SORTING BASICS

David Kauchak
CS 62 – Spring 2021

1

Admin

Erin's office hours today 7-8pm (going forward)

My office hours today 3:30-4pm

Compression assignment hints/observations

2

Sorting

What sorting algorithms have you seen before?

If I gave you a deck of cards and asked you to sort it, how would you do it?

3

Sorting algorithms

Adaptive heapsort	Comb sort	Pancake sort
Bitonic sorter	Flashsort	**Quicksort**
Block sort	Gnome sort	Radix sort
Bubble sort	**Heapsort**	**Selection sort**
Bucket sort	**Insertion sort**	Shell sort
Cascade mergsort	Library sort	Spaghetti sort
Cocktail sort	**Mergesort**	**Treesort**

4

Selection sort

Divide the data into two parts: sorted and unsorted

Repeat:

5

Selection sort

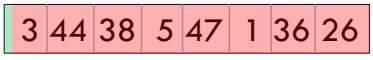
Divide the array into two parts: a sorted part on the left and an unsorted part on the right

Repeat:

- Find the smallest element in the unsorted part
- Swap it with the leftmost element of the unsorted array
- The sorted array is now one element larger

6

Selection sort



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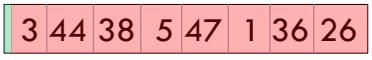

sorted unsorted

Smallest?

Divide the array into two parts: a sorted part on the left and an unsorted part on the right

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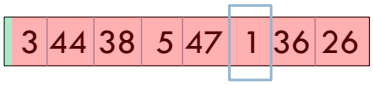

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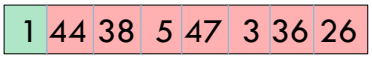

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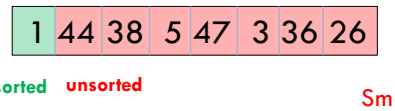

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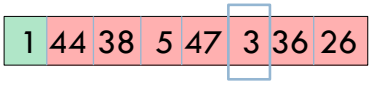

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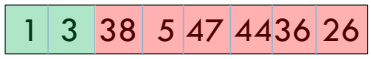

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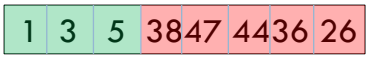

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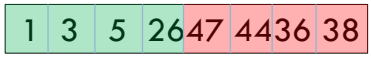

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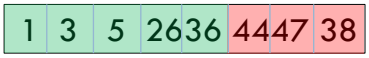

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Running time to find the smallest element

Best case?

Worst case?

Average case?

Divide the array into two parts: a sorted part on the left and an unsorted part on the right

Repeat:

- **Find the smallest element in the unsorted part**
- Swap it with the leftmost element of the unsorted array
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Running time to find the smallest element

All cases: size_of_unsorted_array – we have to search through the entire unsorted array to find it

Divide the array into two parts: a sorted part on the left and an unsorted part on the right

Repeat:

- **Find the smallest element in the unsorted part**
- Swap it with the leftmost element of the unsorted array
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18

Overall runtime

3	44	38	5	47	1	36	26

sorted **unsorted**

size_of_unsorted_array

How big is this for the first iteration?

19

Overall runtime

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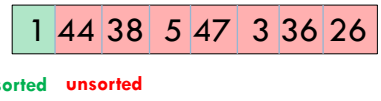
sorted **unsorted**

size_of_unsorted_array

How big is this for the first iteration? n

20

Overall runtime

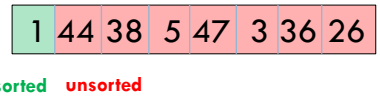


size_of_unsorted_array

How big is this for the second iteration?

21

Overall runtime

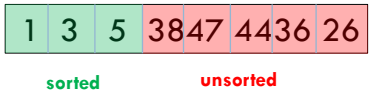


size_of_unsorted_array

How big is this for the second iteration? n-1

22

Overall runtime

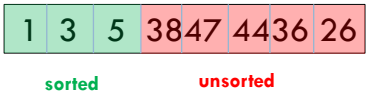


size_of_unsorted_array

How big is this for the second iteration?

23

Overall runtime

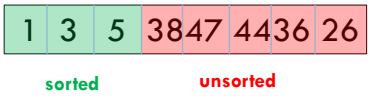


size_of_unsorted_array

How big is this for the second iteration? n-2

24

Overall runtime

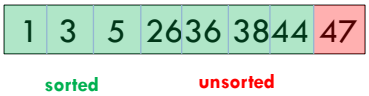


size_of_unsorted_array

How big is this for the last iteration?

25

Overall runtime



size_of_unsorted_array

How big is this for the last iteration? 1

26

Overall runtime

$$runtime = 1 + 2 + 3 + n - 2 + n - 1 + n = \sum_{i=1}^{n} i$$

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Overall runtime

$$runtime = \sum_{i=1}^{n} i$$?

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Overall runtime

$$runtime = \sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$

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Overall runtime

$$runtime = \sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$ O(?)

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Selection sort: overall runtime

$$runtime = \sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$ $O(n^2)$

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Insertion sort

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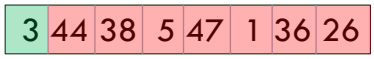

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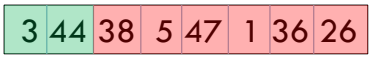

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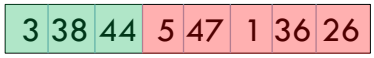

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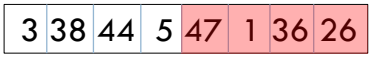

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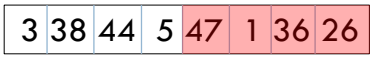

sorted unsorted

Is 5 in the correct spot?

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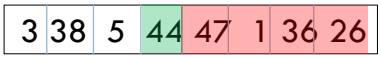

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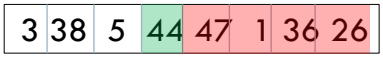

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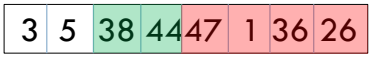

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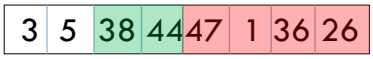

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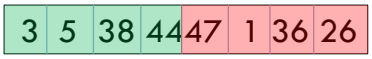

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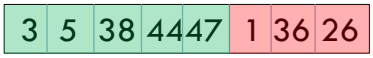

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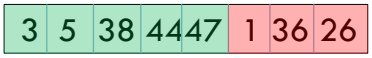

sorted unsorted

Was that fast or slow?

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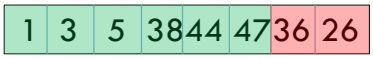

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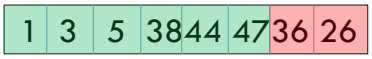

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Running time to find the correct spot

Best case?

Worst case?

Average case?

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Running time to find the correct spot

Best case: O(1), it's larger than any element to the left

Worst case: size_sorted_part, it's smaller than any element to the left

Average case: size_sorted_part/2

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Repeat:
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Insertion sort: overall runtime

Best case? When does this happen?

Worst case? When does this happen?

Average case?

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Overall runtime

Best case: $O(n)$, the array is already sorted

Worst case: $O(n^2)$, the array is reverse sorted (same sum as before)

Average case: $O(n^2)$, n iterations and still have to move $n/2$ entries on average

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