

## TECHNIQUES

1. See the Data - *algo question = numbers and data*
2. Multiple Passes - *simplify & modify into more familiar problems*
3. Problem Toolbox
4. Data Type Toolbox

## ADT TOOLBOX

**hash-map** *dictionary* -  $O(1)$  to look up data based on key,  $O(1)$  to set data based on key. **Your fave ADT for faster, simpler algos!**

**list** *array, sequence* -  $O(n)$  to linear search,  $O(1)$  to look up index - good for ordered data

**stack** *Last in First Out* -  $O(1)$  to add or remove - good for reversing things, recursive things

**queue** *First in First Out* -  $O(1)$  to add or remove - good for processing things in order

**tree** *root* node connected to children and descendants

**graph** *vertices* connected with *edges*

## SORTING ALGOS

**quicksort** *time avg*  $O(n \log n)$  - *space*  $O(\log n)$  - pick a pivot, sort w.r.t. to pivot into two partitions, sort each partition using quicksort (another pivot)

**mergesort** *time avg*  $O(n \log n)$  - *space*  $O(n)$  - split into arrays, sort each array using mergesort (smaller arrays), combine sorted arrays in order

**insertion sort** *time avg*  $O(n^2)$  - *space*  $O(1)$  - "pick up" an item, and move left into sorted portion until you find a spot where it fits between, then place

**selection sort** *time avg*  $O(n^2)$  - *space*  $O(1)$  - find smallest item, put on left in sorted portion, then repeat for next smallest in unsorted

**bubblesort** *time avg*  $O(n^2)$  - *space*  $O(1)$  - keep on swapping adjacent items, until you go through the array with no more items needing to be swapped

## PROBLEM TOOLBOX

**minimum**  $O(n)$

```
min_found = None
for n in list_of_numbers:
    if min_found == None:
        min_found = n
    if n < min_found:
        min_found = n
```

**maximum**  $O(n)$  - implementation is same as above, save for  $n > \text{max\_found}$

**counting occurrences**  $O(n)$

```
c = {}
for item in items:
    if item not in c:
        c[item] = 0
    c[item] += 1
```

**filtering collection**  $O(n)$  - create a new, smaller list only containing data adhering to a condition

```
output = []
for item in items:
    if item > 5: # or something
        output.append(item)
```

**transforming collection**  $O(n)$  - create a list of same length, but with data changed

```
output = []
for item in items:
    # Any method or operation
    modified = item * 2
    output.append(modified)
```

**intersection between collections**  $O(n)$  - find items in one collection that are (or are not) in another collection. Use **set** instead of **list** since set operations are  $O(1)$

```
data_2_set = set(data_2)
overlap = []
for item in data_1:
    if item in data_2_set:
        overlap.append(item)
```

**cross operation**  $O(n^2)$  - perform operation on each element w.r.t. another element

```
out = []
for a in data_1:
    for b in data_2:
        out.append(a * b)
```

## DATA STRUCTURES

Many approaches to implement ADTs:

**Linked lists** Implement with dicts

```
c = {"data": "C", "next": None}
b = {"data": "B", "next": c}
a = {"data": "A", "next": b}
```

**Stacks, queues** Just a list, but only using first and/or last items

**Tree** Impl. with dicts and lists

```
root = {
    "data": "Grandma",
    "children": [{
        "data": "Mom",
        "children": [{"data": "Me"}],
    }, {
        "data": "uncle",
        "children": []
    }]
}
```

**Graph (directed)** Store vertices in dict, outward edges in list

```
graph = {
    "NYC": ["SFO", "ORD", "DTW", "LAX"],
    "SFO": ["LAX", "OAK", "NYC", "DTW"],
    "SAC": ["OAK", "SFO", "LAX"],
}
```

## TERMINOLOGY

**Problem** Given an input of a certain type, make an output (solution)

**Algorithm** A precise series of steps that solves a problem

**Implementation** The code used to perform an algorithm

**Time complexity** *algorithmic speed* - "Given a problem input of size  $n$ , how many steps does algo take to solve?"

**Big O** Notation for time complexity

**Abstract Data Types** Ways to structure data, defined in English, useful to model data

**Data structures** Implementations with code of an ADT, used to implement algorithms