Competitive Programming Hakpak

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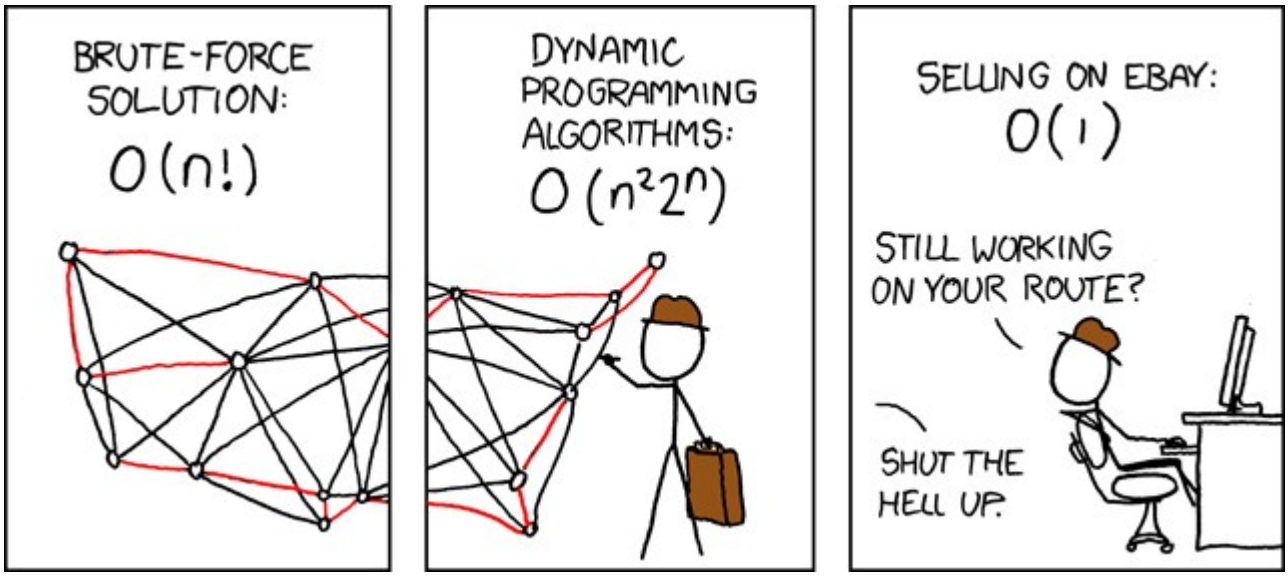

xkcd: Travelling Salesman Problem

```java
public static int BS(int[] arr, int query){
	int low = 0,high = arr.length;
	while(low<high){
		int mid = (low+high)/2;
		//Insert comparator here
		int cmp = arr[mid] - query;
		if(cmp==0){
			return mid;
		}
		else if(cmp>0){
			high = mid;
		}
		else {
			low = mid+1;
		}

	}
	return -1;
}
```

Regular Binary search.

-Search Complexity of O(log n) where n is the size of the array.

-Will return an index of the number `query`.

-Will return -1 if the element is not present.

-Array must be sorted.

-Can be modified to work for any comparator simply by modifying the way `cmp` is calculated.

```java
public static int BFS(int[] arr, int query){
	//Binary Floor Search
	int low = -1,high = arr.length;
	while(low+1<high){
		int mid = (low+high)/2;
		//Insert comparator here
		int cmp = arr[mid] - query;
		if(cmp>0){
			high = mid;
		}
		else {
			low = mid;
		}
	}
	return low;
}
```

Floored Binary search.

-Search Complexity of O(log n) where n is the size of the array.

-Will return the largest index that contains a value less than or equal to the given `query.`

-Will return -1 if no element that satisfies the conditions is present.

-Array must be sorted.

-Can be modified to work for any comparator simply by modifying the way `cmp` is calculated.

-Useful when searching for up to what point a given input/solution/etc. is valid.

For c++ look into function upper_bound and lower_bound in the algorithm library. upper_bound can be used as a floor search by subtracting 1 from the **MEMORY LOCATION** returned by it.

Segmented Tree

```
//All global variables needed
int lo[],hi[],delta[],query[],size;

//This is use-defined. (Note sums don't work with this implementation of lazy
propagation)

	static final int IDENTITY = Integer.MAX_VALUE;//Identity for Min

	int queryFunction(int a,int b){
		return Math.min(a,b);//Min Function (Clearly)
	}
```

```
public SegmentTree(int n){
	size = 4*n;
	lo = new int[size];
	hi = new int[size];
	delta = new int[size];
	query = new int[size];

	init(0,0,n-1);
}
```

```
void init(int node, int li,int ri){

	lo[node] = li;
	hi[node] = ri;
	if(li==ri)
		return;
	int mid = (li+ri)/2;
	init(node*2+1,li,mid);
	init(node*2+2,mid+1,ri);
}
```

```
void prop(int node){
	delta[2*node+1]+=delta[node];
	delta[2*node+2]+=delta[node];
	delta[node]=0;
}
```

```
void update(int node){
	query[node] = queryFunction(
		query[2*node+1]+delta[2*node+1],
		query[2*node+2]+delta[2*node+2]);
}
```

```
int query(int node,int li,int ri){
	if(ri<lo[node]||hi[node]<li)
		return IDENTITY;

	if(li<=lo[node]&&hi[node]<=ri)
		return query[node]+delta[node];

	prop(node);

	int ret = queryFunction(
		query(2*node+1,li,ri),
		query(2*node+2,li,ri));
	update(node);

	return ret;
}
```

```
void increment(int node,int li,int ri,int val){
		if(ri<lo[node]||hi[node]<li)
			return;

		if(li<=lo[node]&&hi[node]<=ri){
			delta[node]+=val;
			return;
		}

		prop(node);

		increment(2*node+1,li,ri,val);
		increment(2*node+2,li,ri,val);

		update(node);
}
```