线段树练习

人员

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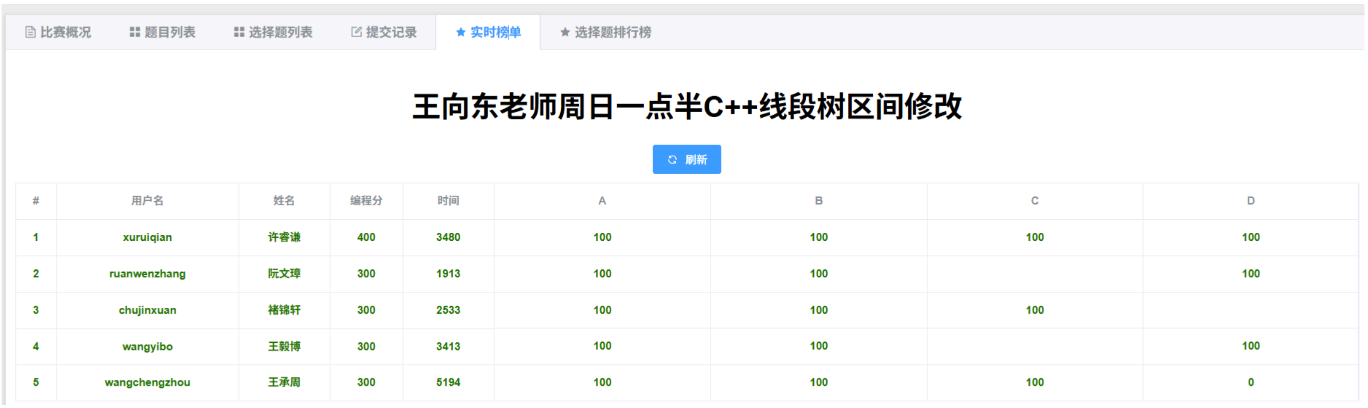
上周作业检查

上周作业链接: https://cppoj.kids123code.com/contest/1689



王向东老师周日一点半C++线段树区间修改

#	用户名	姓名	编程分	时间	A	B	C	D
1	xuruiqian	许睿谦	400	3480	100	100	100	100
2	ruanwenzhang	阮文璋	300	1913	100	100		100
3	chujinxuan	褚锦轩	300	2533	100	100	100	
4	wangyibo	王毅博	300	3413	100	100		100
5	wangchengzhou	王承周	300	5194	100	100	100	0

本周作业

https://cppoj.kids123code.com/contest/1789 (课上讲了 A ~ C 题, 课后作业是 C 题)

课堂表现

今天讲了几道线段树比较复杂的题目, 同学们课上做起来整体会比较吃力一些, 会遇到各种各样的错误

连上之前的课, 最近 3 节课一共讲了 10 道线段树的题目, 同学们课下要多复习这 10 道题, 确保能把这 10 道题写熟, 这样以后遇到线段树的题, 才能比较快的做对。

课堂内容

[TJOI2009] 开关 (上周作业)

tr[u].sum: u 这一段中 1 的数量

tr[u].len: u 这一段的长度

tr[u].flag: u 这一段被修改了多少次

每修改一次, 相当于做一次翻转, sum 需要改成 len-sum

```
#include <bits/stdc++.h>

using namespace std;

const int maxn = 1e5 + 5;
```

```
struct node {
  int l, r, len, sum;
  int flag;
} tr[maxn*4];

void pushup(int u) { tr[u].sum = tr[u*2].sum + tr[u*2+1].sum; }

void pushdown(int u) {
  if (tr[u].flag & 1) {
    tr[u*2].flag += 1, tr[u*2+1].flag += 1;
    tr[u*2].sum = tr[u*2].len - tr[u*2].sum;
    tr[u*2+1].sum = tr[u*2+1].len - tr[u*2+1].sum;
  }
  tr[u].flag = 0;
}

void build(int u, int l, int r) {
  tr[u] = {l, r, r-l+1};
  if (l == r) return;

  int mid = (l + r) / 2;
  build(u*2, l, mid), build(u*2+1, mid+1, r);
}

void modify(int u, int l, int r) {
  if (tr[u].l>=l && tr[u].r<=r) {
    tr[u].flag++; tr[u].sum = tr[u].len-tr[u].sum; return;
  }

  pushdown(u);
  int mid = (tr[u].l + tr[u].r) / 2;
  if (l <= mid) modify(u*2, l, r);
  if (r > mid) modify(u*2+1, l, r);
  pushup(u);
}

int query(int u, int l, int r) {
  if (tr[u].l>=l && tr[u].r<=r) return tr[u].sum;

  pushdown(u);
  int mid = (tr[u].l + tr[u].r) / 2;
  int sum = 0;
  if (l <= mid) sum += query(u*2, l, r);
  if (r > mid) sum += query(u*2+1, l, r);
  return sum;
}

int main()
{
  int n, m; cin >> n >> m;
  build(1, 1, n);
  while (m -- ) {
    int op, l, r; cin >> op >> l >> r;
    if (op == 0) modify(1, l, r);
    else cout << query(1, l, r) << endl;
  }
  return 0;
}
```

扶苏的问题

同时维护 flag 和 add 两个懒标记, 代表是否变为同一值 和 加了多少

```
#include <bits/stdc++.h>
#define int long long

using namespace std;

const int maxn = 1e6 + 5;
const int inf = 0x3f3f3f3f3f3f3f3f;
struct node {
  int l, r, maxx, flag, add;
} tr[maxn*4];
int w[maxn];

void pushup(int u) { tr[u].maxx = max(tr[u*2].maxx, tr[u*2+1].maxx); }
void pushdown(int u) {
  if (tr[u].flag != inf) {
    int v = tr[u].flag + tr[u].add;
    tr[u*2].flag = v, tr[u*2].add = 0, tr[u*2].maxx = v;
    tr[u*2+1].flag = v, tr[u*2+1].add = 0, tr[u*2+1].maxx = v;
    tr[u].flag = inf, tr[u].add = 0;
  } else if (tr[u].add) {
    tr[u*2].add += tr[u].add, tr[u*2].maxx += tr[u].add;
    tr[u*2+1].add += tr[u].add, tr[u*2+1].maxx += tr[u].add;
    tr[u].add = 0;
  }
}
void build(int u, int l, int r) {
  tr[u] = {l, r, 0, inf, 0};
  if (l == r) { tr[u].maxx = w[l]; return; }

  int mid = (l + r) / 2;
  build(u*2, l, mid), build(u*2+1, mid+1, r);
  pushup(u);
}
void modify(int u, int l, int r, bool is_flag, int k) {
  if (tr[u].l>=l && tr[u].r<=r) {
    if (is_flag) tr[u].flag = k, tr[u].add = 0, tr[u].maxx = k;
    else tr[u].add += k, tr[u].maxx += k;
    return;
  }

  pushdown(u);
  int mid = (tr[u].l + tr[u].r) / 2;
```

```
    if (l <= mid) modify(u*2, l, r, is_flag, k);
    if (r > mid) modify(u*2+1, l, r, is_flag, k);
    pushup(u);
  }
  int query(int u, int l, int r) {
    if (tr[u].l>=l && tr[u].r<=r) return tr[u].maxx;

    pushdown(u);
    int mid = (tr[u].l + tr[u].r) / 2, res = -inf;
    if (l <= mid) res = max(res, query(u*2, l, r));
    if (r > mid) res = max(res, query(u*2+1, l, r));
    return res;
  }

  signed main()
  {
    ios::sync_with_stdio(false);
    cin.tie(0); cout.tie(0);

    int n, m; cin >> n >> m;
    for (int i = 1; i <= n; ++i) cin >> w[i];
    build(1, 1, n);

    while (m -- ) {
      int op, l, r; cin >> op >> l >> r;
      if (op == 1) {
        int k; cin >> k; modify(1, l, r, true, k);
      } else if (op == 2) {
        int k; cin >> k; modify(1, l, r, false, k);
      } else cout << query(1, l, r) << "\n";
    }
    return 0;
  }
```

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维护 sum, lmax, rmax, vmax 四个信息

分别代表 区间和, 前缀最大子段, 后缀最大子段, 内部最大子段 4 个信息

```
#include <bits/stdc++.h>

using namespace std;

const int maxn = 5e5 + 5;
const int inf = 0x3f3f3f3f;
struct node {
  int l, r;
  int sum, lmax, rmax, vmax;
} tr[maxn*4];
int w[maxn];
```

```
void pushup(int u) {
  node &uu = tr[u], &ll = tr[u*2], &rr = tr[u*2+1];
  uu.sum = ll.sum + rr.sum;
  uu.lmax = max(ll.lmax, ll.sum + rr.lmax);
  uu.rmax = max(rr.rmax, rr.sum + ll.rmax);
  uu.vmax = max({ll.vmax, rr.vmax, ll.rmax+rr.lmax});
}
void build(int u, int l, int r) {
  tr[u] = {l, r, 0, 0, 0, 0};
  if (l == r) { tr[u].sum = tr[u].lmax = tr[u].rmax = tr[u].vmax = w[l]; return; }

  int mid = (l + r) / 2;
  build(u*2, l, mid), build(u*2+1, mid+1, r);
  pushup(u);
}
void modify(int u, int pos, int k) {
  if (tr[u].l == tr[u].r) {
    tr[u].sum = tr[u].lmax = tr[u].rmax = tr[u].vmax = k; return;
  }

  int mid = (tr[u].l + tr[u].r) / 2;
  if (pos <= mid) modify(u*2, pos, k);
  else modify(u*2+1, pos, k);
  pushup(u);
}
node query(int u, int l, int r) {
  if (tr[u].l>=l && tr[u].r<=r) return tr[u];

  int mid = (tr[u].l + tr[u].r) / 2;
  if (r <= mid) return query(u*2, l, r);
  if (l > mid) return query(u*2+1, l, r);

  node a = query(u*2, l, r), b = query(u*2+1, l, r);
  node c = {a.l, b.r, a.sum+b.sum, max(a.lmax,a.sum+b.lmax), \
            max(b.rmax,b.sum+a.rmax), max({a.vmax,b.vmax,a.rmax+b.lmax})};
  return c;
}

int main()
{
  int n, m; cin >> n >> m;
  for (int i = 1; i <= n; ++i) cin >> w[i];
  build(1, 1, n);

  while (m -- ) {
    int op; cin >> op;
    if (op == 1) {
      int l, r; cin >> l >> r;
      if (l > r) swap(l, r);
      cout << query(1, l, r).vmax << endl;
    } else {
      int pos, k; cin >> pos >> k;
      modify(1, pos, k);
    }
  }
  return 0;
}
```

无聊的数列

维护 2 个懒标记 K 和 D, 分别代表对于 u 这一段, 对首项加了多少, 以及后面每一项的公差多多少

```
#include <bits/stdc++.h>
#define int long long

using namespace std;

const int maxn = 1e5 + 5;
struct node {
  int l, r, K, D;
} tr[maxn*4];
int w[maxn];

void pushdown(int u) {
  node &uu = tr[u], &ll = tr[u*2], &rr = tr[u*2+1];
  ll.K += uu.K, ll.D += uu.D;
  rr.K += uu.K + uu.D*(rr.l-uu.l), rr.D += uu.D;
  uu.K = 0, uu.D = 0;
}
void build(int u, int l, int r) {
  tr[u] = {l, r, 0, 0};
  if (l == r) { tr[u].K = w[l]; return; }

  int mid = (l + r) / 2;
  build(u*2, l, mid), build(u*2+1, mid+1, r);
}
void modify(int u, int l, int r, int k, int d) {
  if (tr[u].l>=l && tr[u].r<=r) {
    tr[u].K += k + d*(tr[u].l-l), tr[u].D += d;
    return;
  }

  pushdown(u);
  int mid = (tr[u].l + tr[u].r) / 2;
  if (l <= mid) modify(u*2, l, r, k, d);
  if (r > mid) modify(u*2+1, l, r, k, d);
}
int query(int u, int pos) {
  if (tr[u].l == tr[u].r) return tr[u].K;

  pushdown(u);
  int mid = (tr[u].l + tr[u].r) / 2;
  if (pos <= mid) return query(u*2, pos);
  return query(u*2+1, pos);
}

signed main()
{
  int n, m; cin >> n >> m;
  for (int i = 1; i <= n; ++i) cin >> w[i];
  build(1, 1, n);

  while (m -- ) {
    int op; cin >> op;
    if (op == 1) {
      int l, r, k, d; cin >> l >> r >> k >> d;
      modify(1, l, r, k, d);
    } else {
      int pos; cin >> pos;
      cout << query(1, pos) << endl;
    }
  }
  return 0;
}
```