CSc 110

Sort

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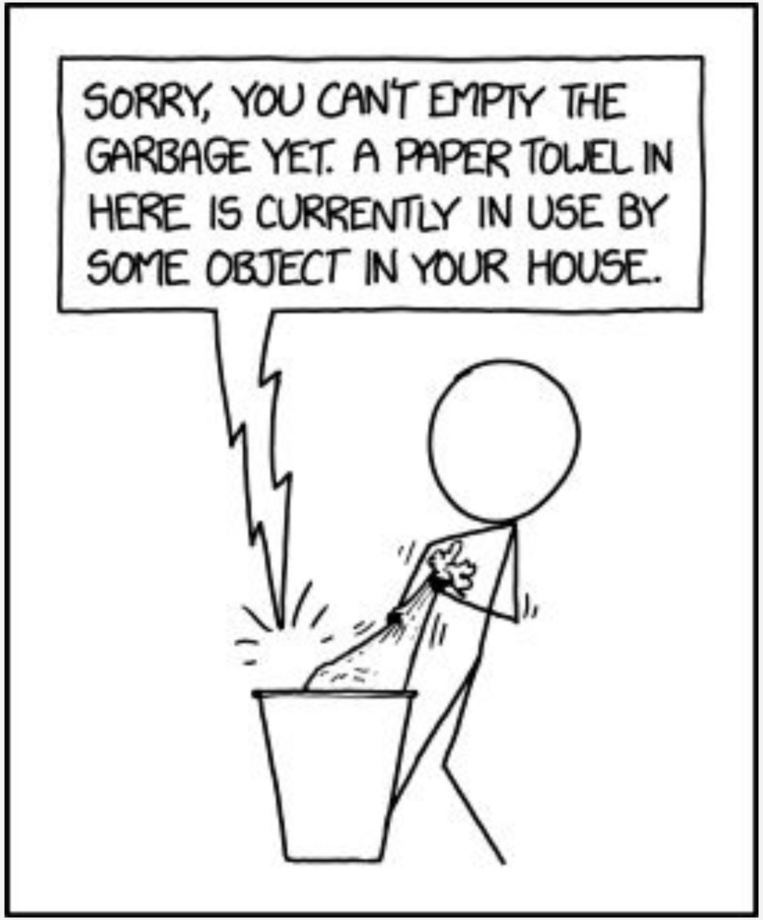
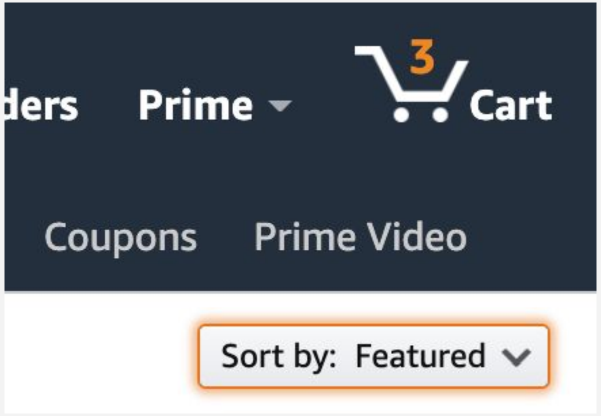

SORRY, YOU CAN'T EMPTY THE GARBAGE YET. A PAPER TOWEL IN HERE IS CURRENTLY IN USE BY SOME OBJECT IN YOUR HOUSE.

Sorting

- A number of reasons to want sorted data
  - For doing binary search!
  - Finding a median value
  - Finding the min and max
  - Others?



Sorting

- lists have built-in functionality to rearrange the elements to be in sorted order
    - `list_var.sort()` or `sorted(list_var)`
- But, someone at some point had to come up with an **algorithm** for this!
- How does sorting work, behind the scenes?

What is a sorted list?

- A **sorting algorithm** is an algorithm that puts elements of a list in a certain order
- However, there are different types of “ordering”
    - Ascending numeric order (numbers)
    - Descending numeric order (numbers)
    - Lexicographic (strings)
    - Others…
- We will mostly stick with Ascending numeric for the examples in this lecture

What is a sorted list?

```
items = [5, 10, 20, 6, 7, 9, 43, 10, 12]
```

index	0	1	2	3	4	5	6	7	8
value	5	10	20	6	7	9	43	10	12

Not Sorted

```
items = [5, 6, 7, 9, 10, 10, 12, 20, 43]
```

index	0	1	2	3	4	5	6	7	8
value	5	6	7	9	10	10	12	20	43

Sorted (ascending)

Come up with a sorting algorithm

- Discuss ideas for how to sort numbers
- Depict your algorithm with drawings/diagrams or with pseudocode
- can't use the `.sort()` function

In-place and Out-of-place

- **In-place sorting:** does not require a secondary data structure
- **Out-of-place sorting:** may require a secondary data structure

Selection Sort

- **Selection Sort** is a very simple sorting algorithm
  - Scan the list and find the smallest element
  - Swap this element with the beginning element
  - Continue these steps for the remaining list, not including the element just swapped
  - Repeat

Selection Sort

- Visualizing sorting algorithms with graphics can give one a better understanding

https://visualgo.net/en/sorting

Selection Sort

```python
def selection_sort(items):
    begin = 0
    for i in range(len(items)-1):
        small_i = begin
        for j in range(begin, len(items)):
            if items[small_i] > items[j]:
                small_i = j
        items[begin], items[small_i] = items[small_i], items[begin]
        begin += 1
```

How many total sweeps and swaps to sort this list?

index	0	1	2	3	4
value	3	1	7	2	4

How many total swaps to sort this list?

index	0	1	2	3	4	5	6
value	3	1	7	2	4	8	5

Bubble Sort

- **Bubble Sort**: another sorting algorithm
    - Scan through each element in the list, comparing the current element with the next one
    - If the next one is smaller, swap the elements
    - Continue these iterations until the whole list is sorted
- This causes the large elements to “bubble up” to the top

Bubble Sort

```python
def bubble_sort(items):
    end = len(items)
    for i in range(len(items)-1):
        for j in range(0, end-1):
            if items[j] > items[j+1]:
                items[j], items[j+1] = items[j+1], items[j]
        end -= 1
```

Activity

How many sweeps and swaps until it is sorted?

index	0	1	2	3	4
value	3	1	7	2	4

Activity

How many sweeps and swaps until it is sorted?

index	0	1	2	3	4	5	6
value	7	1	5	2	4	3	8

Insertion Sort

- **Insertion Sort**: another sorting algorithm
- Let’s go to the visualization tool

Insertion Sort

```python
def insertion_sort(items):
    for compare_index in range(1, len(items)):
        ci = compare_index
        for j in range(ci-1, -1, -1):
            if ci < 0 or items[ci] >= items[j]:
                break
            else:
                items[ci], items[j] = items[j], items[ci]
                ci -= 1
```

How many TOTAL swaps to sort?

index	0	1	2	3	4
value	3	1	7	2	4

Activity

How many TOTAL swaps to sort?

index	0	1	2	3	4	5	6
value	3	1	7	2	4	8	5

Lots of algorithms

- There are many sorting algorithms
    - **Bogo sort**
    - **Selection sort**
    - **Bubble sort**
    - **Insertion sort**
    - **Merge sort**
    - **Quick sort**
    - ...more...

Timing and Vis

- sort_timing.py
- https://www.youtube.com/watch?v=kPRA0W1kECg