

Sort

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Popular sorting algorithm

- Insertion sort
- Selection sort
- Bubble sort
- Merge sort
- Quicksort

Popular sorting algorithm

- **Insertion sort**
- Selection sort
- Bubble sort
- **Merge sort**
- Quicksort

Insertion sort

Using arrays

1	5	3	6	4
---	---	---	---	---

Insertion sort

Using arrays

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Insertion sort

Using arrays

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Insertion sort

Using arrays

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Insertion sort

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Insertion sort

Using arrays

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Insertion sort

Using arrays

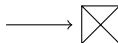
1	3	4	5	6
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Insertion sort

Using arrays

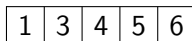
1	3	4	5	6
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Using linked lists

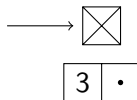


Insertion sort

Using arrays

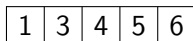


Using linked lists

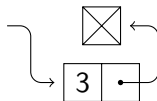


Insertion sort

Using arrays

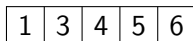


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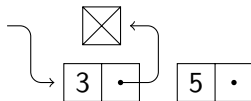


Insertion sort

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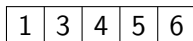


Using linked lists

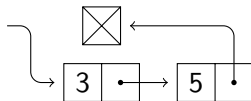


Insertion sort

Using arrays

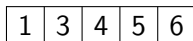


Using linked lists

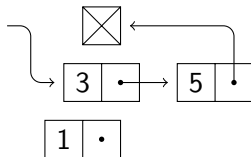


Insertion sort

Using arrays

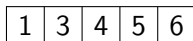


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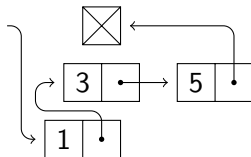


Insertion sort

Using arrays

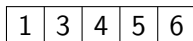


Using linked lists

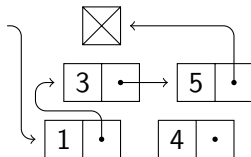


Insertion sort

Using arrays

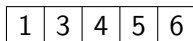


Using linked lists

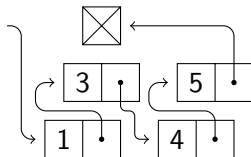


Insertion sort

Using arrays



Using linked lists



Merge sort

Merging two sorted arrays

1	3	5
---	---	---

2	7	9
---	---	---

Merge sort

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2	7	9
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--	--	--	--	--	--

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Merge sort

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1	3	5
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2	7	9
---	---	---

1					
---	--	--	--	--	--

Merge sort

Merging two sorted arrays

1	3	5
---	---	---

2	7	9
---	---	---

1					
---	--	--	--	--	--

Merge sort

Merging two sorted arrays

1	3	5
---	---	---

2	7	9
---	---	---

1	2				
---	---	--	--	--	--

Merge sort

Merging two sorted arrays

1	3	5
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2	7	9
---	---	---

1	2				
---	---	--	--	--	--

Merge sort

Merging two sorted arrays

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2	7	9
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1	2	3			
---	---	---	--	--	--

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2	7	9
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2	7	9
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1	2	3	5		
---	---	---	---	--	--

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Merging two sorted arrays

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2	7	9
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1	2	3	5	7	
---	---	---	---	---	--

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Merging two sorted arrays

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2	7	9
---	---	---

1	2	3	5	7	
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Merging two sorted arrays

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1	2	3	5	7	9
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Merge sort

Merging two sorted arrays

1	3	5
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2	7	9
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1	2	3	5	7	9
---	---	---	---	---	---

Merge sort

Dichotomic sort

1	5	3	6	4
---	---	---	---	---

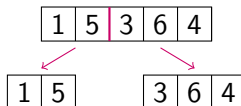
Merge sort

Dichotomic sort

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---	---	---	---	---

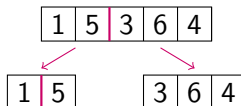
Merge sort

Dichotomic sort



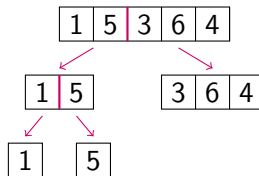
Merge sort

Dichotomic sort



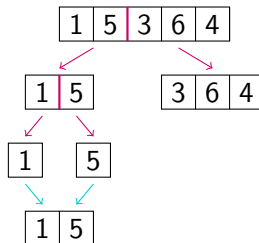
Merge sort

Dichotomic sort



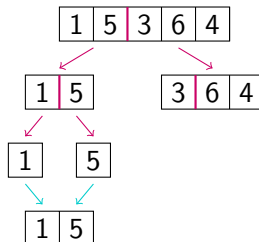
Merge sort

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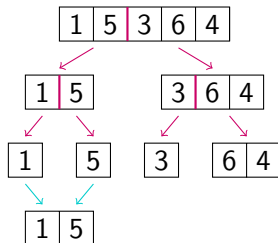
Merge sort

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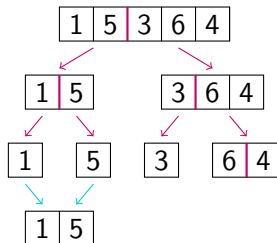
Merge sort

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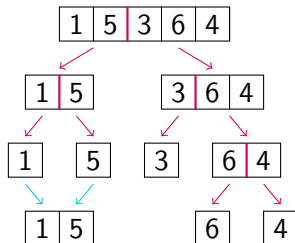
Merge sort

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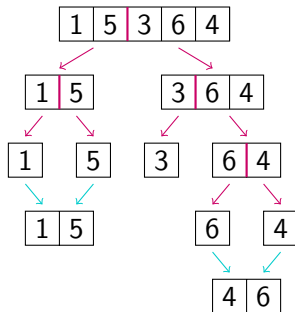
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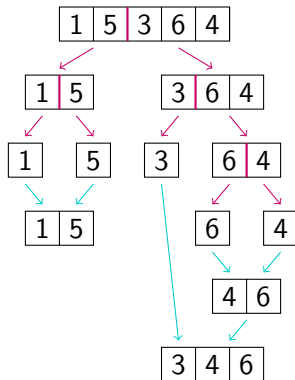
Merge sort

Dichotomic sort



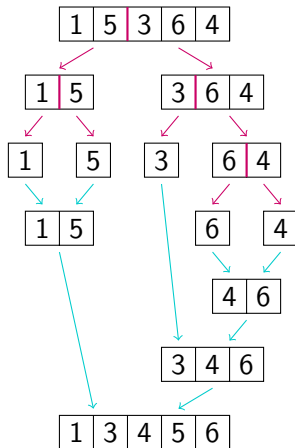
Merge sort

Dichotomic sort



Merge sort

Dichotomic sort



Exercise 1: Candy Distribution

Statement

Given N integers indicating the number of students in each of Alice's classes, and N integers corresponding to the price of a type of candy. Knowing that all students in the same class will receive the same kind of candy, compute the least amount of money Alice must spend to give a candy to each of her students.

Example

Input:

```
5
10 80 37 22 109
6 8 8 20 15
```

Output:

```
2120
```

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What problems can arise?

- What do we know of N ?

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- Of the number of students?

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- How great can the solution be?

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What problems can arise?

- What do we know of N ?
- Of the number of students?
- Of the price of the candies?
- How great can the solution be?
⇒ Are integers big enough for the solution?

Exercise 1: Candy Distribution

Solution 1: Homemade

Using two lists or arrays with insertion sort

Solution 2: Integrated

Using two arrays and the sort procedure in your preferred language

Exercise 1: Candy Distribution

More test cases

Input:

4

1 10 2 1

1 2 4 2

5

10 80 37 22 89

6 8 8 20 15

0

Output:

20

2000

Exercise 2: Inversion Count

Statement

Given an array A of integers. If $i < j$ and $A[i] > A[j]$ then the pair (i, j) is called an inversion of A . Count the number of inversions of A

Example

Input:

2 3 8 6 1

Output:

5

Exercise 2: Inversion Count

Statement

Given an array A of integers. If $i < j$ and $A[i] > A[j]$ then the pair (i, j) is called an inversion of A . Count the number of inversions of A

What problems can arise?

- How great can the array be?

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- How great can the values in the array be?

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What problems can arise?

- How great can the array be?
- How great can the values in the array be?
- How great can the solution be?
⇒ Are integers big enough for the solution?

Exercise 2: Inversion Count

Solution 1: Brut Force

```
read  $n$  on standard input
read the array  $A$  on standard input

result  $\leftarrow 0$ 

for  $i$  from 0 to  $n-2$ 
    for  $j$  from  $i+1$  to  $n-1$ 
        if  $A[i] > A[j]$  then
            result  $\leftarrow$  result + 1

print result
```

Exercise 2: Inversion Count

Solution 2: Using Merge sort

Key idea: if there are no inversions, then during the merge, all the elements of the left array should be added before any element of the right array

Exercise 2: Inversion Count

Solution 2: Using Merge sort

2	3	8	6	1
---	---	---	---	---

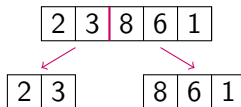
Exercise 2: Inversion Count

Solution 2: Using Merge sort

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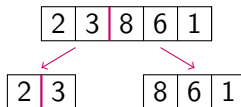
Exercise 2: Inversion Count

Solution 2: Using Merge sort



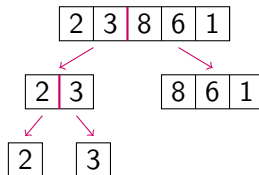
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Solution 2: Using Merge sort



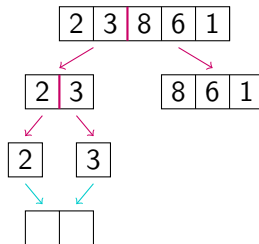
Exercise 2: Inversion Count

Solution 2: Using Merge sort



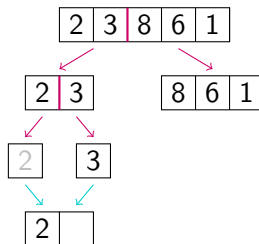
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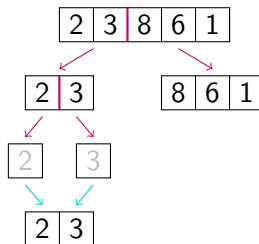
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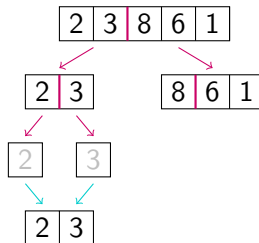
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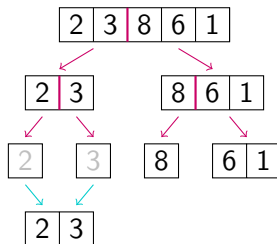
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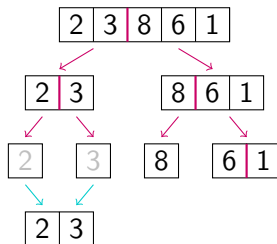
Exercise 2: Inversion Count

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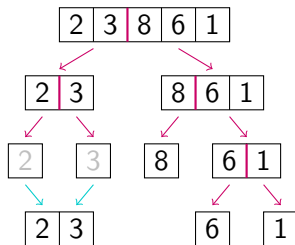
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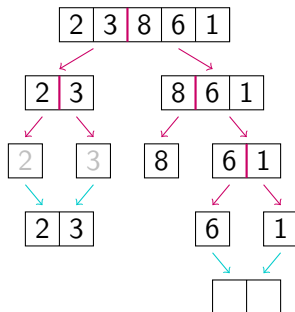
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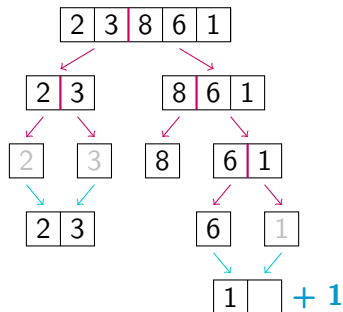
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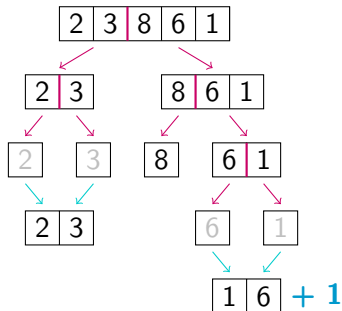
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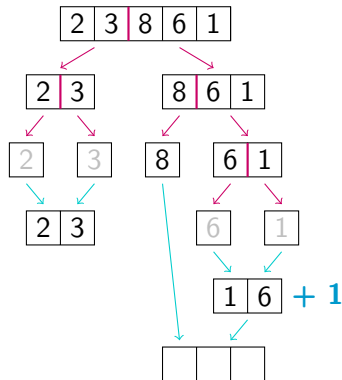
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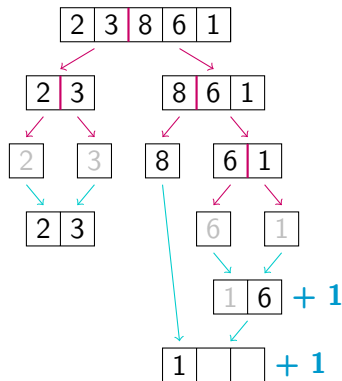
Exercise 2: Inversion Count

Solution 2: Using Merge sort



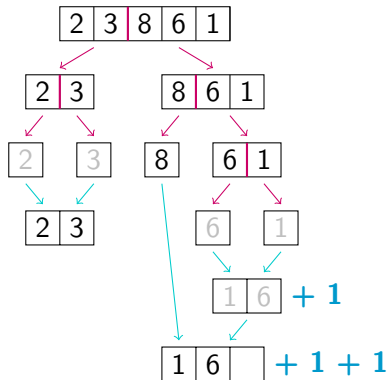
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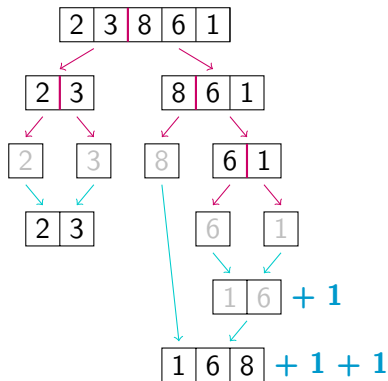
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Solution 2: Using Merge sort



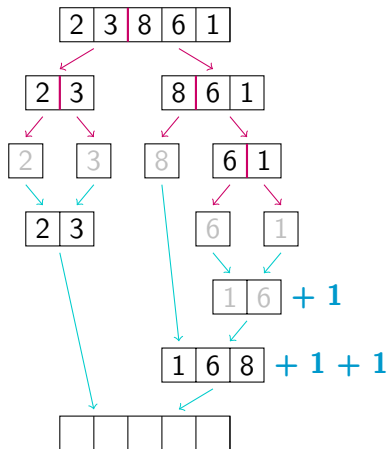
Exercise 2: Inversion Count

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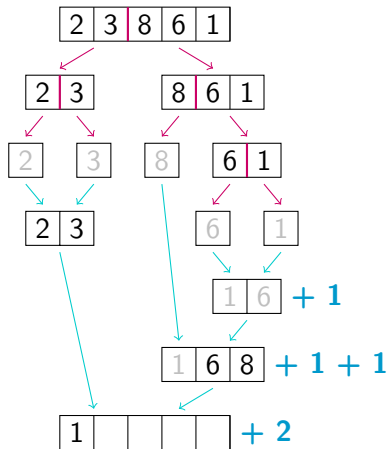
Exercise 2: Inversion Count

Solution 2: Using Merge sort



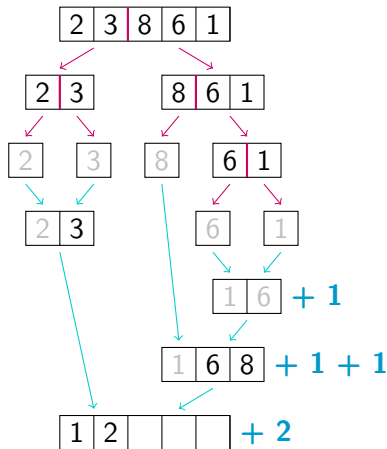
Exercise 2: Inversion Count

Solution 2: Using Merge sort



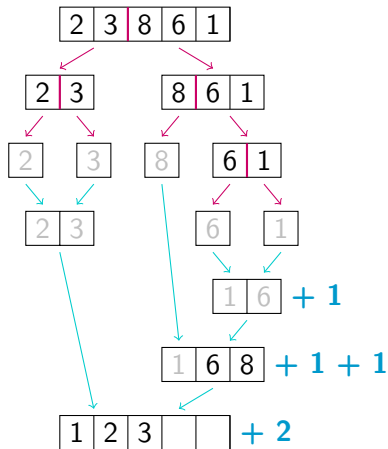
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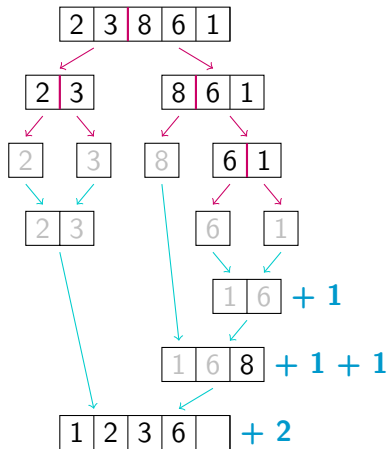
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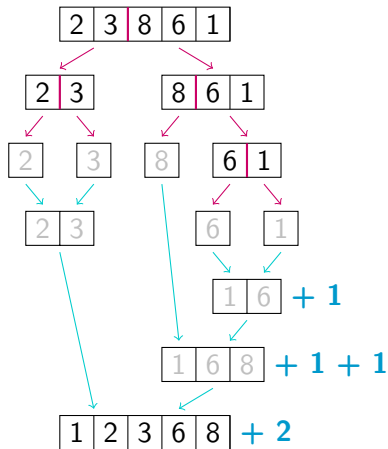
Exercise 2: Inversion Count

Solution 2: Using Merge sort



Exercise 2: Inversion Count

Solution 2: Using Merge sort



Exercise 2: Inversion Count

More test cases

Input:

3

6

1 2 3 4 5 6

8

5 1 4 2 6 2 6 2

1

1

Output:

0

11

0

Exercise 3: It's a Murder

Statement

Given an array of integers, for each number sum the previous strictly smaller number

Example

Input: Output:

1 15

5

1 5 3 6 4

Solution: Elegant

Using Merge sort

Exercise 4: Yodaness Level

Statement

Given a statement as Yoda says it and the same statement as it should be said normally count the number of pairs of words that changed their order

Example

Input:

1

6

much to learn you still have

you still have much to learn

Output:

9

Solution: Elegant

Using Merge sort