GREEDY!

Dont worry its definitely not cancer

What is greedy?

Basically just take best at current position lol

> *“A greedy algorithm is any algorithm that follows the problem-solving heuristic of making the locally optimal choice at each stage. In many problems, a greedy strategy does not produce an optimal solution, but a greedy heuristic can yield locally optimal solutions that approximate a globally optimal solution in a reasonable amount of time.”*

Greedy - proving it

Essentially we want to prove that the **local optimum guarantees the overall optimum.**

How will we do this? ~~Math~~

- Stay ahead argument
- Bounding argument
- Exchange argument

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- Show that the greedy algorithm's measures are at least as good as any optimal solution's measures (This usually involves induction)

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Generally :

- Find a series of measurements M_1, M_2, …, M□ you can apply to any solution
- Show that the greedy algorithm's measures are at least as good as any optimal solution's measures (This usually involves induction)
- Prove that because the greedy solution's measures are at least as good as any solution's measures, the greedy solution must be optimal (This is usually a proof by contradiction)

Application - lunchbox

Go do lunchbox!

Hahaha get skemmed again

Just prove by ac lmao

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How will we do this? ~~Math~~

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- **Proof by AC**

Abridged problem statement

Given n lunchboxes, find the maximum number of schools you can give lunchboxes to.

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Or this…

Shi tianle is giving C people conduct slips. He can give each person C_i L[i] or 0 conduct slips. Since he is not a teacher and is not supposed to be given conduct slips, he will get caught by the teacher if he gives more than K conduct slips and be given a conduct slip! (OH NOOO) Tianle does not want to be given a conduct slip, so help tianle maximise the number of people he can give conduct slips to!

Abridged problem statement

Given n lunchboxes, find the maximum number of schools you can give lunchboxes to.

Let i_1, i_2, …, i_{grd} be the indices of schools the greedy algorithm picks. Assume $K[i_1] \leq K[i_2] \leq \ldots \leq K[i_{grd}]$.
Let j_1, j_2, …, j_{opt} be the indices of schools that an arbitrary optimal algorithm picks. Assume $K[j_1] \leq K[j_2] \leq \ldots \leq K[j_{opt}]$.

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$K[i_1] + K[i_2] + \ldots + K[i_{grd}] \leq N$

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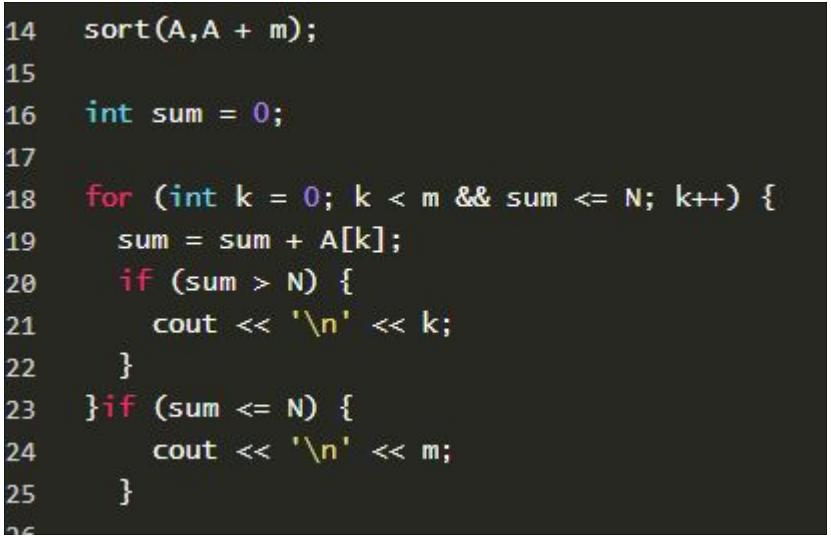
Since we know that $K[i_x] \leq K[j_x]$ for every x, grd ≥ opt. Therefore the greedy algorithm is optimal.

Lunchbox - sample code



```
sort(A,A + m);

int sum = 0;

for (int k = 0; k < m && sum <= N; k++) {
  sum = sum + A[k];
  if (sum > N) {
    cout << '\n' << k;
  }
}if (sum <= N) {
    cout << '\n' << m;
  }
```

More greedy problems

Easy problems: potato salad, gss, paint

~~Harder~~ also easy problems: catlunch, bestplace, competition

Harder problems: Luarulers

Imple cancer problem: Lualectures

Luarulers - abridged problem statement

In an array a of n elements, maximise the number of a_i such that a[1]+a[2]+a[3]…+a_i[i]= 0. We are allowed to change the values of a[b[j]] where b is an array of length m for all j.

Luarulers - st2

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We create a prefix sums array for all a[i] and find the most number of repeated sums.

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m=1, b[1] can be anywhere in a.

We realise that changing the value a[b[1]] only affects values **after** a[b[1]].

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So we maintain the same prefix sum array and just count the most number of repeated sums starting from a[b[1]].

Remember to add those sums that are already 0 in the a[1] - a[b[1]] range.

Luarulers - st4

M≥1.

We observe that for each a[b[i]] only affects the range a[b[i]] to a[b[i+1]].

Luarulers - st4

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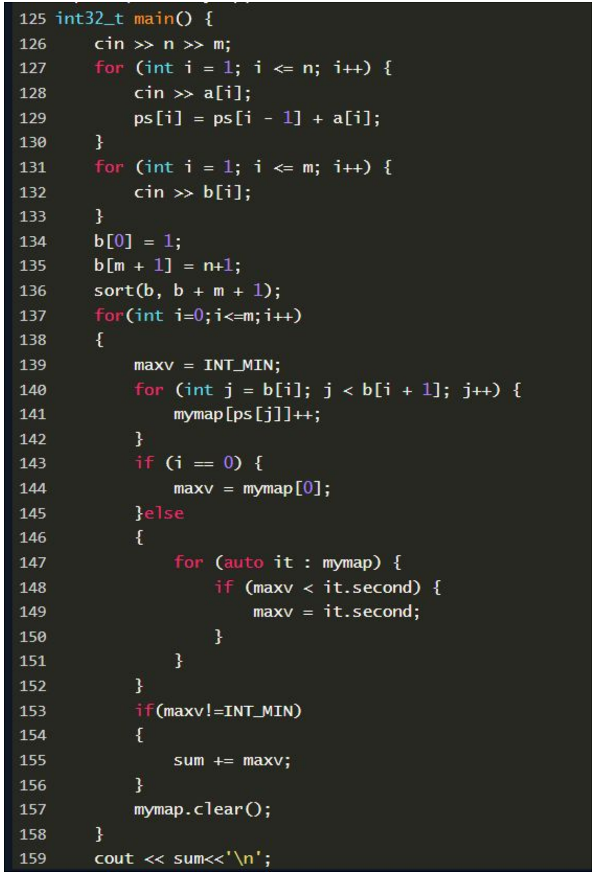
We observe that for each a[b[i]] only affects the range a[b[i]] to a[b[i+1]]. We just compute the most repeated sum in the prefix sum array for all ranges a[b[i]] to a[b[i+1]].

Remember to add the number of 0s in the range 1 to a[b[i]].

Sample code



```
int32_t main() {
    cin >> n >> m;
    for (int i = 1; i <= n; i++) {
        cin >> a[i];
        ps[i] = ps[i - 1] + a[i];
    }
    for (int i = 1; i <= m; i++) {
        cin >> b[i];
    }
    b[0] = 1;
    b[m + 1] = n+1;
    sort(b, b + m + 1);
    for(int i=0;i<=m;i++)
    {
        maxv = INT_MIN;
        for (int j = b[i]; j < b[i + 1]; j++) {
            mymap[ps[j]]++;
        }
        if (i == 0) {
            maxv = mymap[0];
        }else
        {
            for (auto it : mymap) {
                if (maxv < it.second) {
                    maxv = it.second;
                }
            }
        }
        if(maxv!=INT_MIN)
        {
            sum += maxv;
        }
        mymap.clear();
    }
    cout << sum<<'\n';
```

Sample code

Haha no stop copying my code >:(

Ac or no lunch >:(

Easy?

The previous problems were quite easy right?

Greedy easy?

Cancer problem :O free snack if solve

Lualectures

Lualectures - Abridged problem statement

Find the minimum number of lecture halls needed to hold n lectures and output the designation of each lecture hall respectively.

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Remember to give the assignment in order that the lectures are given by the question

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We observe that we can reuse a lecture hall if the start time of the lecture we are processing is more than the end time of a lecture that we have already processed.

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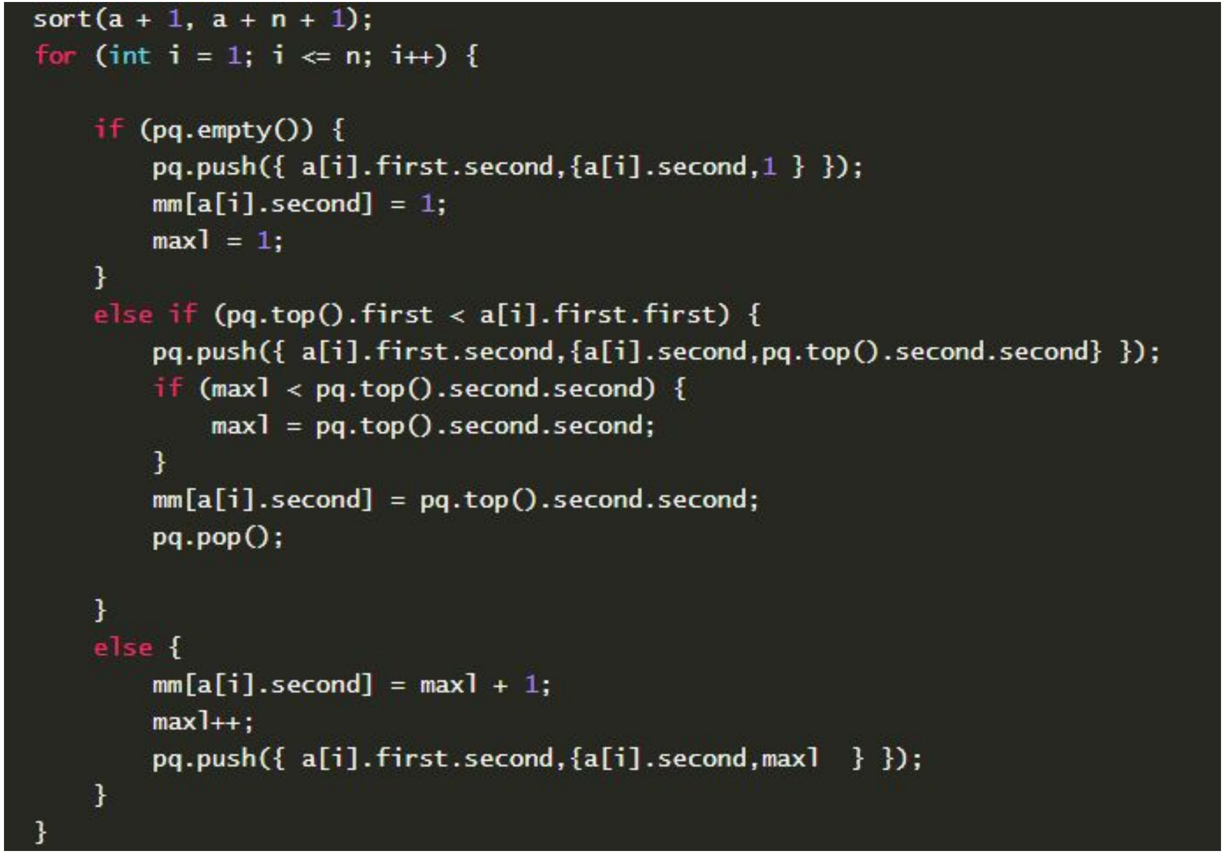
We then process lectures by their start time and keep track of ongoing lectures in a priority queue. We check that a lecture has ended when we process each new lecture and try to reuse halls as much as possible, otherwise we allocate a new lecture hall to the current lecture. We need to store this in a map as we need to give our answer in the order the question gives.

Lualectures - solution

In the end, iterate the map.

Sample code



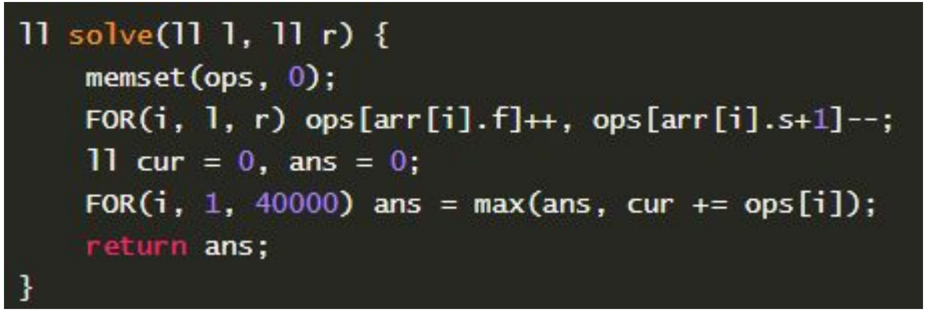
```
sort(a + 1, a + n + 1);
for (int i = 1; i <= n; i++) {

    if (pq.empty()) {
        pq.push({ a[i].first.second,{a[i].second,1 } });
        mm[a[i].second] = 1;
        maxl = 1;
    }
    else if (pq.top().first < a[i].first.first) {
        pq.push({ a[i].first.second,{a[i].second,pq.top().second.second} });
        if (maxl < pq.top().second.second) {
            maxl = pq.top().second.second;
        }
        mm[a[i].second] = pq.top().second.second;
        pq.pop();

    }
    else {
        mm[a[i].second] = maxl + 1;
        maxl++;
        pq.push({ a[i].first.second,{a[i].second,maxl  } });
    }
}
```

Fun!

Getting the maximum number of lectures is easy

Just range add 1 to [l, r] for all lecture halls and…

Range max (1, 1e9)



```
ll solve(ll l, ll r) {
    memset(ops, 0);
    FOR(i, l, r) ops[arr[i].f]++, ops[arr[i].s+1]--;
    ll cur = 0, ans = 0;
    FOR(i, 1, 40000) ans = max(ans, cur += ops[i]);
    return ans;
}
```

See workload2 (99 points).

Constructing tho… die.