsRoot(); stk[++top] = u = u->fa);
45     while (top) stk[top--]->pushdown();
46     while (!IsRoot()) {
47         if (fa->IsRoot()) {
48             fa->rotate(Getson());
49         } else {
50             auto pa = fa->fa;
51             int l1 = Getson(), l2 = fa->Getson();
52             if (l1 == l2) {
53                 pa->rotate(l2);
54                 fa->rotate(l1);
55             } else {
56                 fa->rotate(l1);
57                 fa->rotate(l2);
58             }
59         }
60     }
61 }
62 };
63 Node *node[maxn], Mem[maxn];
64
65 void Cut(const int x, const int y);
66 void Link(const int x, const int y);
67 void Query(const int x, const int y);
68 void Update(const int x, const int y);
69
70 void access(Node *u) {
71     for (Node *v = nullptr; u; u = (v = u)->fa) {
72         u->splay();
73         u->ch[1] = v; u->pushup();
74     }
75 }
76
77 void makeroot(Node *const u) {
78     access(u);
79     u->splay();
80     u->maketag();
81 }
82
83 void Query(const int x, const int y) {
84     auto u = node[x], v = node[y];
85     makeroot(u);
86     access(v);
87     v->splay();
88     qw(v->s, '\n');

```

```

89 }
90
91 void Link(const int x, const int y) {
92     auto u = node[x], v = node[y];
93     makeroot(u);
94     access(v); v->splay();
95     if (u->IsRoot() == false) return;
96     u->fa = v;
97 }
98
99 void Cut(const int x, const int y) {
100     auto u = node[x], v = node[y];
101     makeroot(u); access(v); u->splay();
102     if ((u->ch[1] != v) || (v->ch[0] != nullptr)) return;
103     u->ch[1] = v->fa = nullptr;
104     u->pushup();
105 }
106
107 // w[x] -> y
108 void Update(const int x, const int y) {
109     auto u = node[x];
110     u->splay();
111     u->s ^= u->v;
112     u->s ^= (u->v = a[x] = y);
113 }

```

扫描线

```

1 //二维数点
2 struct Segment{
3     int l,r,h,add;
4     bool operator <(const Segment a)const{
5         return h < a.h;
6     }
7 };
8 struct SegTree {
9     int l, r;
10    SegTree *ls, *rs;
11    int mn,len;
12    int plus;
13    SegTree (const int L, const int R) : l(L), r(R) {
14        plus = 0;len = 0;
15        if (L == R) {
16            ls = rs = nullptr;
17        } else {
18            int M = (L + R) >> 1;
19            ls = new SegTree (L, M);
20            rs = new SegTree (M + 1, R);
21            pushup();
22        }
23    }
24    void pushup() {
25        if(plus) len = r - l + 1;
26        else if(l == r)len = 0;
27        else len = ls->len + rs->len;
28    }
29    void make_tag(int w) {
30        plus += w;
31    }
32    void pushdown() {
33        if (plus == 0) return;
34        ls->make_tag(plus);
35        rs->make_tag(plus);
36        plus = 0;
37    }
38    void update(const int L, const int R, const int w) {
39        if ((L > r) || (l > R)) {
40            return;
41        }
42        if ((L <= l) && (r <= R)) {
43            make_tag(w);

```

```

44         pushup();
45         return ;
46     } else {
47         ls->update(L, R, w);
48         rs->update(L, R, w);
49         pushup();
50     }
51 }
52 };
53 //矩形面积并
54 #include<bits/stdc++.h>
55
56 using namespace std;
57 typedef long long ll;
58 const double eps = 1e-8;
59 const int maxn = 2e5 + 7;
60 std::vector<int> x;
61 struct Segment{
62     int l,r,h,add;
63     bool operator <(const Segment a)const{
64         return h < a.h;
65     }
66 };
67 struct SegTree {
68     int l, r;
69     SegTree *ls, *rs;
70     int mn,len;
71     int plus;
72     SegTree (const int L, const int R) : l(L), r(R) {
73         plus = 0;len = 0;
74         if (L == R) {
75             ls = rs = nullptr;
76         } else {
77             int M = (L + R) >> 1;
78             ls = new SegTree (L, M);
79             rs = new SegTree (M + 1, R);
80             pushup();
81         }
82     }
83     void pushup() {
84         if(plus) len = x[r] - x[l - 1];
85         else if(l == r)len = 0;
86         else len = ls->len + rs->len;
87     }
88     void make_tag(int w) {
89         plus += w;
90     }
91     void pushdown() {
92         if (plus == 0) return;
93         ls->make_tag(plus);
94         rs->make_tag(plus);
95         plus = 0;
96     }
97     void update(const int L, const int R, const int w) {
98         if ((L >= x[r]) || (x[l - 1] >= R)) {
99             return;
100         }
101         if ((L <= x[l - 1]) && (x[r] <= R)) {
102             make_tag(w);
103             pushup();
104             return ;
105         } else {
106             //pushdown();
107             ls->update(L, R, w);
108             rs->update(L, R, w);
109             pushup();
110         }
111     }
112 };
113 int main(){
114     ios::sync_with_stdio(false);

```



```

115     cin.tie(0);
116
117     vector<Segment> s;
118     int n;
119     cin >> n;
120     for(int i = 0; i < n; i++){
121         int xa,ya,xb,yb;
122         cin >> xa >> ya >> xb >> yb;
123         x.push_back(xa);
124         x.push_back(xb);
125         s.push_back({xa,xb,ya,1});
126         s.push_back({xa,xb,yb,-1});
127     }
128     sort(s.begin(),s.end());
129     sort(x.begin(),x.end());
130     x.erase(unique(x.begin(),x.end()),x.end());
131     int N = x.size();
132     SegTree Seg(1,N - 1);
133     ll ans = 0;
134     if(s.size()){
135         Seg.update(s[0].l,s[0].r,s[0].add);
136         for(int i = 1;i < s.size();i++){
137             ans += 1ll * Seg.len * (s[i].h - s[i - 1].h);
138             Seg.update(s[i].l,s[i].r,s[i].add);
139         }
140     }
141     cout << ans << "\n";
142     return 0;
143 }

```

Seg beats

本质上是维护了两棵线段树，A 树维护区间内最大值产生的贡献，B 树维护剩下树的贡献。注意 A 树某节点的孩子不一定全部能贡献到该节点，因为孩子的最大值不一定是父亲的最大值。所以要注意下传标记时，A 树的孩子下传的可能是 B 的标记。

beats 的部分是，每次让序列里每个数对另一个数 V 取 \min ，则直接暴力递归到 inRange 且 B 的最大值小于 V 的那些节点上，转化成对 A 那个节点的区间加法（加上 $V - \text{val}_A$ ）即可。这么做的均摊复杂度是 $O(\log n)$ 。

做区间历史最大值的方法是，维护两个标记 x, y ， x 是真正的加标记， y 是 x 在上次下传结束并清零后的历史最大值。下传时注意先下传 y 再下传 x 。实现历史最值是平凡的，不需要 beats。beats 解决的仅是取 \min 的操作。

下面五个操作分别是：区间加，区间对 k 取 \min ，区间求和，区间最大值，区间历史最大值。

```

1  #include <array>
2  #include <iostream>
3  #include <algorithm>
4
5  typedef long long int ll;
6
7  const int maxn = 500005;
8
9  ll a[maxn];
10
11  const ll inf = 0x3f3f3f3f3f3f3f3fll;
12
13  struct Node {
14      Node *ls, *rs;
15      int l, r, maxCnt;
16      ll v, add, maxAdd, sum, maxV, maxHistory;
17
18      Node(const int L, const int R) :
19          ls(nullptr), rs(nullptr), l(L), r(R), maxCnt(0),
20          v(0), add(0), maxAdd(0), sum(0), maxV(-inf), maxHistory(-inf) {}
21
22      inline bool inRange(const int L, const int R) {
23          return L <= l && r <= R;
24      }
25      inline bool outRange(const int L, const int R) {
26          return l > R || L > r;
27      }

```

```

28
29 void addVal(const ll t, int len) {
30     add += t;
31     sum += len * t;
32     maxV += t;
33 }
34
35 void makeAdd(const ll t, int len) {
36     addVal(t, len);
37     maxHistory = std::max(maxHistory, maxV);
38     maxAdd = std::max(maxAdd, add);
39 }
40 };
41
42 void pushup(Node *x, Node *y) {
43     y->maxV = std::max(y->ls->maxV, y->rs->maxV);
44     y->sum = y->ls->sum + y->rs->sum;
45     y->maxHistory = std::max({y->maxHistory, y->ls->maxHistory, y->rs->maxHistory});
46     if (x->ls->maxV != x->rs->maxV) {
47         bool flag = x->ls->maxV < x->rs->maxV;
48         if (flag) std::swap(x->ls, x->rs);
49         x->maxV = x->ls->maxV;
50         x->maxCnt = x->ls->maxCnt;
51         y->maxV = std::max(y->maxV, x->rs->maxV);
52         y->sum += x->rs->sum;
53         x->sum = x->ls->sum;
54         if (flag) std::swap(x->ls, x->rs);
55     } else {
56         x->maxCnt = x->ls->maxCnt + x->rs->maxCnt;
57         x->sum = x->ls->sum + x->rs->sum;
58         x->maxV = x->ls->maxV;
59     }
60     x->maxHistory = std::max({x->ls->maxHistory, x->rs->maxHistory, x->maxHistory, y->maxHistory});
61 }
62
63 void New(Node *&u1, Node *&u2, int L, int R) {
64     u1 = new Node(L, R);
65     u2 = new Node(L, R);
66     if (L == R) {
67         u1->v = u1->sum = u1->maxV = u1->maxHistory = a[L];
68         u1->maxCnt = 1;
69     } else {
70         int M = (L + R) >> 1;
71         New(u1->ls, u2->ls, L, M);
72         New(u1->rs, u2->rs, M + 1, R);
73         pushup(u1, u2);
74     }
75 }
76
77 void pushdown(Node *x, Node *y) {
78     ll val = std::max(x->ls->maxV, x->rs->maxV);
79     std::array<Node*, 2> aim({y, x});
80     Node *curl = aim[x->ls->maxV == val], *curr = aim[x->rs->maxV == val];
81     x->ls->maxAdd = std::max(x->ls->maxAdd, x->ls->add + curl->maxAdd);
82     x->ls->maxHistory = std::max(x->ls->maxHistory, x->ls->maxV + curl->maxAdd);
83     x->ls->addVal(curl->add, x->ls->maxCnt);
84     x->rs->maxAdd = std::max(x->rs->maxAdd, x->rs->add + curr->maxAdd);
85     x->rs->maxHistory = std::max(x->rs->maxHistory, x->rs->maxV + curr->maxAdd);
86     x->rs->addVal(curr->add, x->rs->maxCnt);
87     y->ls->maxAdd = std::max(y->ls->maxAdd, y->ls->add + y->maxAdd);
88     y->rs->maxAdd = std::max(y->rs->maxAdd, y->rs->add + y->maxAdd);
89     y->ls->addVal(y->add, x->ls->r - x->ls->l + 1 - x->ls->maxCnt);
90     y->rs->addVal(y->add, x->rs->r - x->rs->l + 1 - x->rs->maxCnt);
91     x->add = y->add = x->maxAdd = y->maxAdd = 0;
92 }
93
94 void addV(Node *x, Node *y, int L, int R, ll k) {
95     if (x->inRange(L, R)) {
96         x->makeAdd(k, x->maxCnt);
97         y->makeAdd(k, x->r - x->l + 1 - x->maxCnt);
98     } else if (!x->outRange(L, R)) {

```

```

99     pushdown(x, y);
100     addV(x->ls, y->ls, L, R, k);
101     addV(x->rs, y->rs, L, R, k);
102     pushup(x, y);
103 }
104 }
105
106 std::array<ll, 3> qry(Node *x, Node *y, const int L, const int R) {
107     if (x->inRange(L, R)) return {x->sum + y->sum * ((x->r - x->l + 1) != x->maxCnt), x->maxV, x->maxHistory};
108     else if (x->outRange(L, R)) return {0, -inf, -inf};
109     else {
110         pushdown(x, y);
111         auto A = qry(x->ls, y->ls, L, R), B = qry(x->rs, y->rs, L, R);
112         return {A[0] + B[0], std::max(A[1], B[1]), std::max(A[2], B[2])};
113     }
114 }
115
116 void minV(Node *x, Node *y, const int L, const int R, int k) {
117     if (x->maxV <= k) return;
118     if (x->inRange(L, R) && y->maxV < k) {
119         ll delta = k - x->maxV;
120         x->makeAdd(delta, x->maxCnt);
121     } else if (!x->outRange(L, R)) {
122         pushdown(x, y);
123         minV(x->ls, y->ls, L, R, k);
124         minV(x->rs, y->rs, L, R, k);
125         pushup(x, y);
126     }
127 }
128
129 int main() {
130     std::ios::sync_with_stdio(false);
131     std::cin.tie(nullptr);
132     int n, m;
133     std::cin >> n >> m;
134     for (int i = 1; i <= n; ++i) std::cin >> a[i];
135     Node *rot1, *rot2;
136     New(rot1, rot2, 1, n);
137     for (int op, l, r; m; --m) {
138         std::cin >> op >> l >> r;
139         if (op == 1) {
140             std::cin >> op;
141             addV(rot1, rot2, l, r, op);
142         } else if (op == 2) {
143             std::cin >> op;
144             minV(rot1, rot2, l, r, op);
145         } else {
146             std::cout << qry(rot1, rot2, l, r)[op - 3] << '\n';
147         }
148     }
149 }

```

珂朵莉树

```

1  auto getPos(int pos) {
2      return --s.upper_bound({pos + 1, 0, 0});
3  }
4
5  void split(int pos) {
6      auto it = getPos(pos);
7      auto [l, r, v] = *it;
8      s.erase(it);
9      if (pos > l) s.insert({l, pos - 1, v});
10     s.insert({pos, r, v});
11 }
12
13 void add(int l, int r, int v) {
14     split(l); split(r + 1);
15     for (auto x = getPos(l), y = getPos(r + 1); x != y; ++x) {
16         x->v += v;
17     }

```

```

18 }
19
20 void upd(int l, int r, int v) {
21     split(l); split(r + 1);
22     s.erase(getPos(l), getPos(r + 1));
23     s.insert({l, r, v});
24 }

```

getPos(pos): 找到 pos 所在的迭代器

split(pos): 把 pos 所在的迭代器区间 [l, r] 分成 [l, pos - 1] 和 [pos, r] 两个

李超树

插入线段 $kx + b$ 求某点最值

```

1  constexpr long long INF = 1'000'000'000'000'000'000;
2  constexpr int C = 100'000;
3  struct Line {
4      int k;
5      long long b;
6      Line(int k, long long b) : k(k), b(b) {}
7  };
8  long long f(const Line &line, int x) {
9      return 1LL * line.k * x + line.b;
10 }
11 struct Node {
12     Node *lc, *rc;
13     Line line;
14     Node(const Line &line) : lc(nullptr), rc(nullptr), line(line) {}
15 };
16 void modify(Node *&p, int l, int r, Line line) {
17     if (p == nullptr) {
18         p = new Node(line);
19         return;
20     }
21     int m = (l + r) / 2;
22     bool le = f(p -> line, l) < f(line, l);
23     bool mi = f(p -> line, m) < f(line, m);
24     if (!mi)
25         std::swap(p -> line, line);
26     if (r - l == 1)
27         return;
28     if (le != mi) {
29         modify(p -> lc, l, m, line);
30     } else {
31         modify(p -> rc, m, r, line);
32     }
33 }
34 Node *merge(Node *p, Node *q, int l, int r) {
35     if (p == nullptr)
36         return q;
37     if (q == nullptr)
38         return p;
39     int m = (l + r) / 2;
40     p -> lc = merge(p -> lc, q -> lc, l, m);
41     p -> rc = merge(p -> rc, q -> rc, m, r);
42     modify(p, l, r, q -> line);
43     return p;
44 }
45 long long query(Node *p, int l, int r, int x) {
46     if (p == nullptr)
47         return INF;
48     long long ans = f(p -> line, x);
49     if (r - l == 1)
50         return ans;
51     int m = (l + r) / 2;
52     if (x < m) {
53         return std::min(ans, query(p -> lc, l, m, x));
54     } else {
55         return std::min(ans, query(p -> rc, m, r, x));
56     }
57 }

```

57 }

动态维护凸壳

```
1  /**
2   * Author: Simon Lindholm
3   * Date: 2017-04-20
4   * License: CC0
5   * Source: own work
6   * Description: Container where you can add lines of the form  $kx+m$ , and query maximum values at points  $x$ .
7   * Useful for dynamic programming.
8   * Time:  $O(\log N)$ 
9   * Status: tested
10  */
11
12 struct Line {
13     mutable ll k, m, p;
14     bool operator<(const Line &o) const { return k < o.k; }
15     bool operator<(ll x) const { return p < x; }
16 };
17
18 struct LineContainer: multiset<Line, less<>> {
19     const ll inf = LLONG_MAX;
20     ll val_offset = 0;
21     void offset(ll x) {
22         val_offset += x; //整体加
23     }
24     ll div(ll a, ll b) {
25         return a / b - ((a^b) < 0 && a%b);
26     }
27     bool isect(iterator x, iterator y) {
28         if (y == end()) {
29             x->p = inf;
30             return 0;
31         }
32         if (x->k == y->k) {
33             x->p = (x->m > y->m)? inf: -inf;
34         } else {
35             x->p = div(y->m - x->m, x->k - y->k);
36         }
37         return x->p >= y->p;
38     }
39     void add(ll k, ll m) {
40         auto z = insert({k, m - val_offset, 0}), y = z++, x = y; //这里加减看情况
41         while (isect(y, z)) z = erase(z);
42         if (x != begin() && isect(--x, y)) isect(x, y = erase(y));
43         while ((y = x) != begin() && (--x)->p >= y->p) isect(x, erase(y));
44     }
45     ll query(ll x) {
46         assert(!empty());
47         auto l = *lower_bound(x);
48         return l.k * x + l.m + val_offset;
49     }
50 };
51
52 LineContainer* merge(LineContainer *S, LineContainer *T) {
53     if (S->size() > T->size())
54         swap(S, T);
55     for (auto l: *S) {
56         T->add(l.k, l.m + S->val_offset);
57     }
58     return T;
59 }
```

TODO

线段树合并和分裂

图论

LCA

- 倍增

```
1 void dfs(int u, int fa) {
2     pa[u][0] = fa; dep[u] = dep[fa] + 1;
3     FOR (i, 1, SP) pa[u][i] = pa[pa[u][i - 1]][i - 1];
4     for (int& v: G[u]) {
5         if (v == fa) continue;
6         dfs(v, u);
7     }
8 }
9
10 int lca(int u, int v) {
11     if (dep[u] < dep[v]) swap(u, v);
12     int t = dep[u] - dep[v];
13     FOR (i, 0, SP) if (t & (1 << i)) u = pa[u][i];
14     FORD (i, SP - 1, -1) {
15         int uu = pa[u][i], vv = pa[v][i];
16         if (uu != vv) { u = uu; v = vv; }
17     }
18     return u == v ? u : pa[u][0];
19 }
```

计算几何

二维几何：点与向量

```
1 #define y1 yy1
2 #define nxt(i) ((i + 1) % s.size())
3 typedef double LD;
4 const LD PI = 3.14159265358979323846;
5 const LD eps = 1E-10;
6 int sgn(LD x) { return fabs(x) < eps ? 0 : (x > 0 ? 1 : -1); }
7 struct L;
8 struct P;
9 typedef P V;
10 struct P {
11     LD x, y;
12     explicit P(LD x = 0, LD y = 0): x(x), y(y) {}
13     explicit P(const L& l);
14 };
15 struct L {
16     P s, t;
17     L() {}
18     L(P s, P t): s(s), t(t) {}
19 };
20
21 P operator + (const P& a, const P& b) { return P(a.x + b.x, a.y + b.y); }
22 P operator - (const P& a, const P& b) { return P(a.x - b.x, a.y - b.y); }
23 P operator * (const P& a, LD k) { return P(a.x * k, a.y * k); }
24 P operator / (const P& a, LD k) { return P(a.x / k, a.y / k); }
25 inline bool operator < (const P& a, const P& b) {
26     return sgn(a.x - b.x) < 0 || (sgn(a.x - b.x) == 0 && sgn(a.y - b.y) < 0);
27 }
28 bool operator == (const P& a, const P& b) { return !sgn(a.x - b.x) && !sgn(a.y - b.y); }
29 P::P(const L& l) { *this = l.t - l.s; }
30 ostream& operator << (ostream& os, const P& p) {
31     return (os << "(" << p.x << ", " << p.y << ")");
32 }
33 istream& operator >> (istream& is, P& p) {
34     return (is >> p.x >> p.y);
35 }
36
37 LD dist(const P& p) { return sqrt(p.x * p.x + p.y * p.y); }
38 LD dot(const V& a, const V& b) { return a.x * b.x + a.y * b.y; }
39 LD det(const V& a, const V& b) { return a.x * b.y - a.y * b.x; }
```

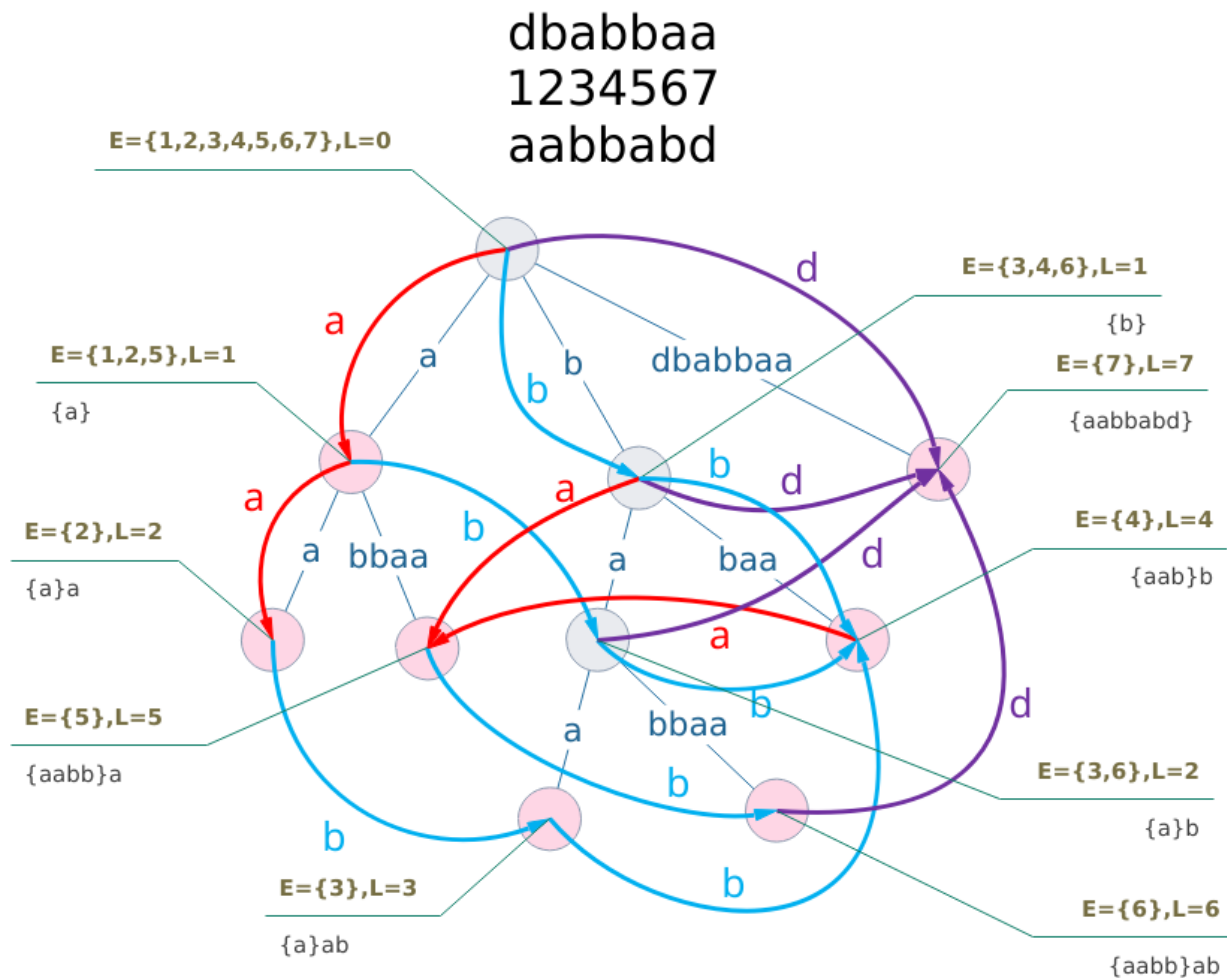
```

40 LD cross(const P& s, const P& t, const P& o = P()) { return det(s - o, t - o); }
41 // -----

```

字符串

后缀自动机



杂项

STL

- copy

```

1 template <class InputIterator, class OutputIterator>
2 OutputIterator copy (InputIterator first, InputIterator last, OutputIterator result);

```