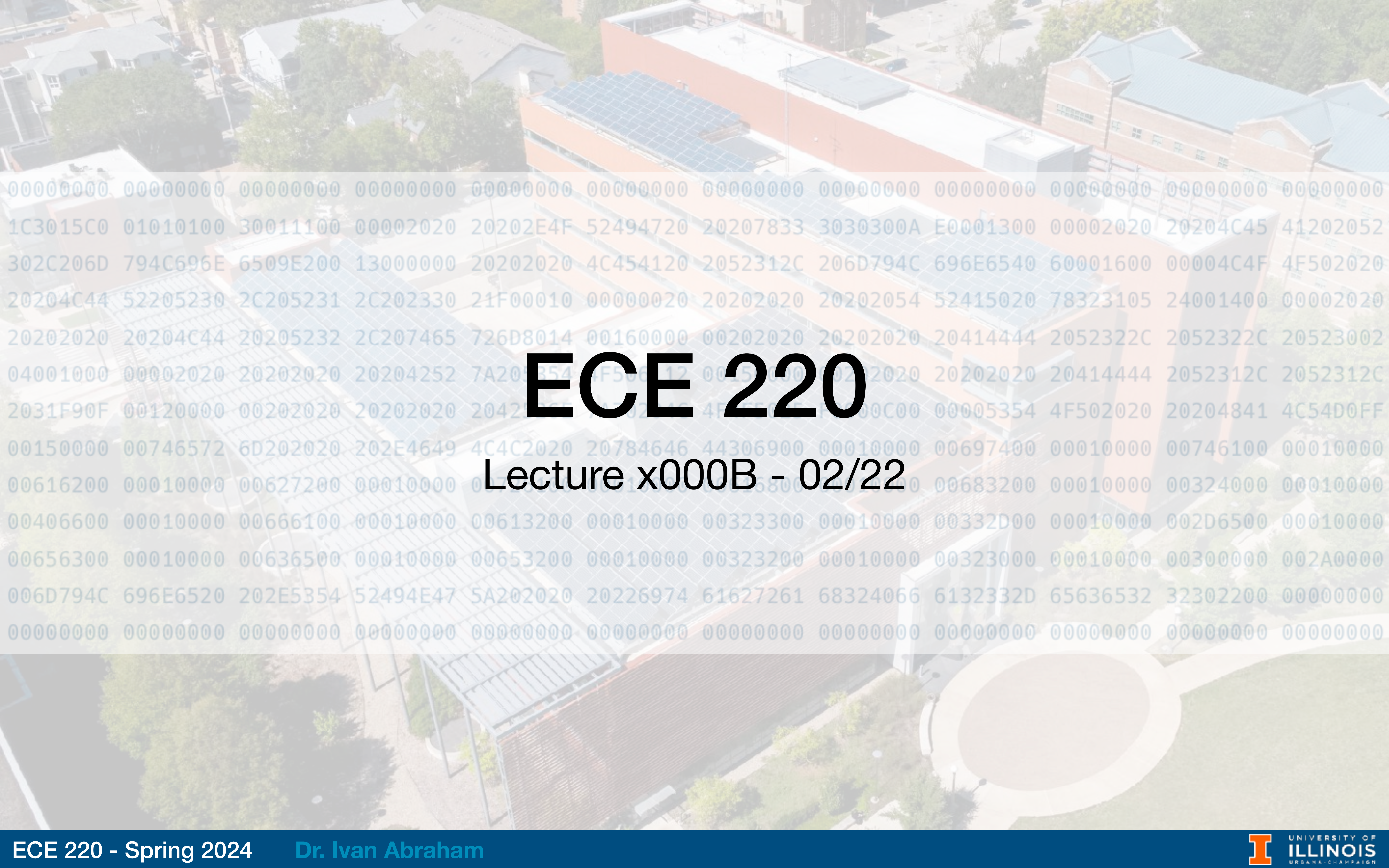
ECE 220
Lecture x000B - 02/22
ECE 220 - Spring 2024
Dr. Ivan Abraham
UNIVERSITY OF ILLINOIS

Recap + reminders

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One dimensional array

0	1	2	3

Two dimensional array

0,0	0,1	0,2	0,3
1,0	1,1	1,2	1,3
2,0	2,1	2,2	2,3

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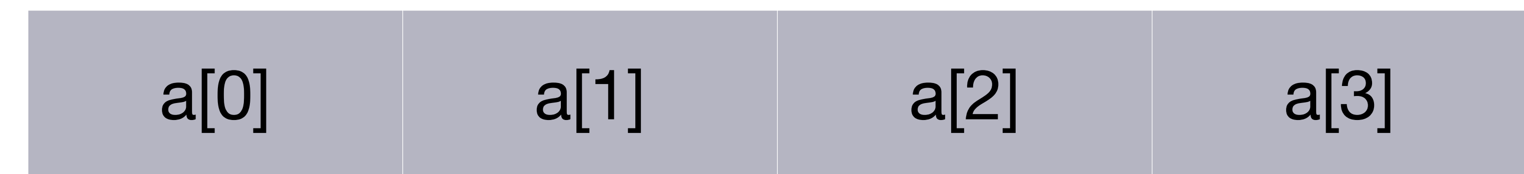

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Two dimensional array

a[0][0]	a[0][1]	a[0][2]	a[0][3]
a[1][0]	a[1][1]	a[1][2]	a[1][3]
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Allocating memory

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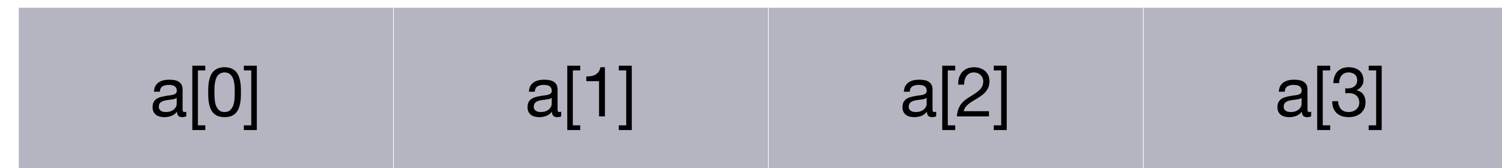
One dimensional array



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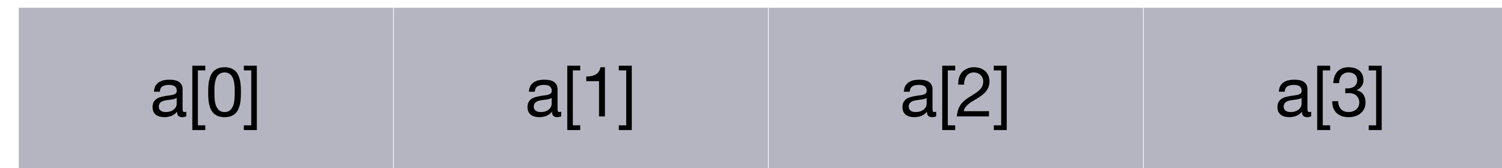

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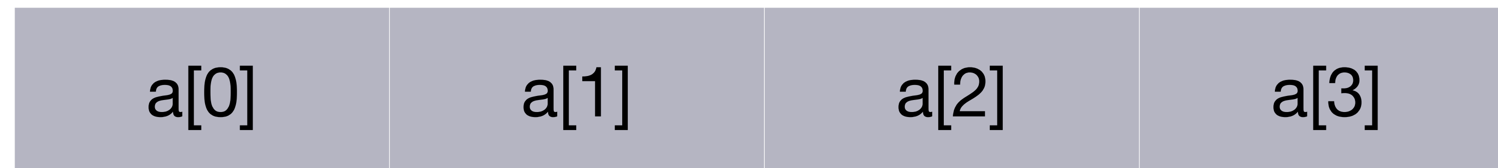

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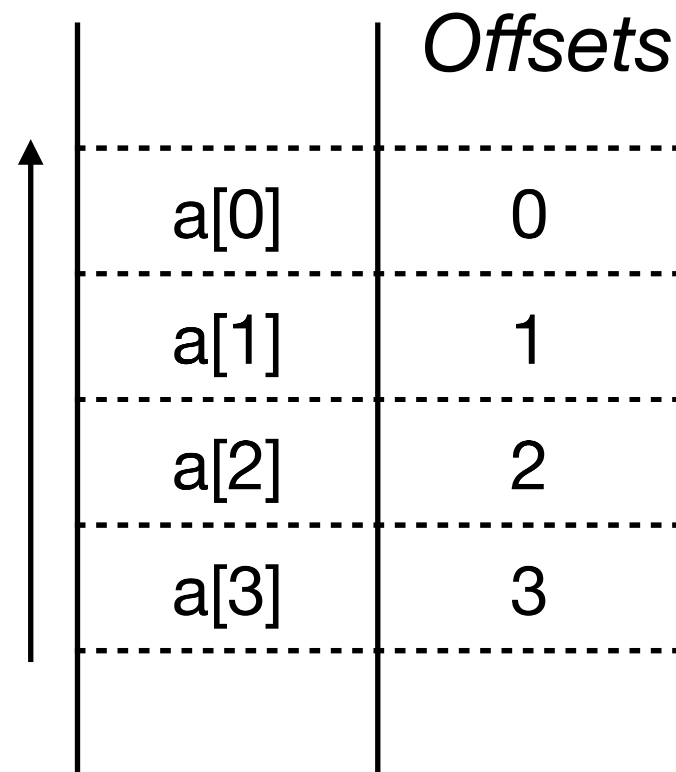

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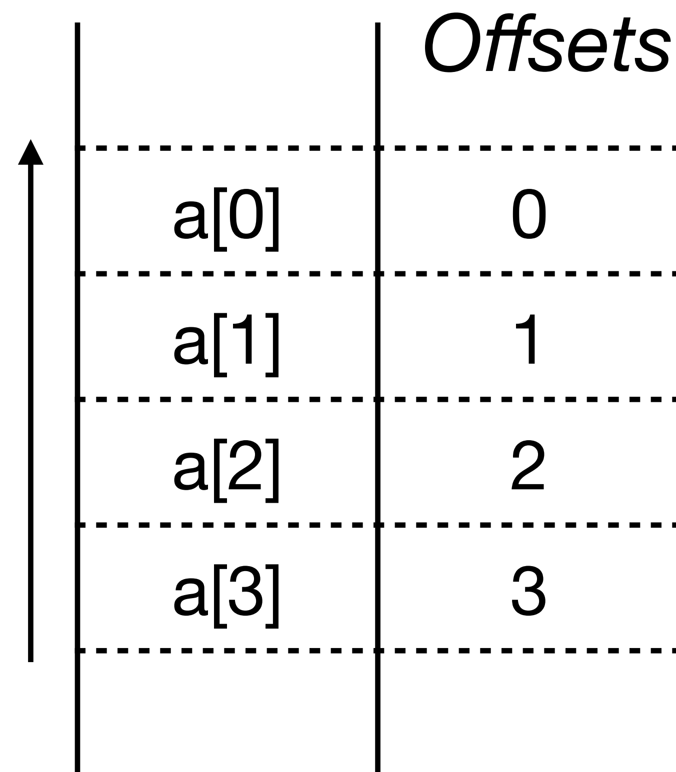

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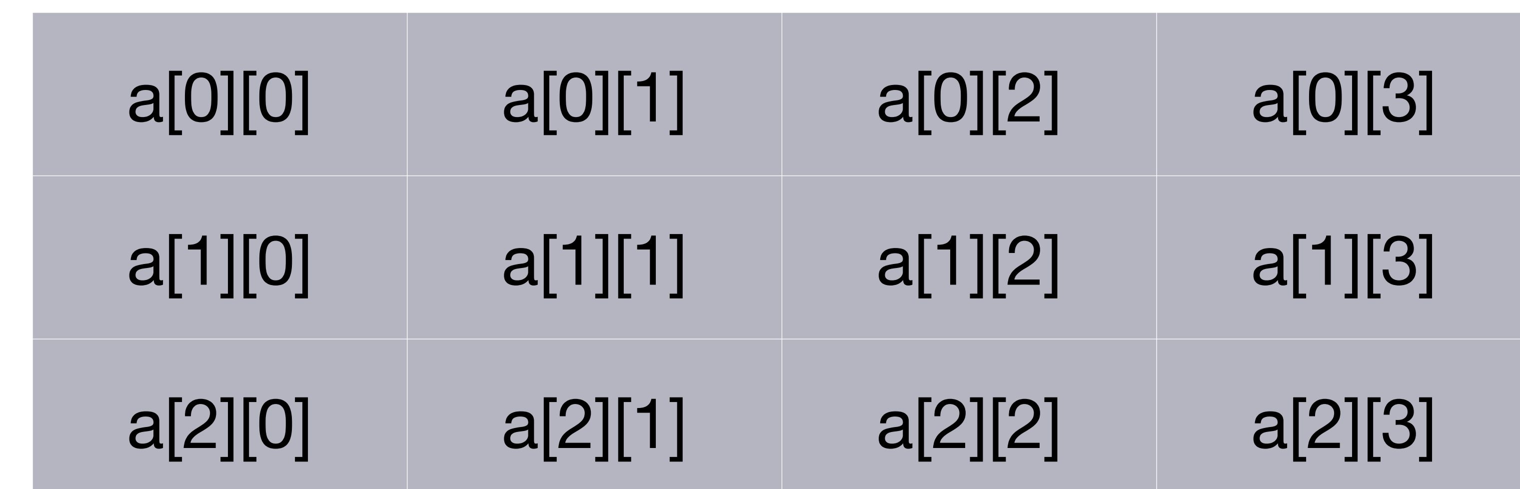

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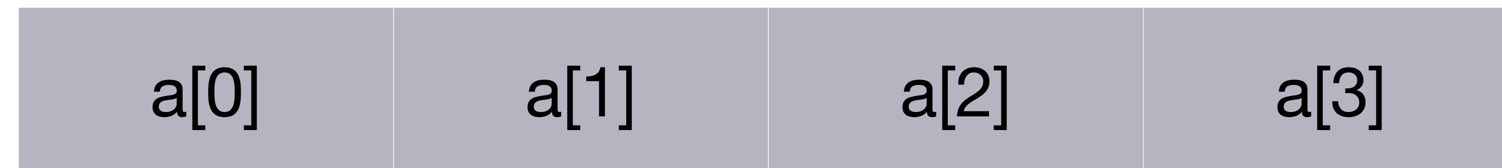

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a[1][2]	6
a[1][3]	7
a[2][0]	8
a[2][1]	9
a[2][2]	10
a[2][3]	11

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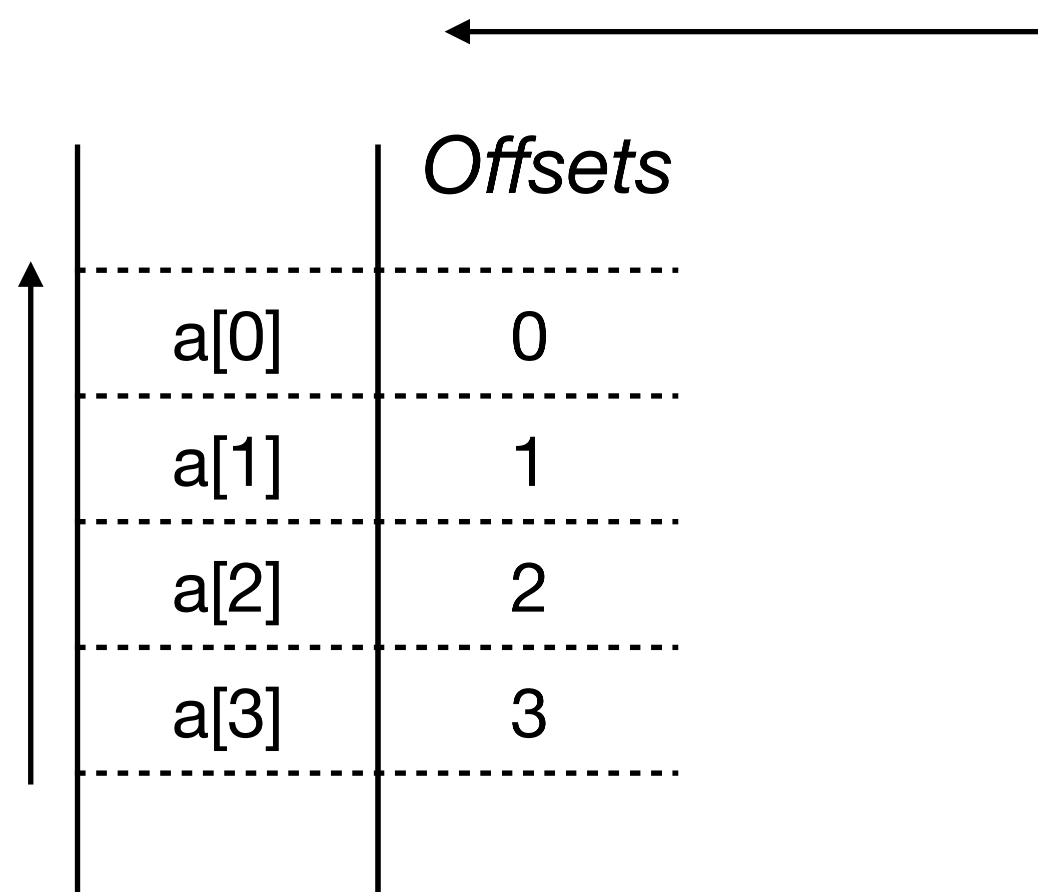

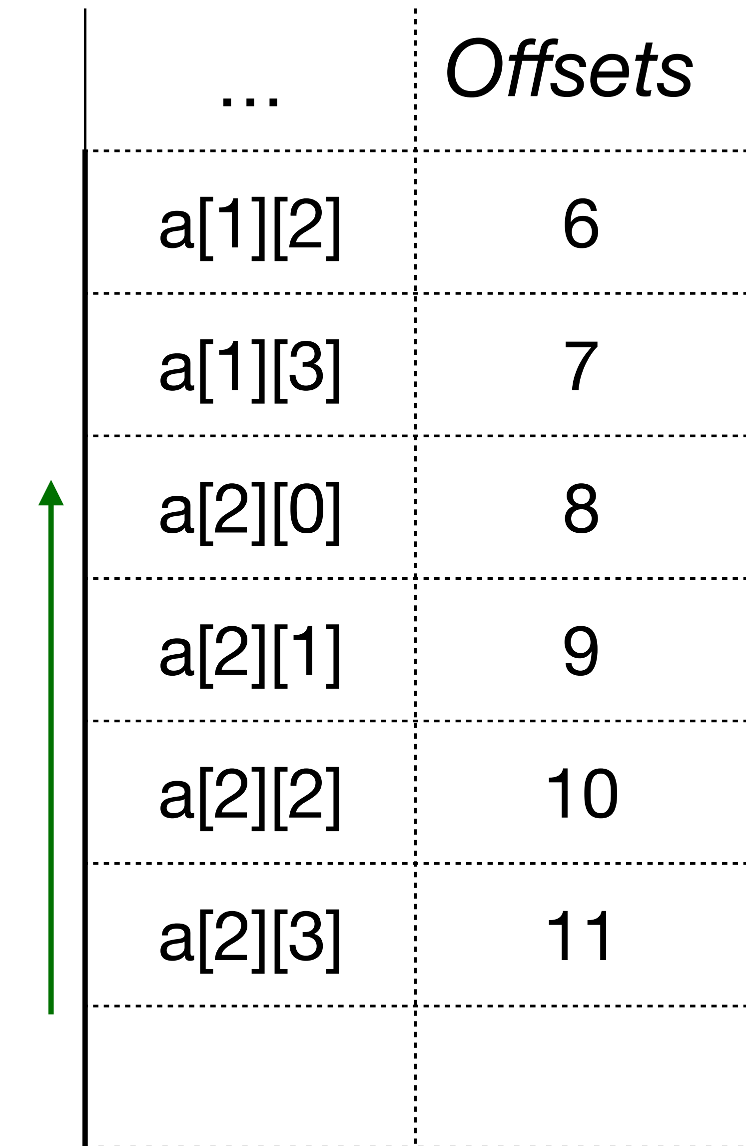

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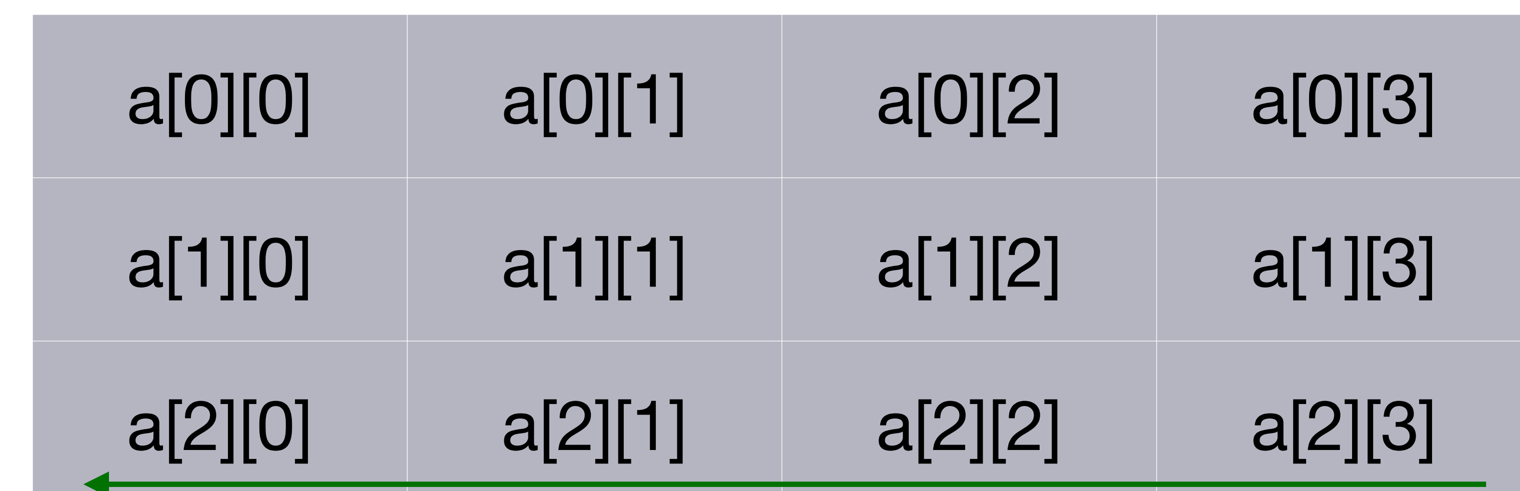

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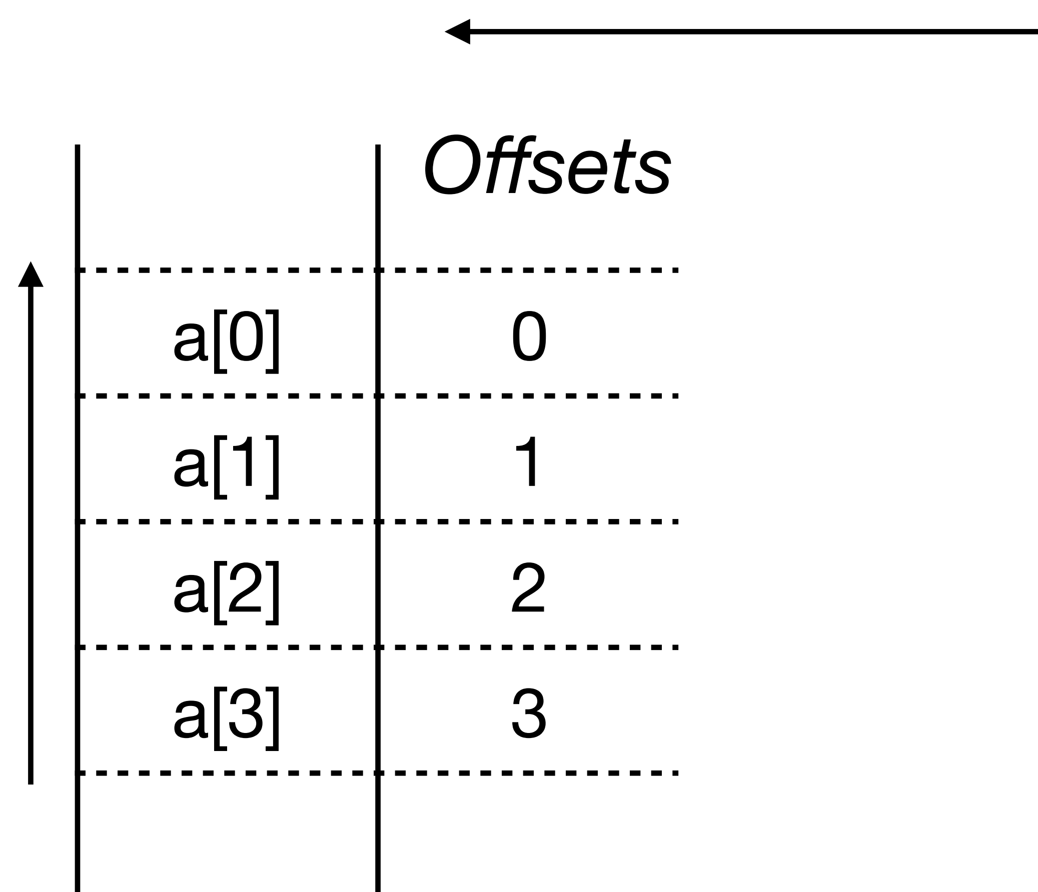

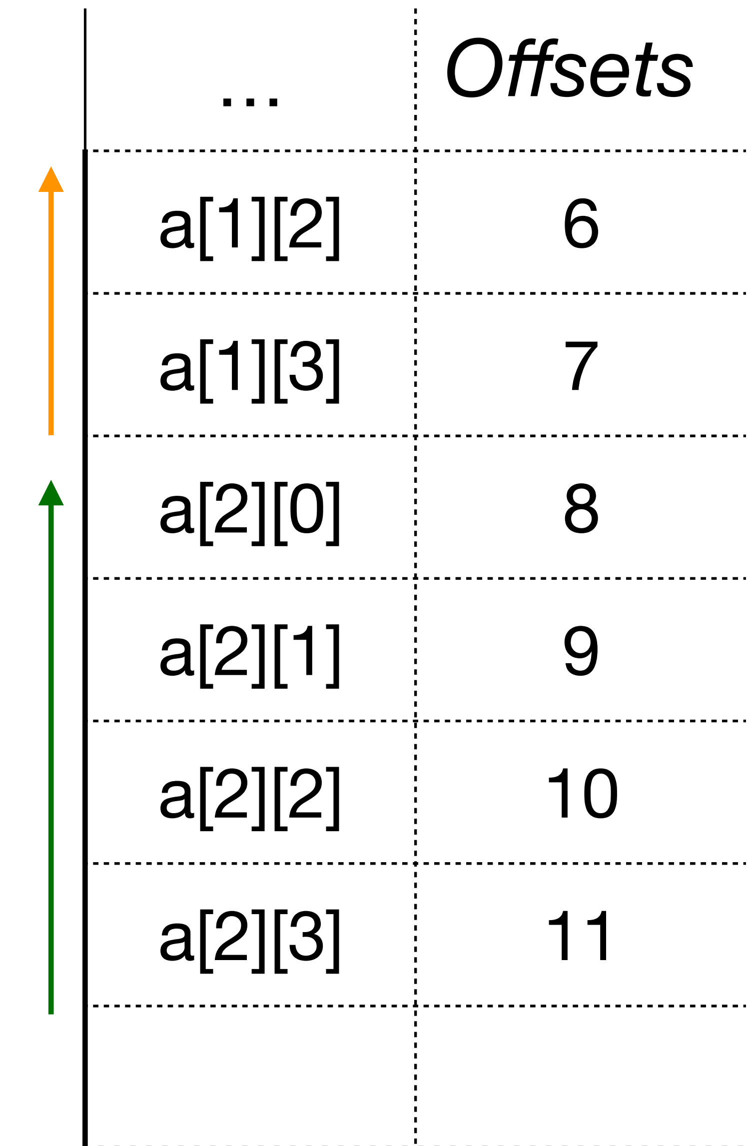

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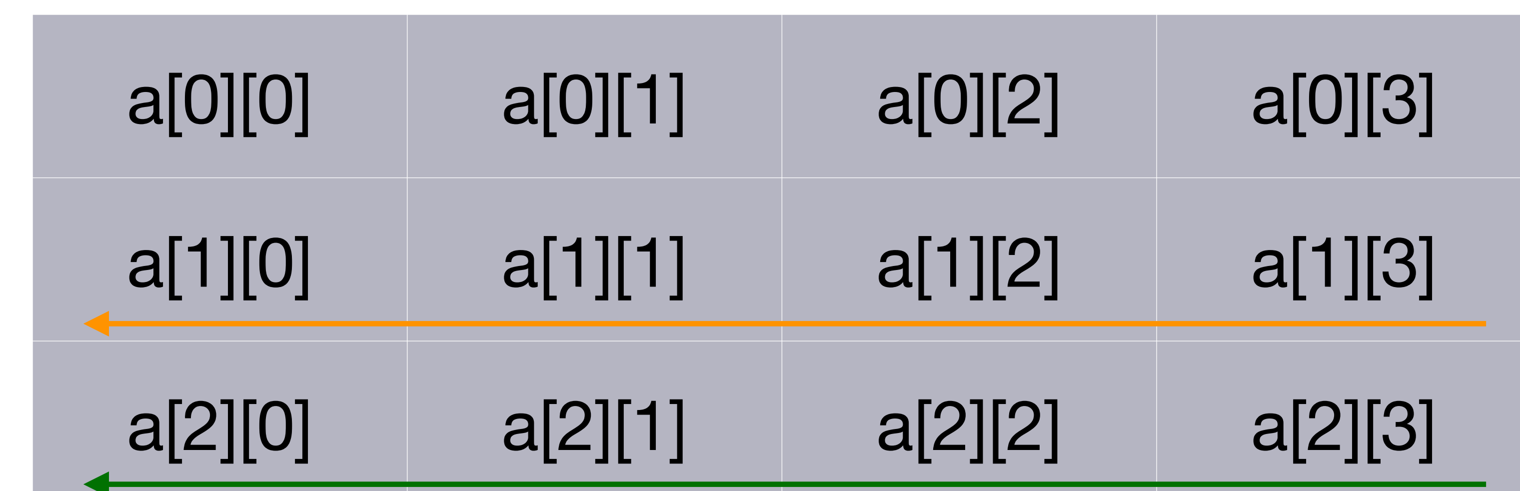

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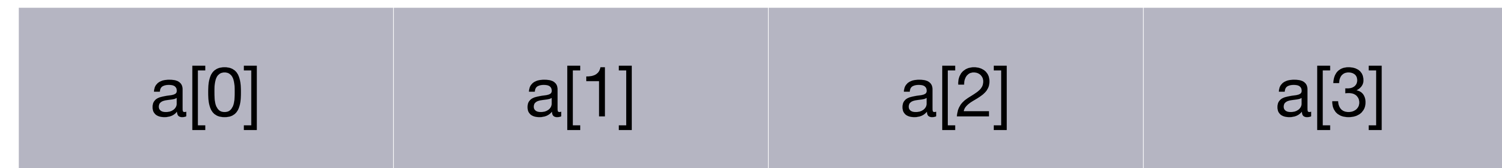

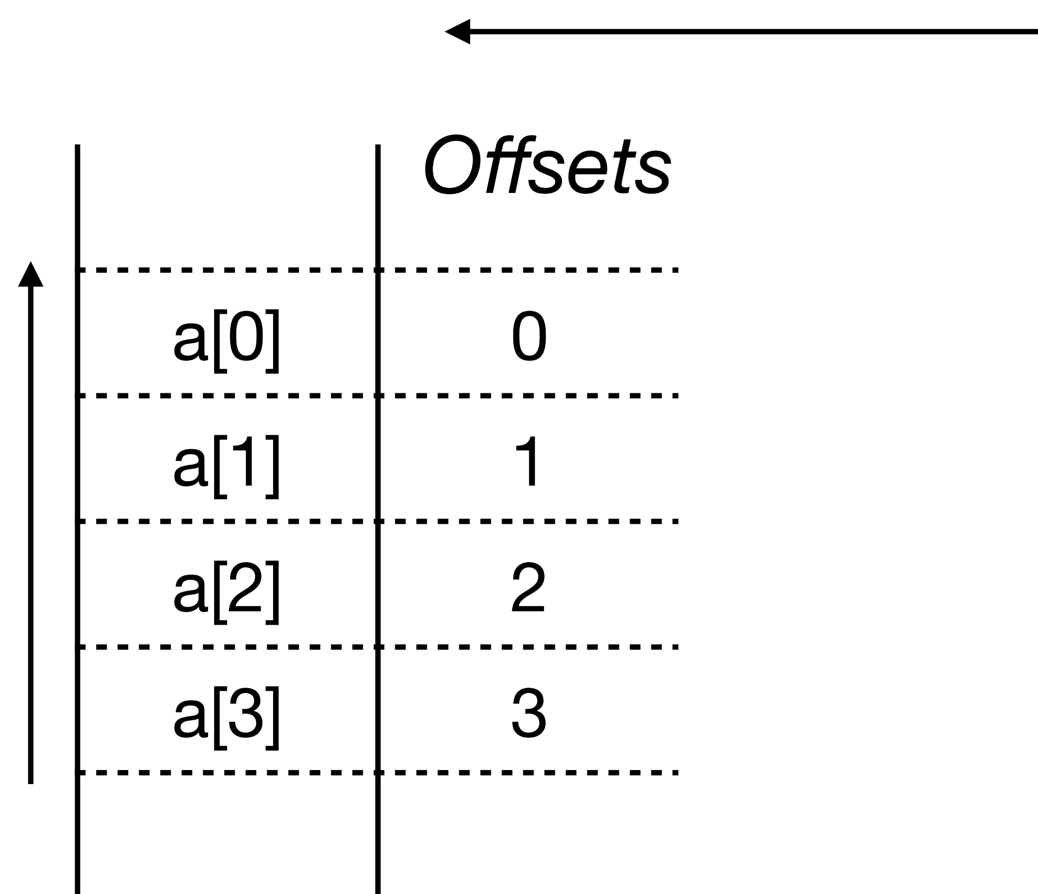

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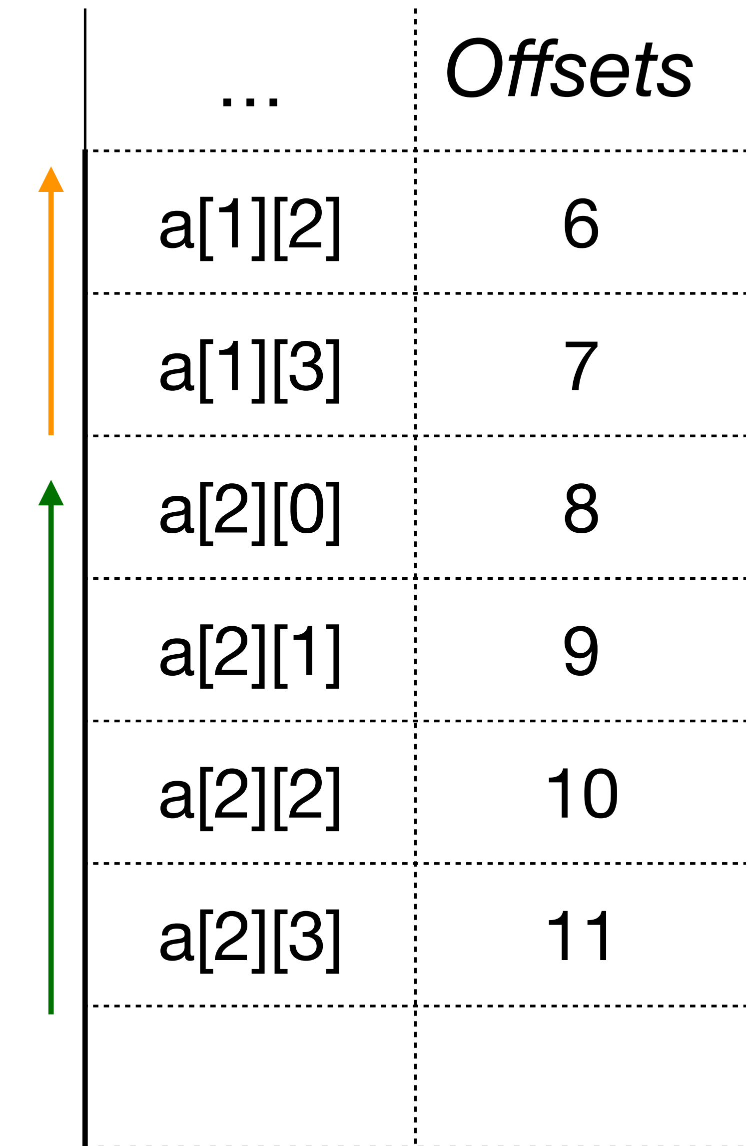

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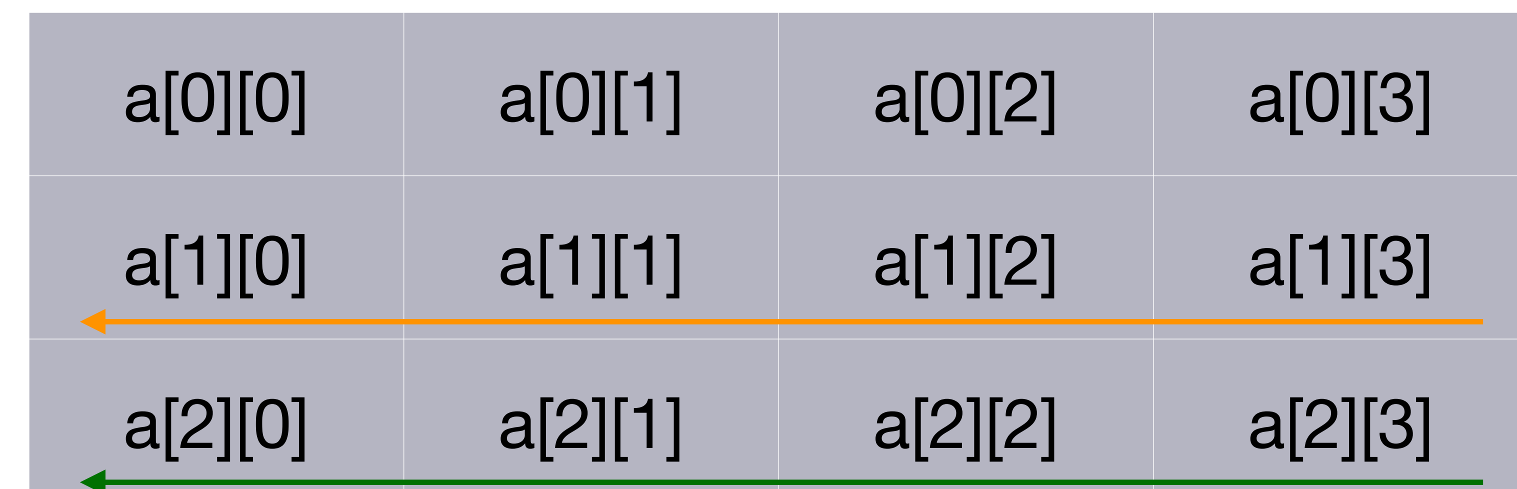

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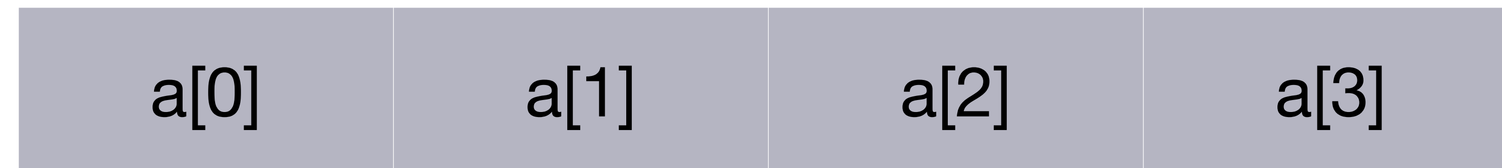

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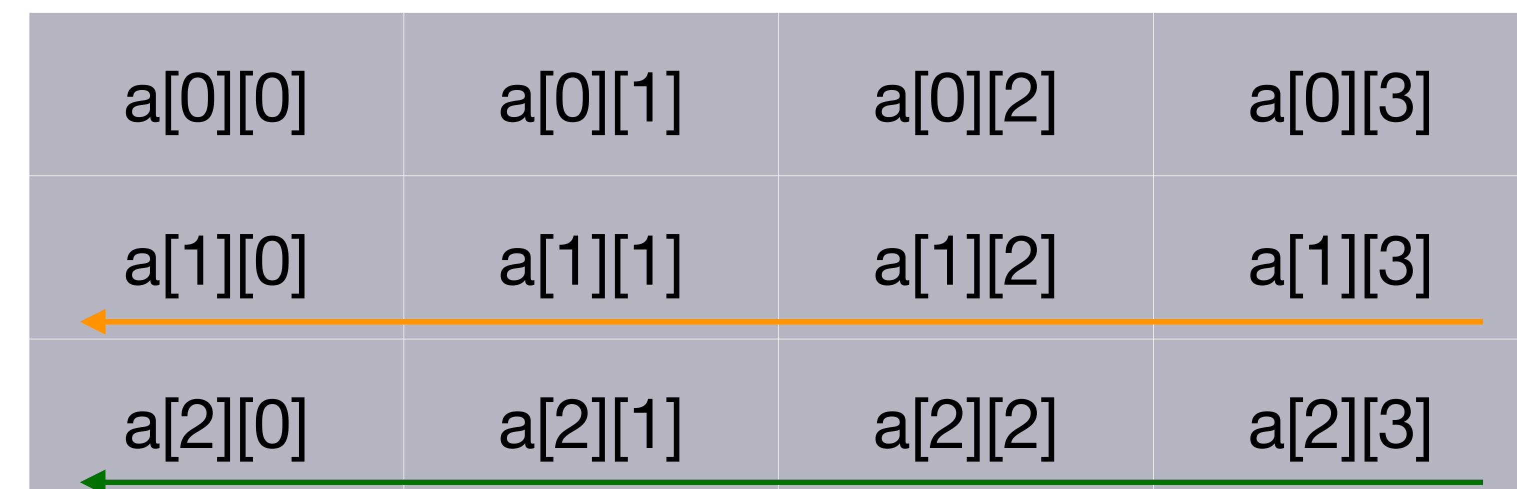

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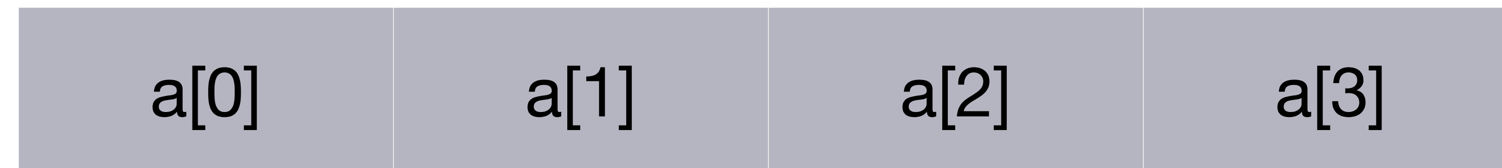

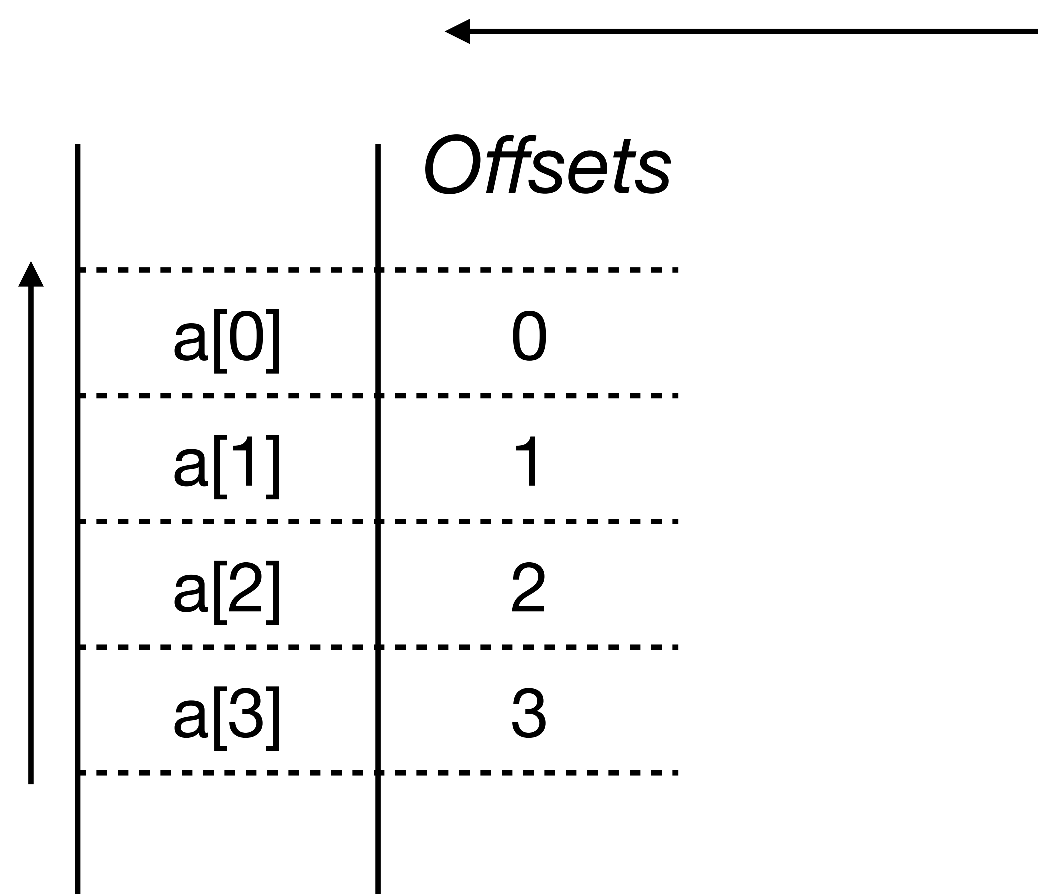

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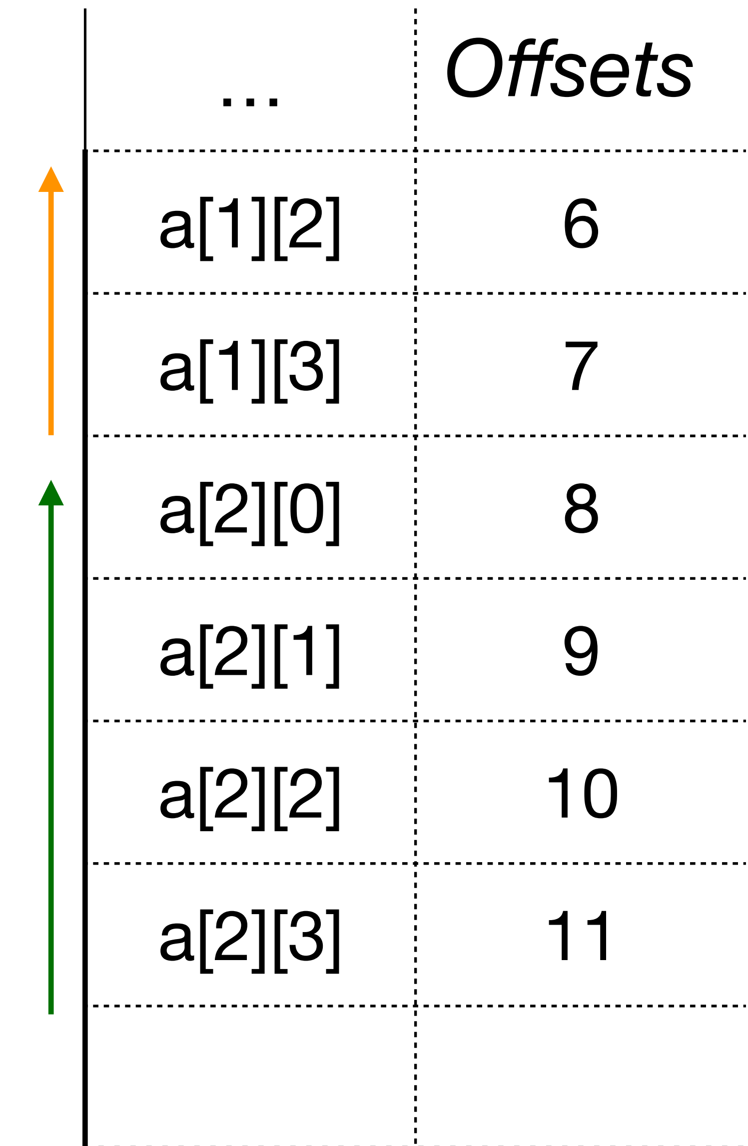
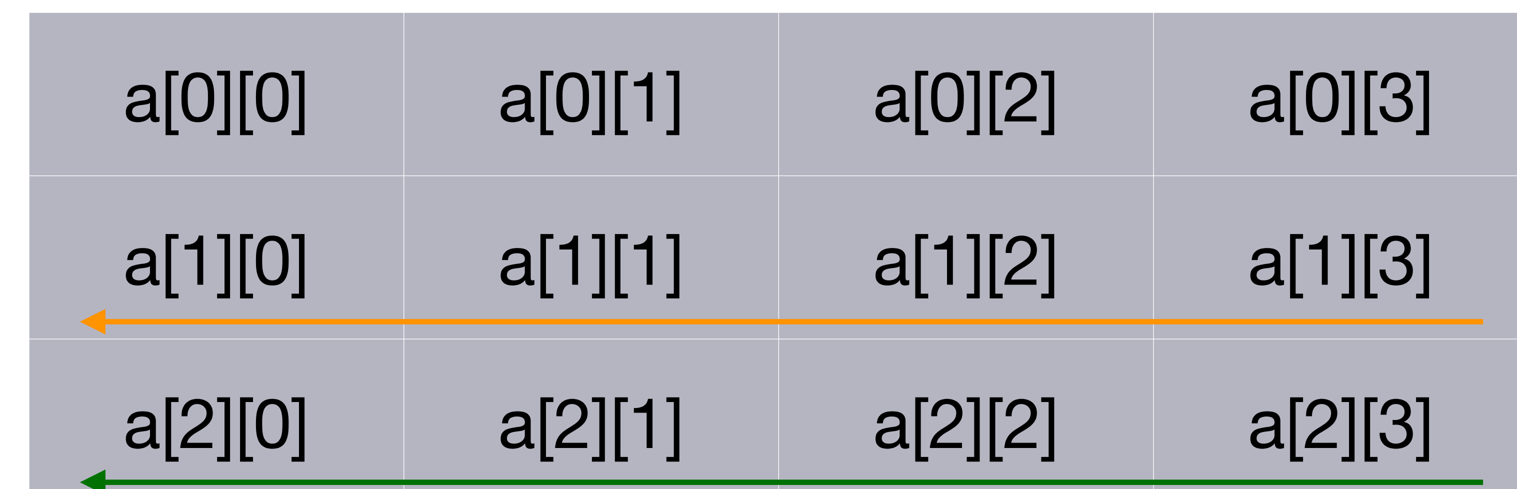


Column index

```
offset = ri * nc + ci
```

Row index

Two dimensional array



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  - `int a[][3] = {1,2,3,4,5,6};`
- Why not: `int a[2][] = {{1,2,3},{4,5,6}};` ?

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Exercise 1

- Given a matrix mat stored as a two dimensional array of integers, write a function `exchng_rows` which will exchange the row `r1` with row `r2` function where: `0 <= r1, r2 < NROWS`.

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This function signature is well defined.

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```
void exchng_rows(int mat[NROWS][NCOLS], int r1, int r2){
  for (int i=0; i<NCOLS; i++){
    int temp = mat[r1][i];
    mat[r1][i] = mat[r2][i];
    mat[r2][i] = temp;
  }
}
```

Exercise 2

Write a C function that given a matrix `mat` of size `nr` × `nm` and another matrix `tr_mat` of size `nr` × `nm` copies the *transpose* of `mat` into `tr_mat`.

```
# include<stdio.h>

void transpose(int *mat, int *tr_mat, ______, ______){
  for (int i=0; ______; i++)
    for (int j=0; ______; j++)
      ________________ = ____________;
}

void print_mat(int *mat, int nr, int nc){
  for (int i=0; i<nr; i++){
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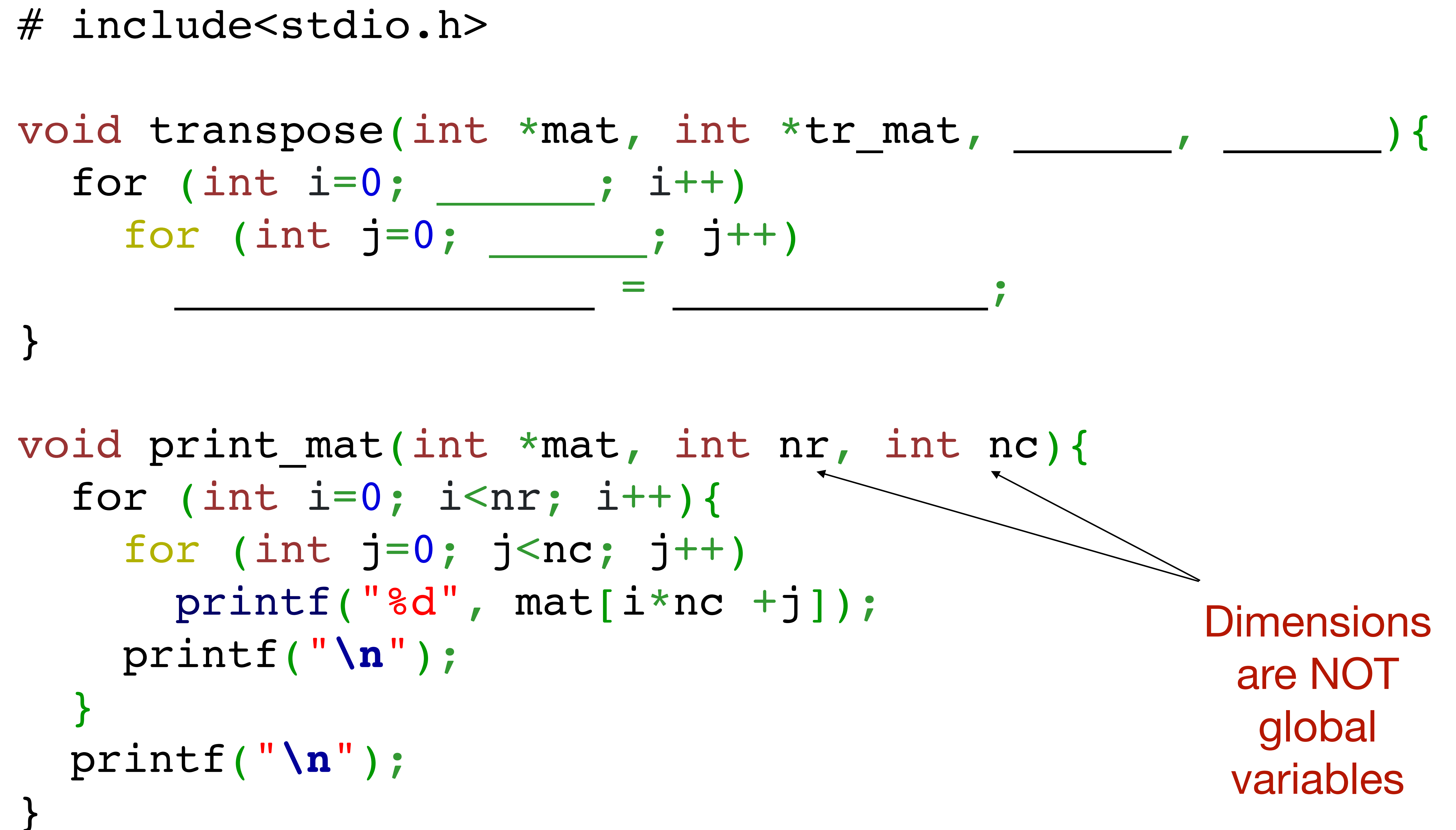

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2D shape information is lost!

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Lets fill in the blanks!

Problem solving: searching

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  - Linear search
  - Binary search

Linear search

- This is as vanilla as a search gets.
- Go through the list from beginning to end until a match is found:
  - Search item is often called *key.*
  - Animation

Linear search - implementation

```
int linear_search(int list[], int n, int key){
    for (int i = 0; i < n; i++){

    if (________________)
        return i;
    }
    ______________;
}
```


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Binary search

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Binary search

```
int binary(int arr[], int n, int key){
  int low = 0;      // Left pointer
  int high = _____; // Right pointer

  while (high >= low){
    int mid = (__________) / 2; // Pick middle element

    // Logic to focus search on left or right of mid
    if (key == arr[mid])
      return mid;
    else if (key < arr[mid])
      high = _______;
    else
      low = ________;
  }
  return -1; // Loop exited, element not present.
}
```

Sorting

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- Many flavors exist: bubble sort, selection sort, insertion sort, quick sort, etc.

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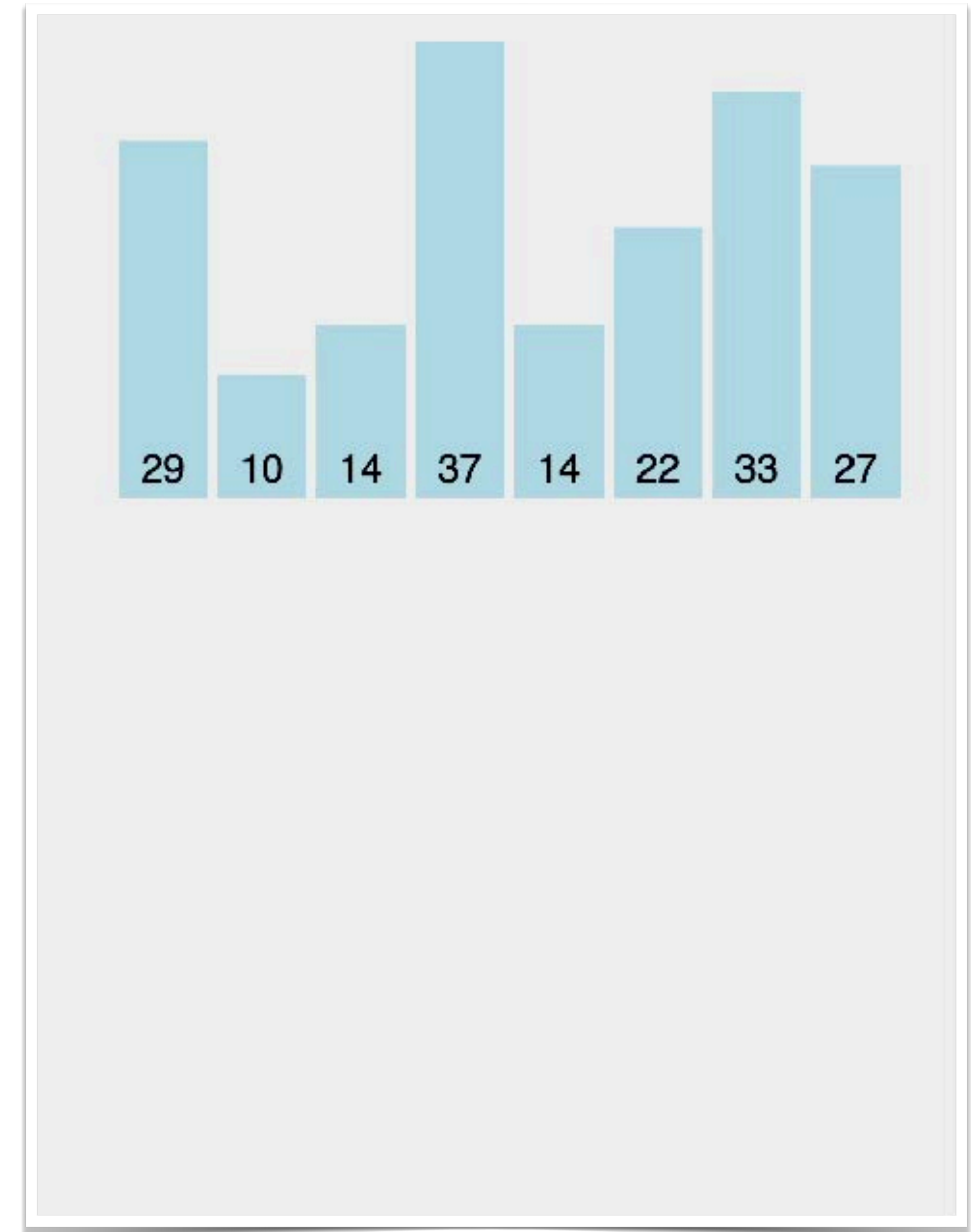
- Finding efficient algorithms for sorting is highly researched problem.
- Many flavors exist: bubble sort, selection sort, insertion sort, quick sort, etc.
- Knowing some of them off the top of your head … probably required for technical interview.

Selection sort



Selection sort

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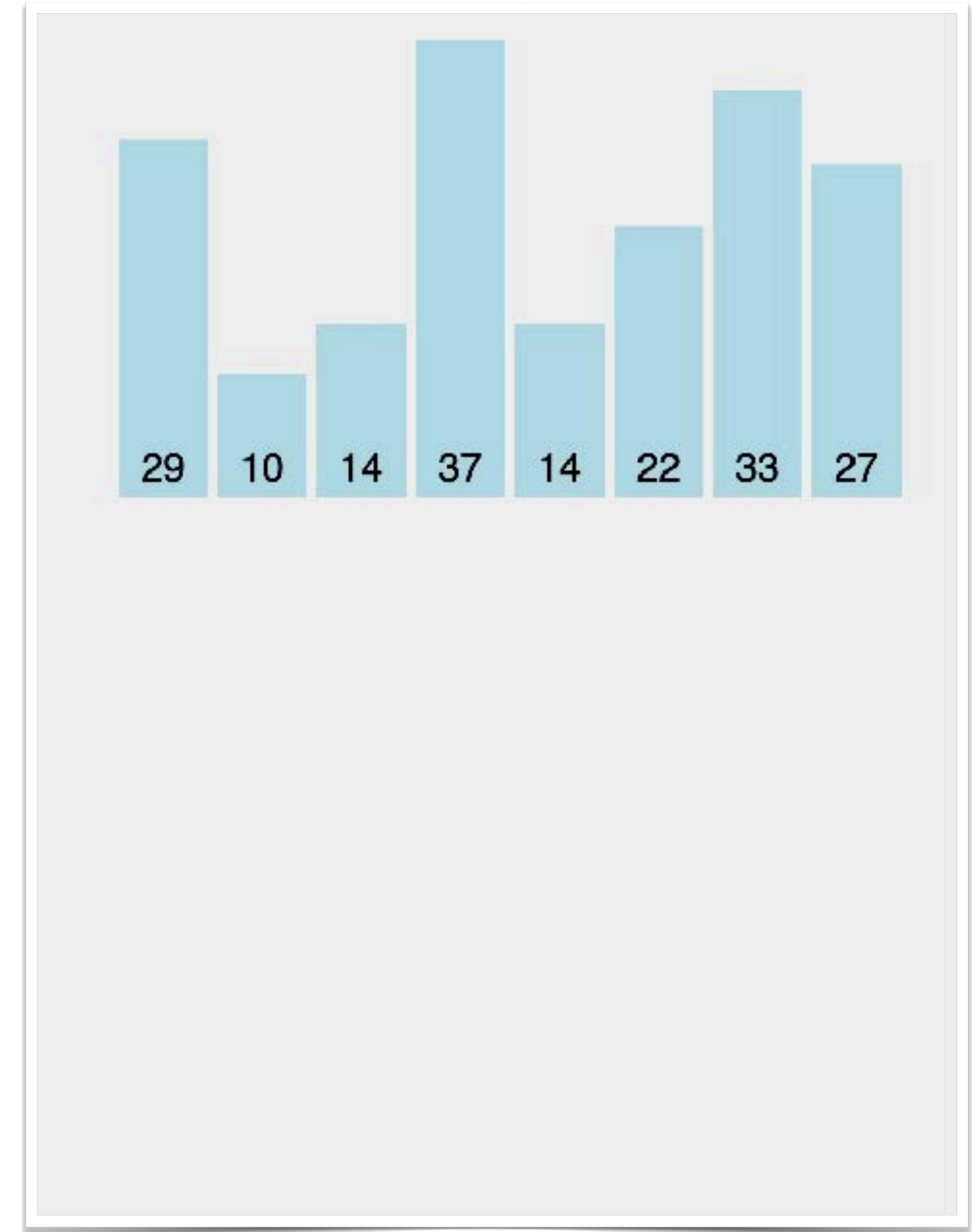

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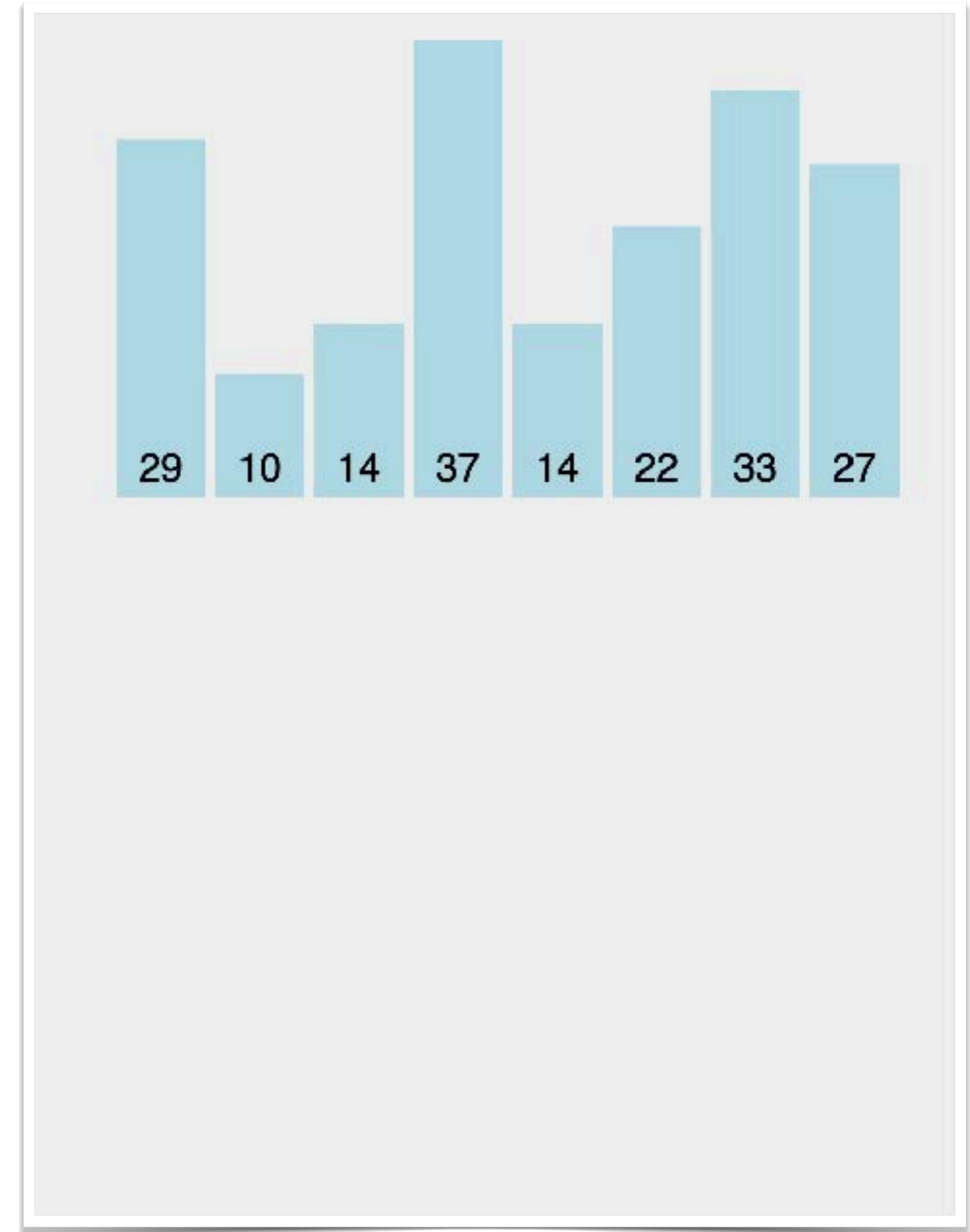

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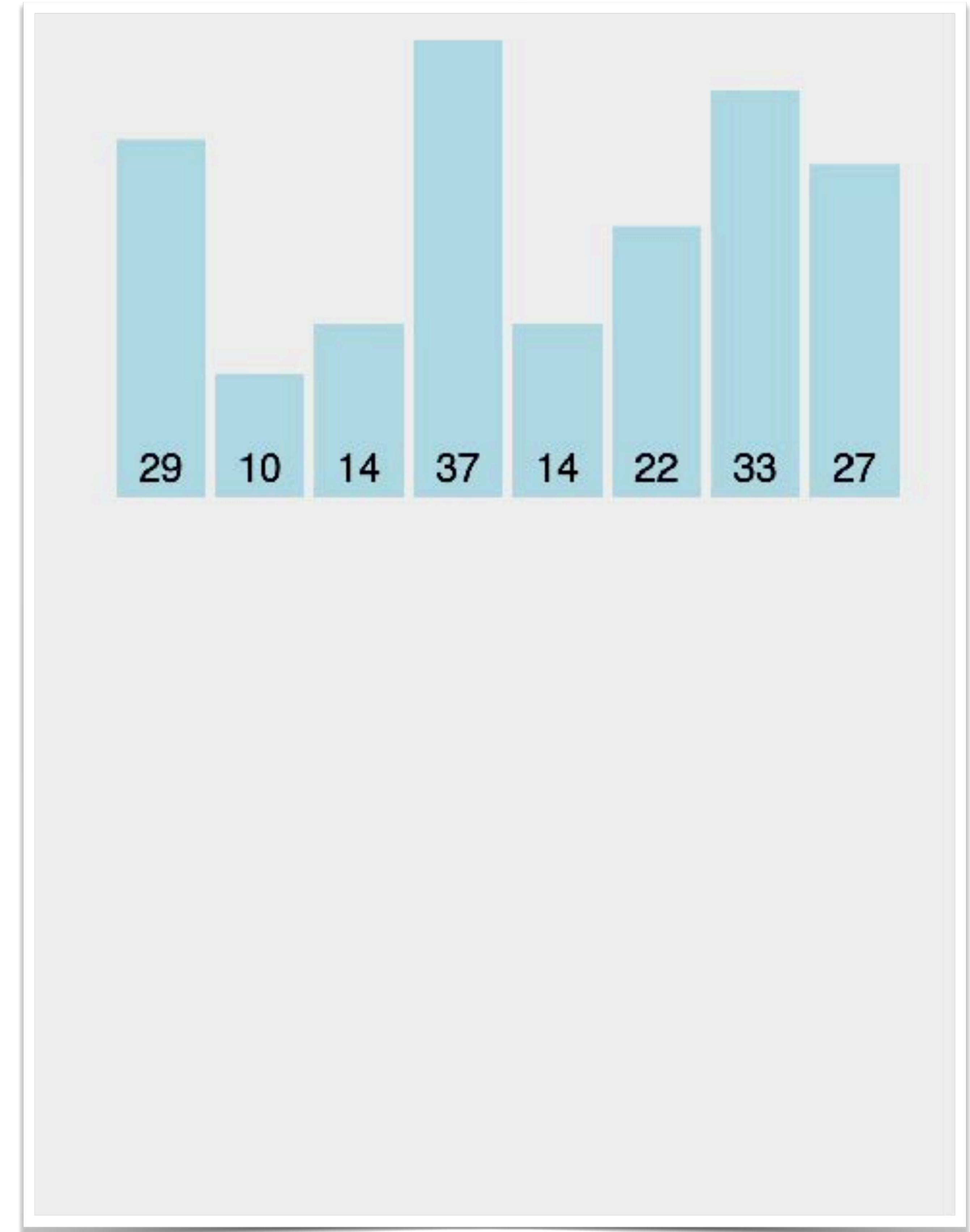

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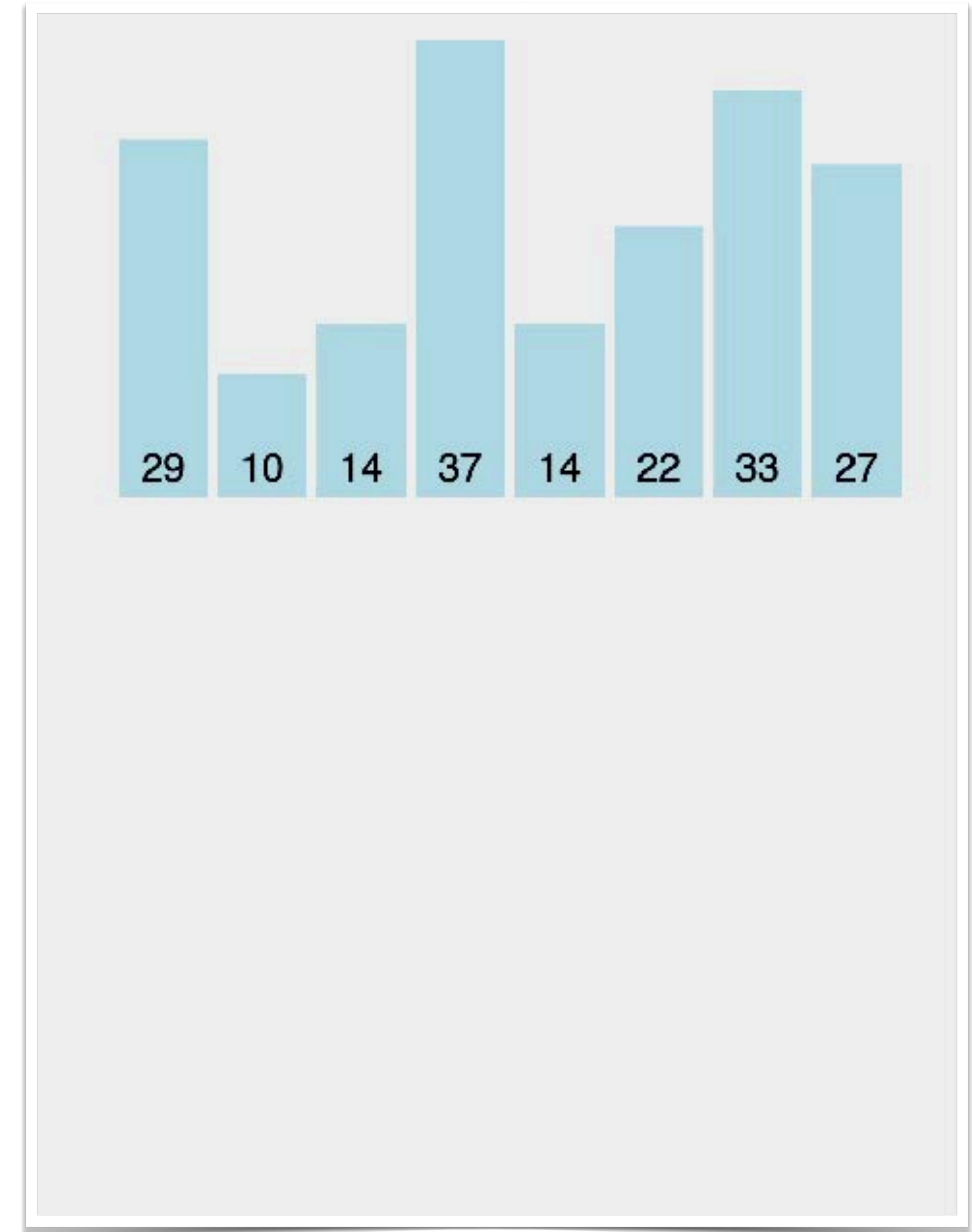

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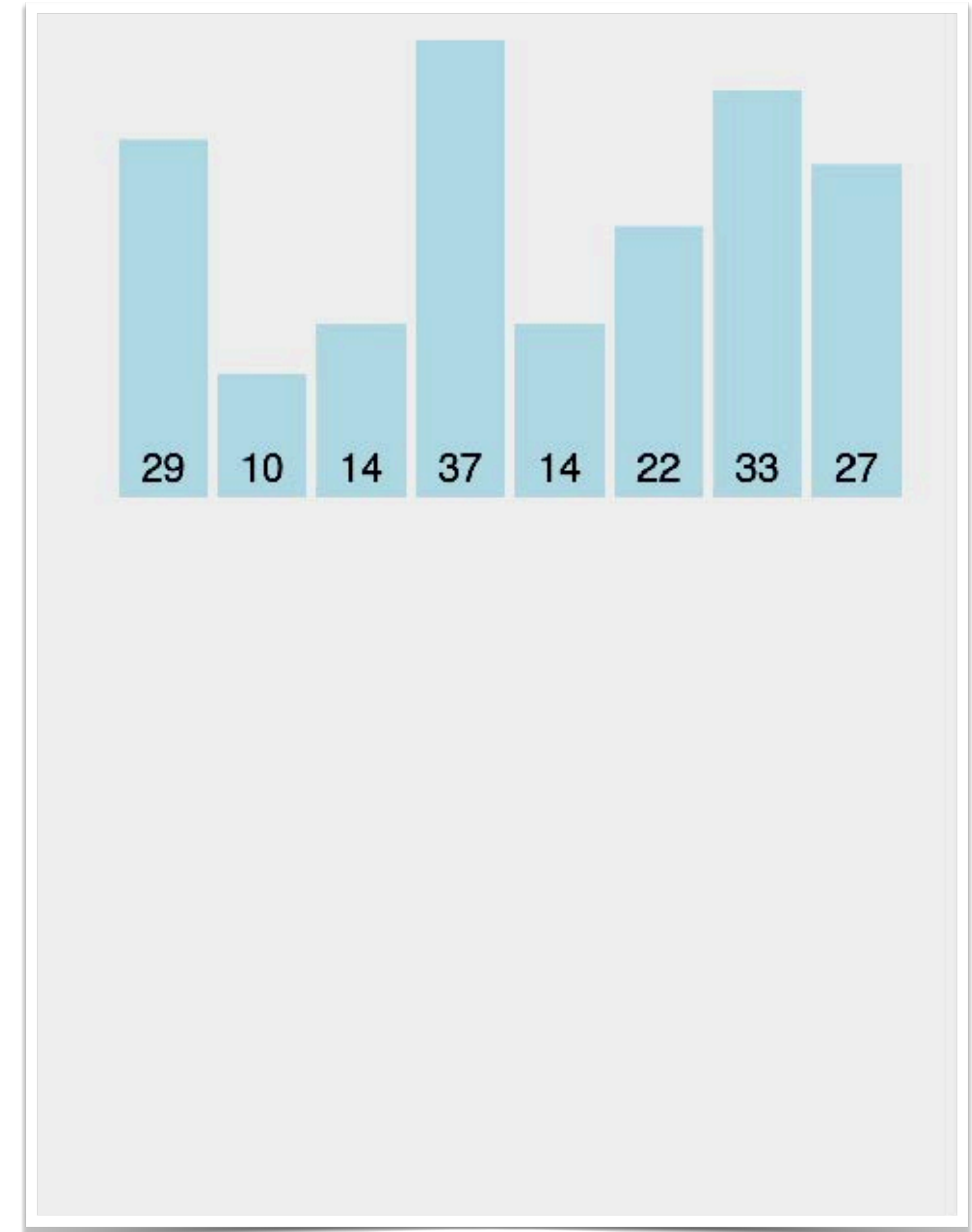

Selection sort

```
void selection_sort(int arr[], int n){
  for (int i = 0; _________; i++){

    int min_idx = i; // Initialize min to first item

    // Find the minimum in the  sublist: list[i..arraySize-1]
    for (int j = i + 1; j < n; j++)
      if (_____________________)
        min_idx = j;

    // swap list[i] with list[currentMinIndex] if necessary;
    if (min_idx != i){
      _______ = ____________;
      arr[min_idx] = arr[i];
      arr[i] = min;
    }
  }
}
```


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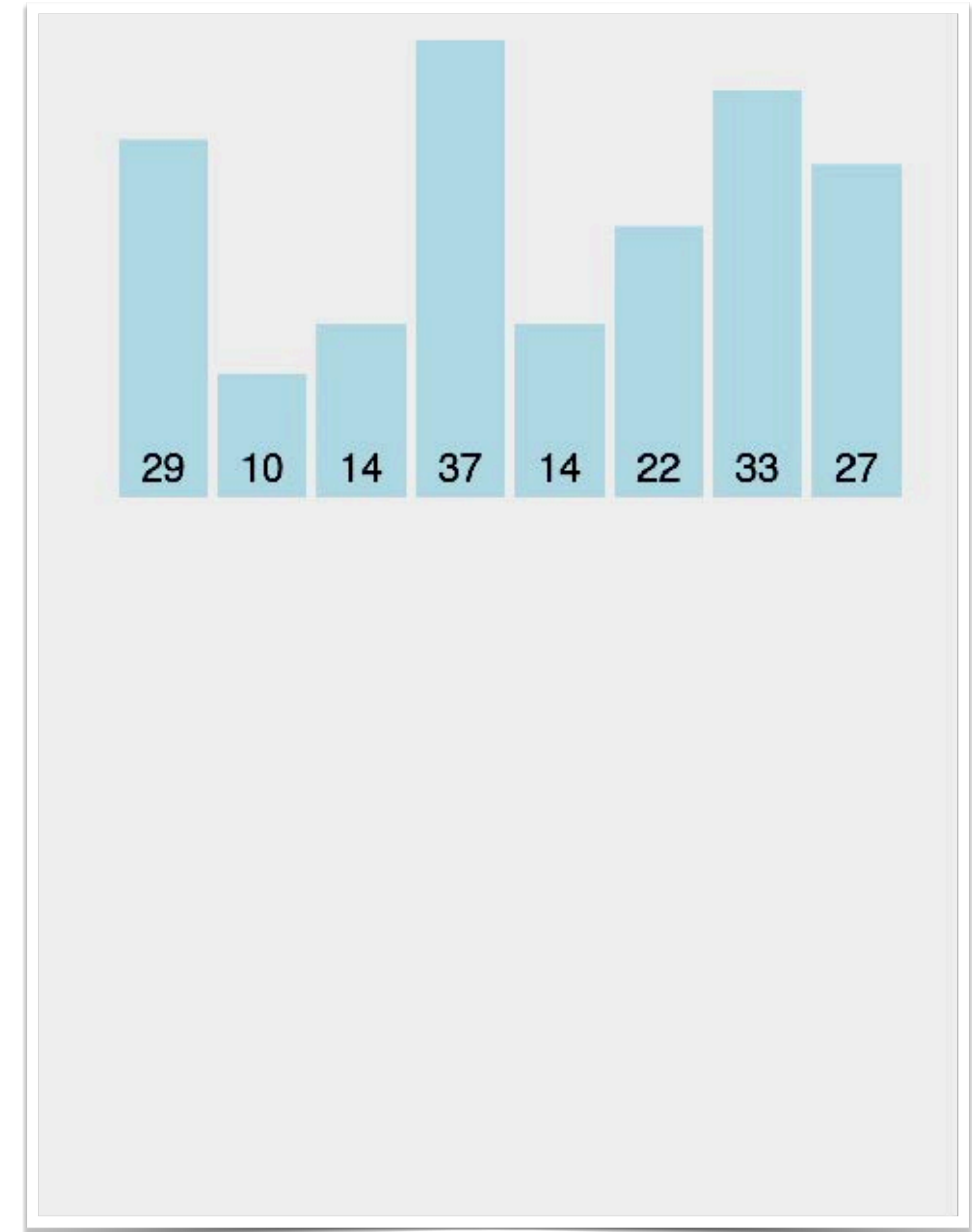
https://visualgo.net/en/sorting

Insertion sort



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Insertion sort

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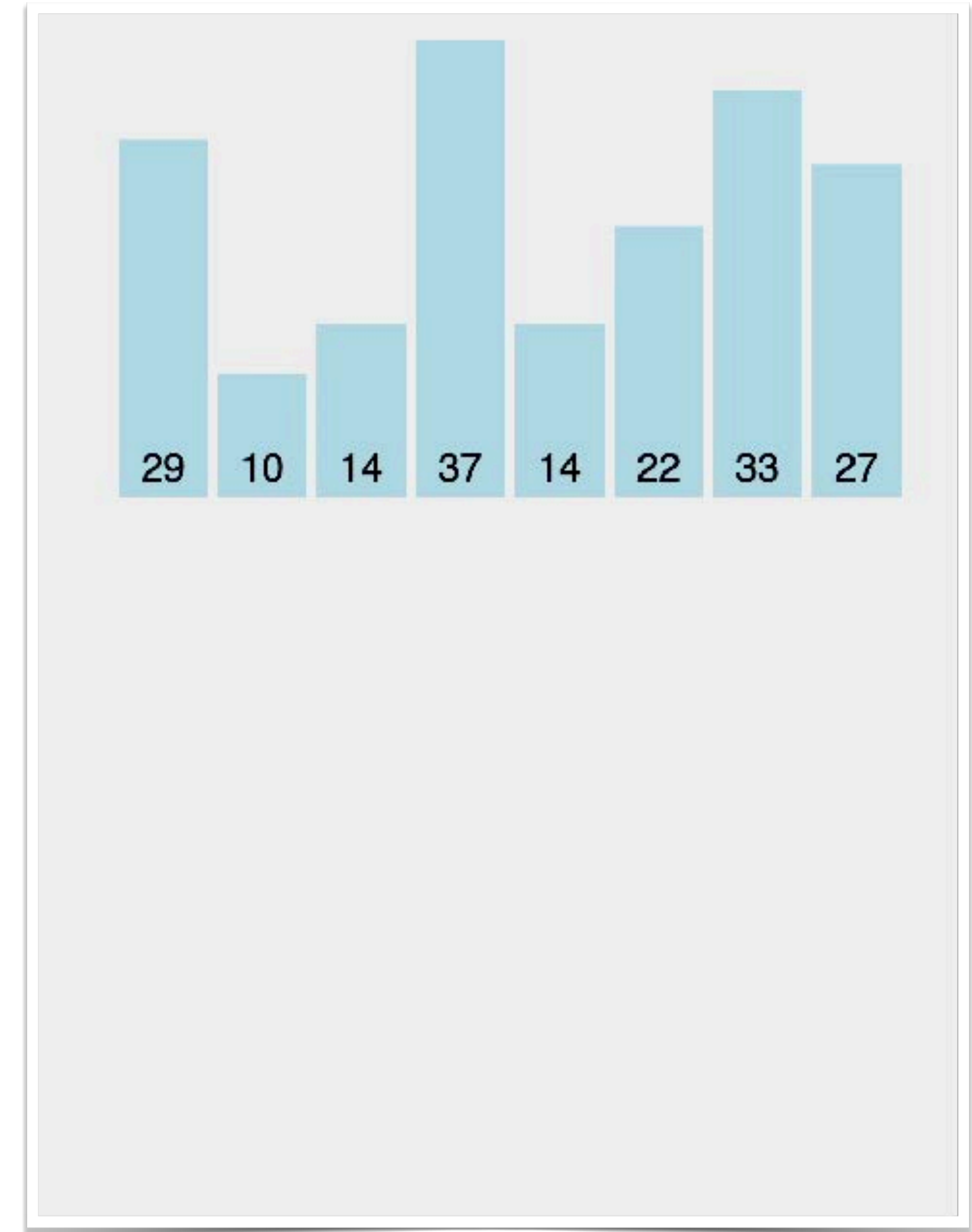

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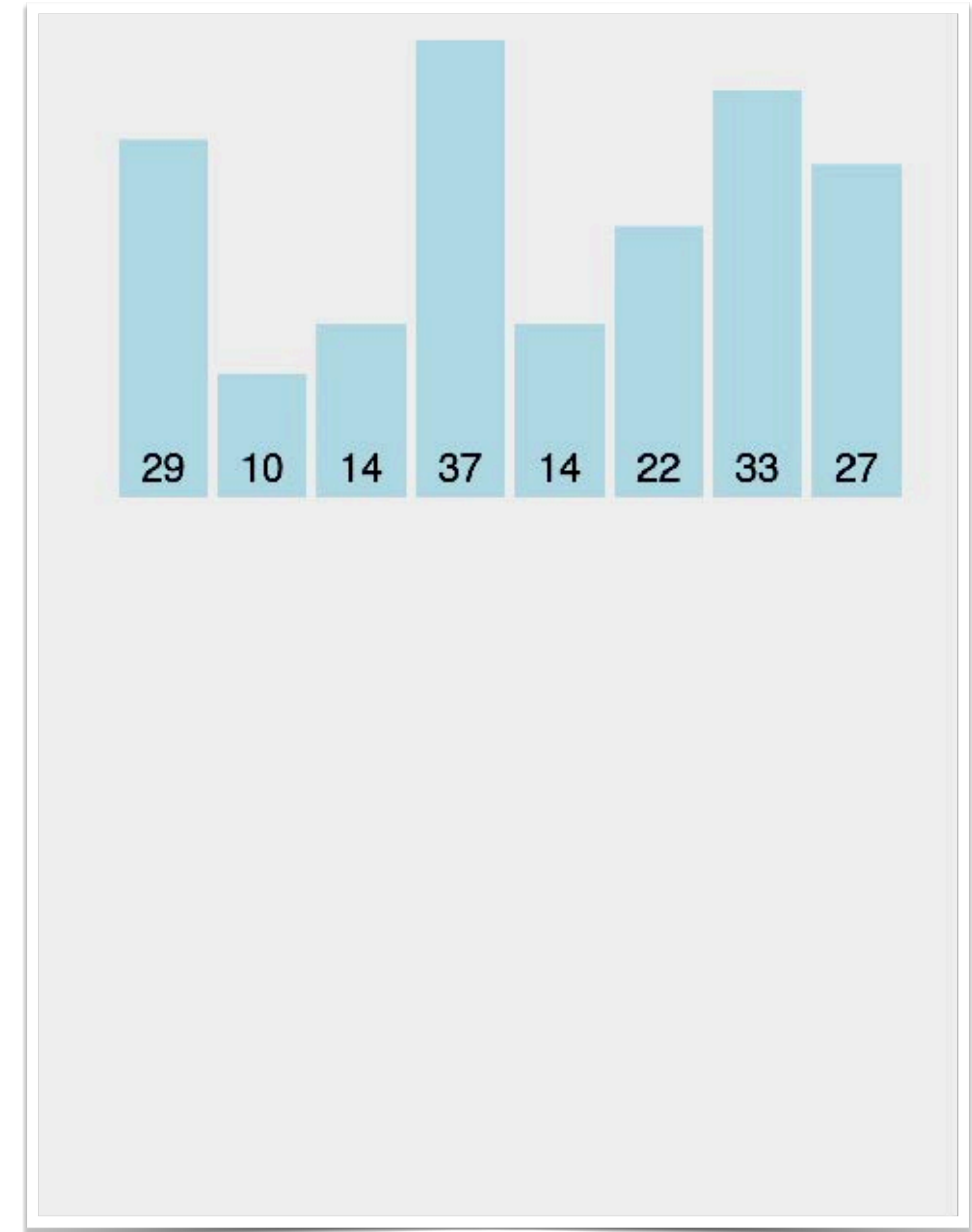

Insertion sort

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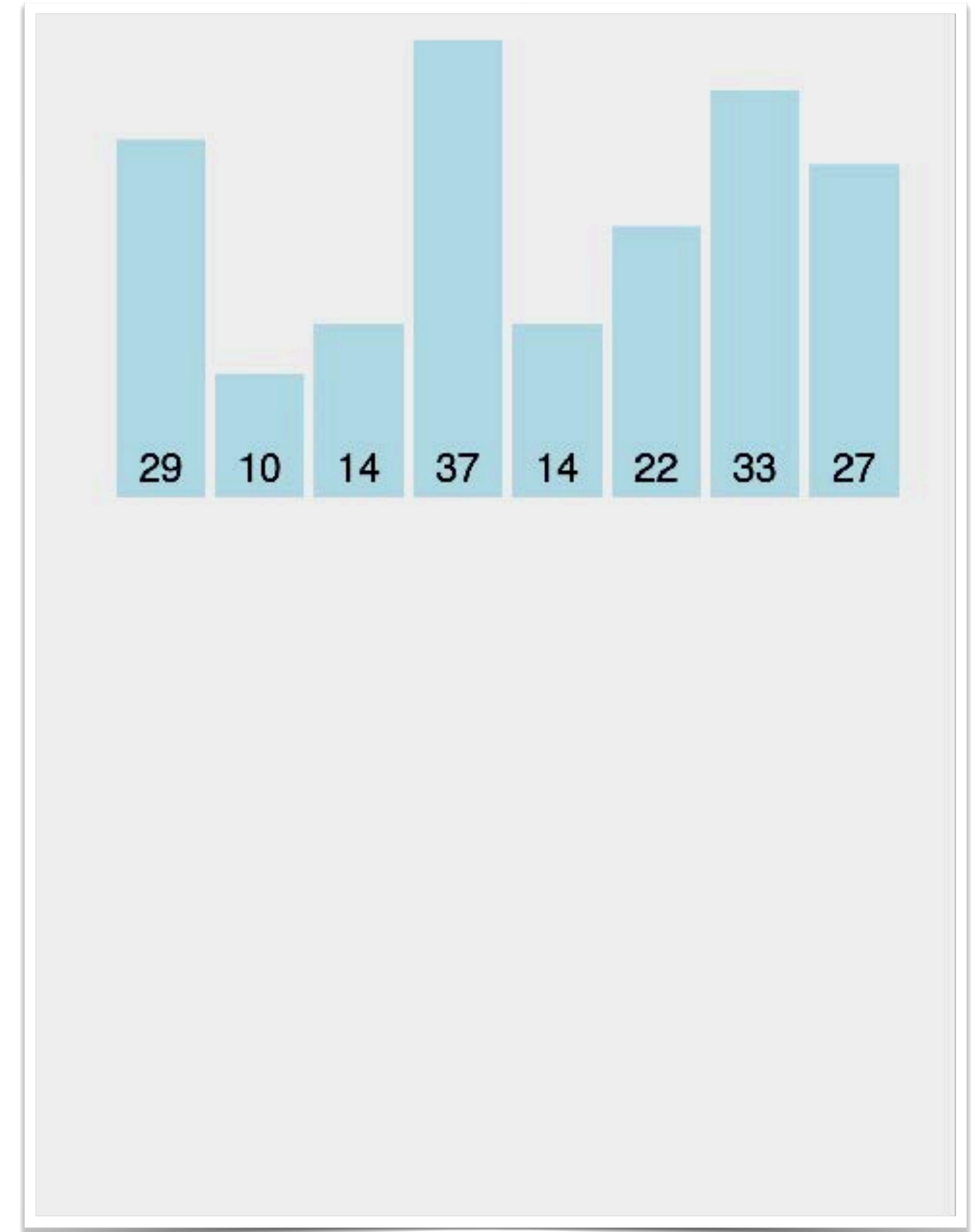
  - Pick the next card and insert it into the right place in the sorted array; moving elements if needed.



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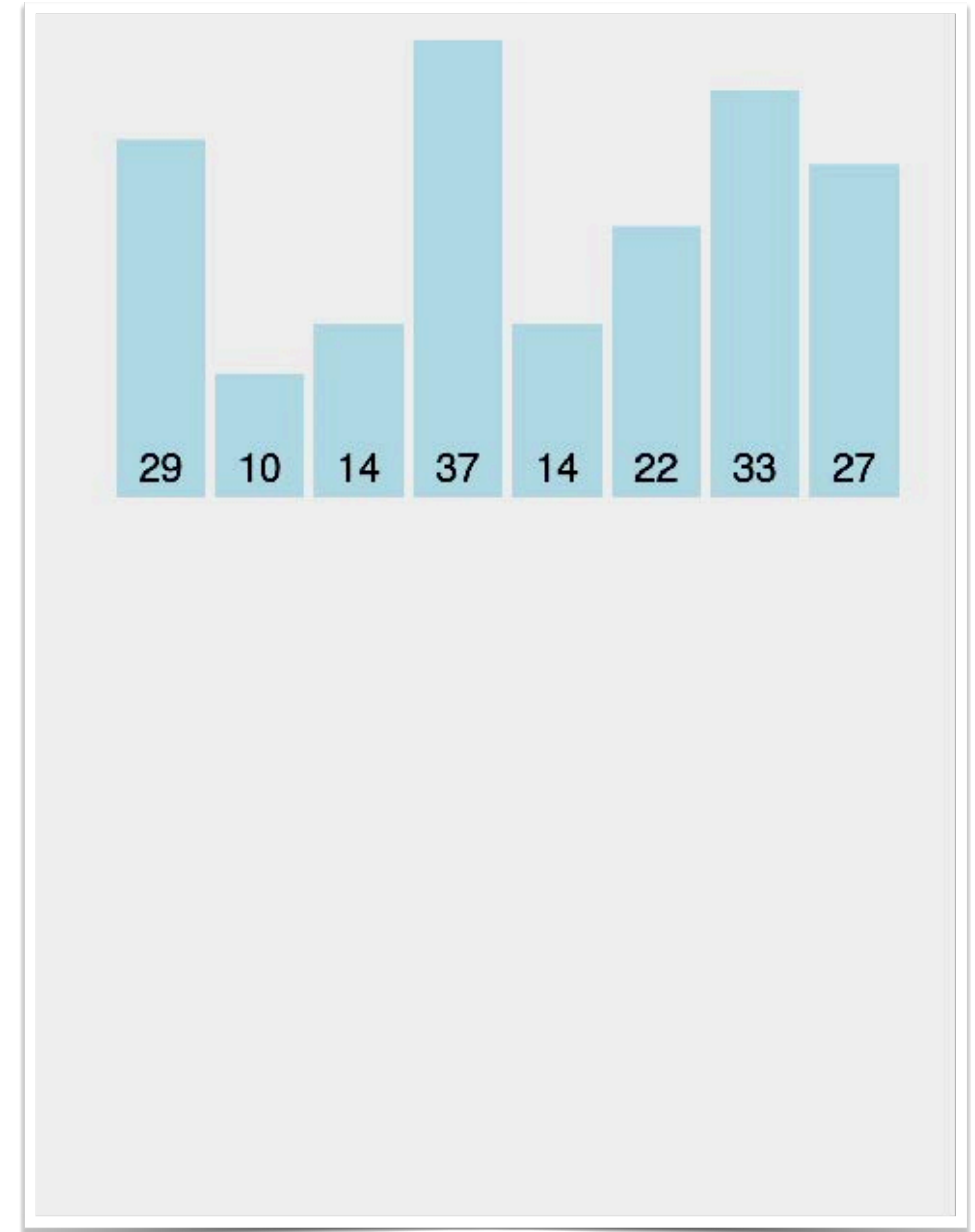

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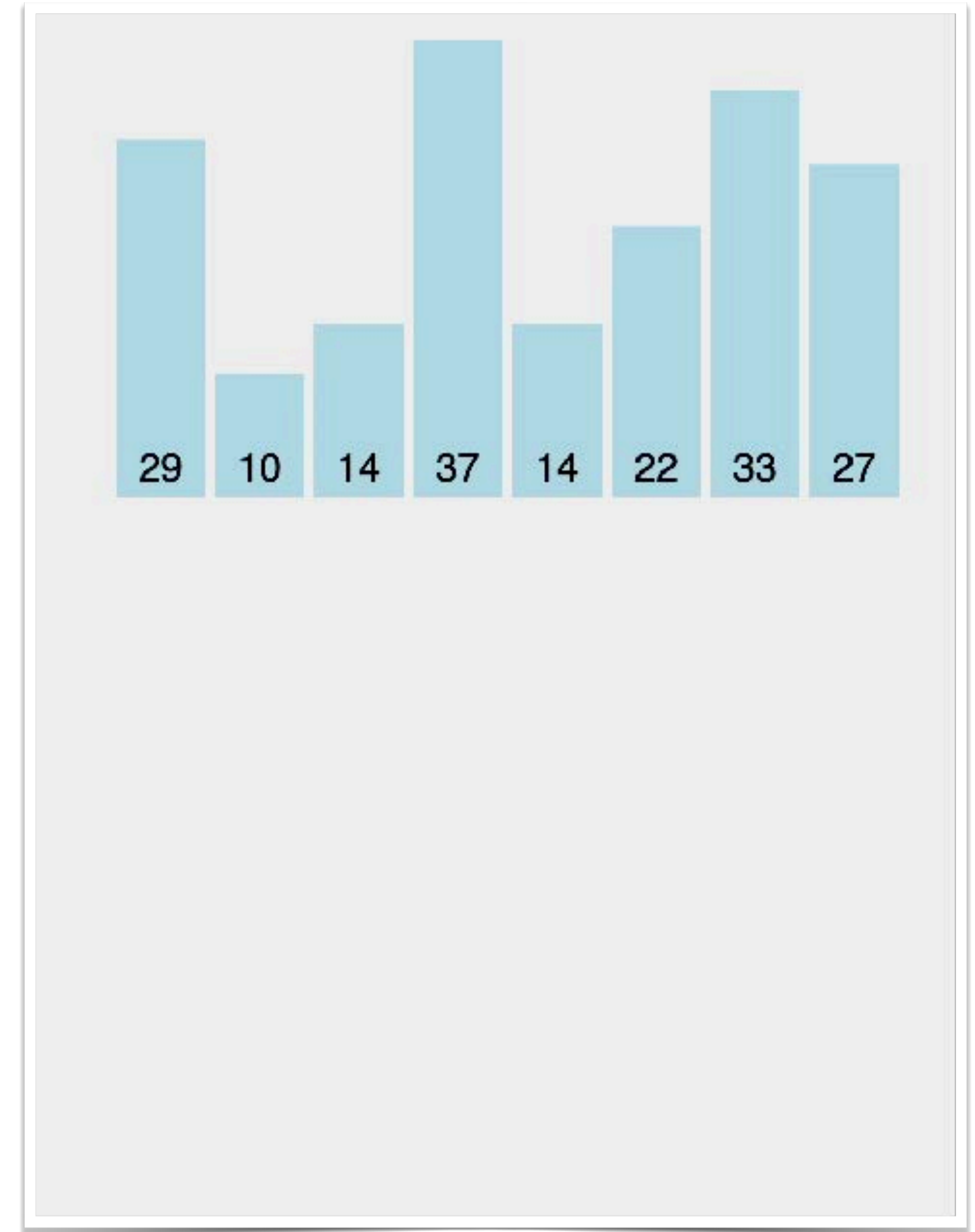

Insertion sort

```
void insertion_sort(int arr[], int n){
   for (int i = 1; i < n; i++){

      /* Insert list[i] into a sorted sublist list[0..i-1] so that
         list[0..i] is sorted. */

      int current = arr[i];
      int k;

      for (k = i - 1; __________________________; k--)
       // Move elements one spot over
        _________________ = _________________;

      // Insert the current element into list[k+1]
      arr[k + 1] = current;
   }
 }
```


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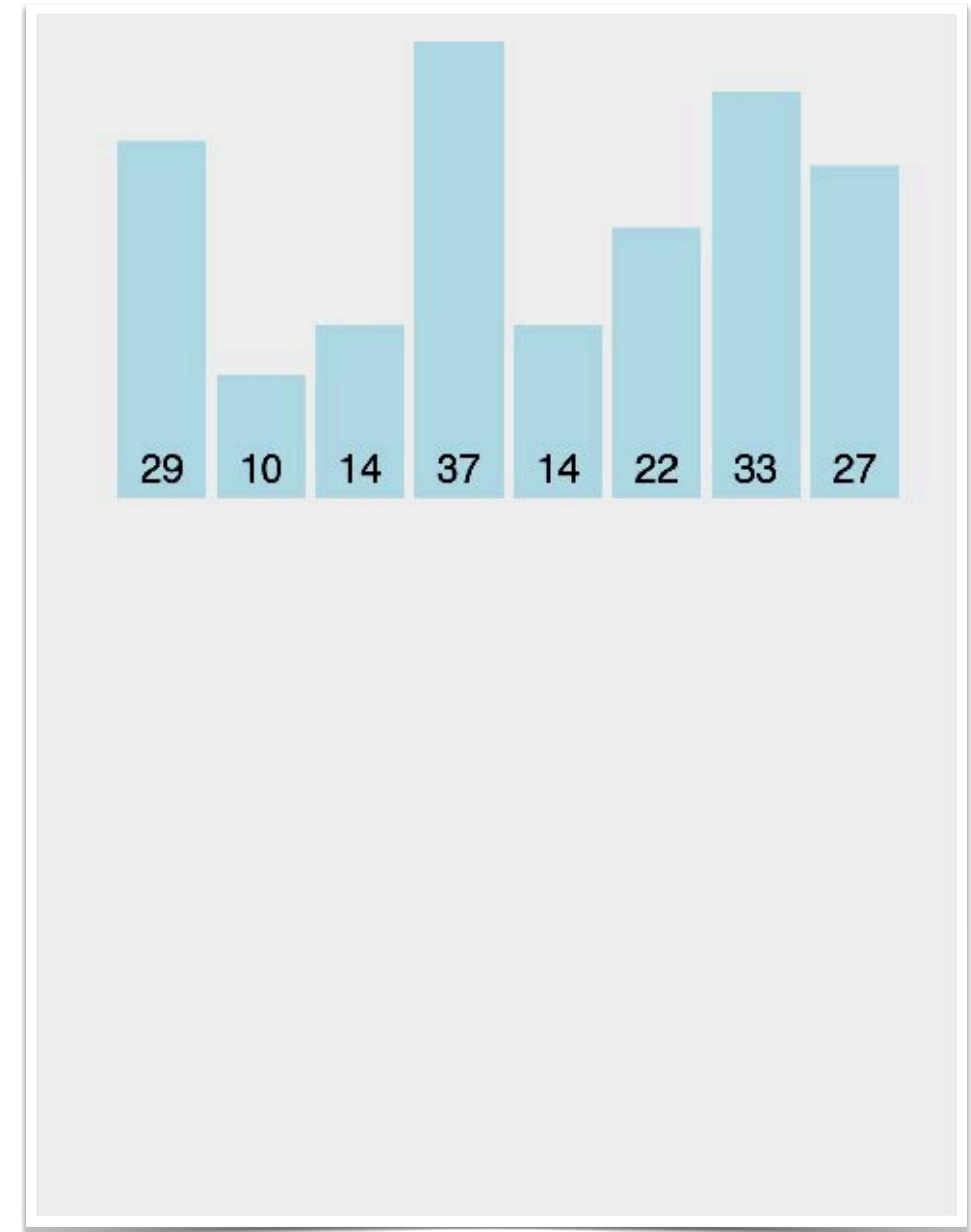
Bubble sort



Bubble sort

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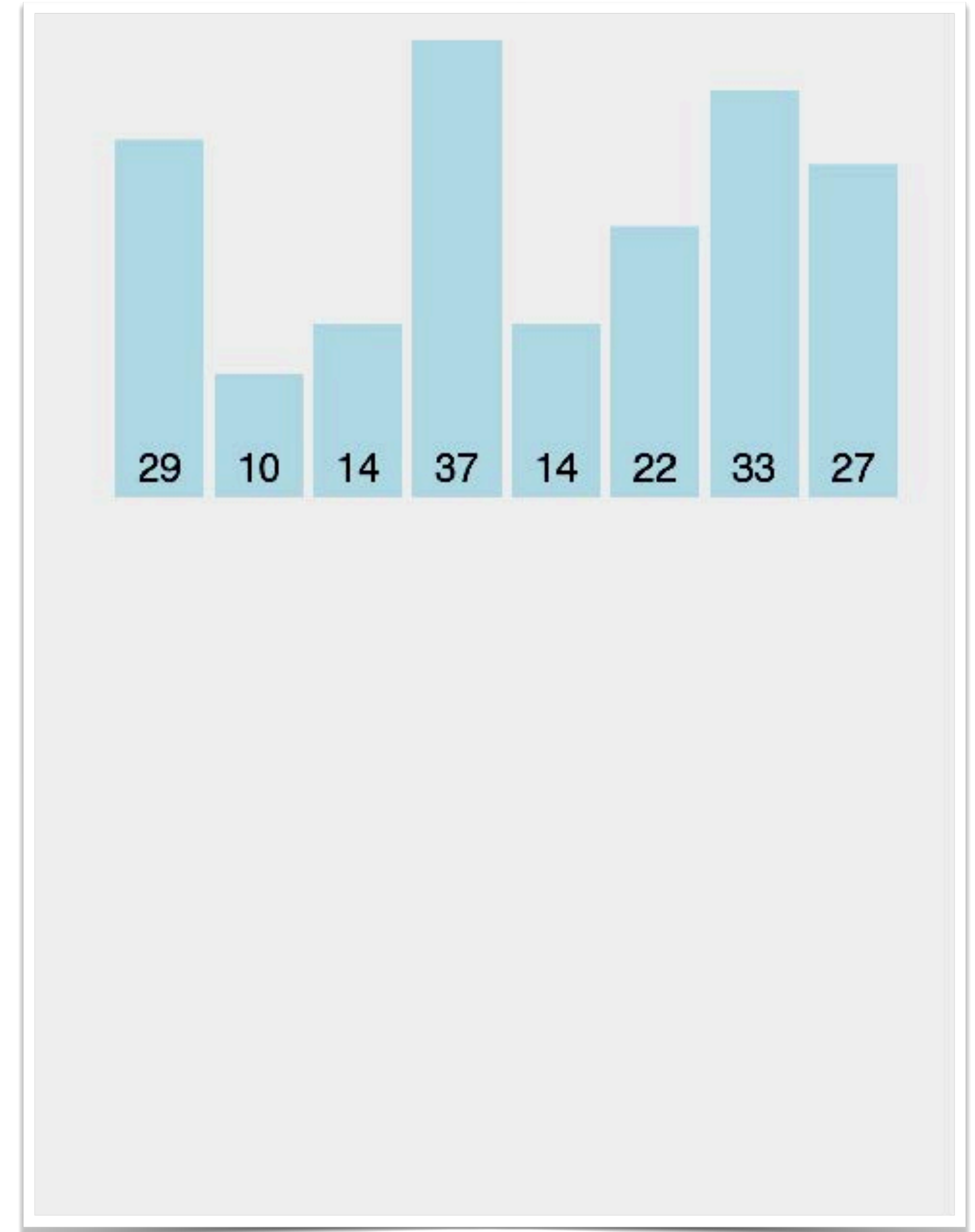

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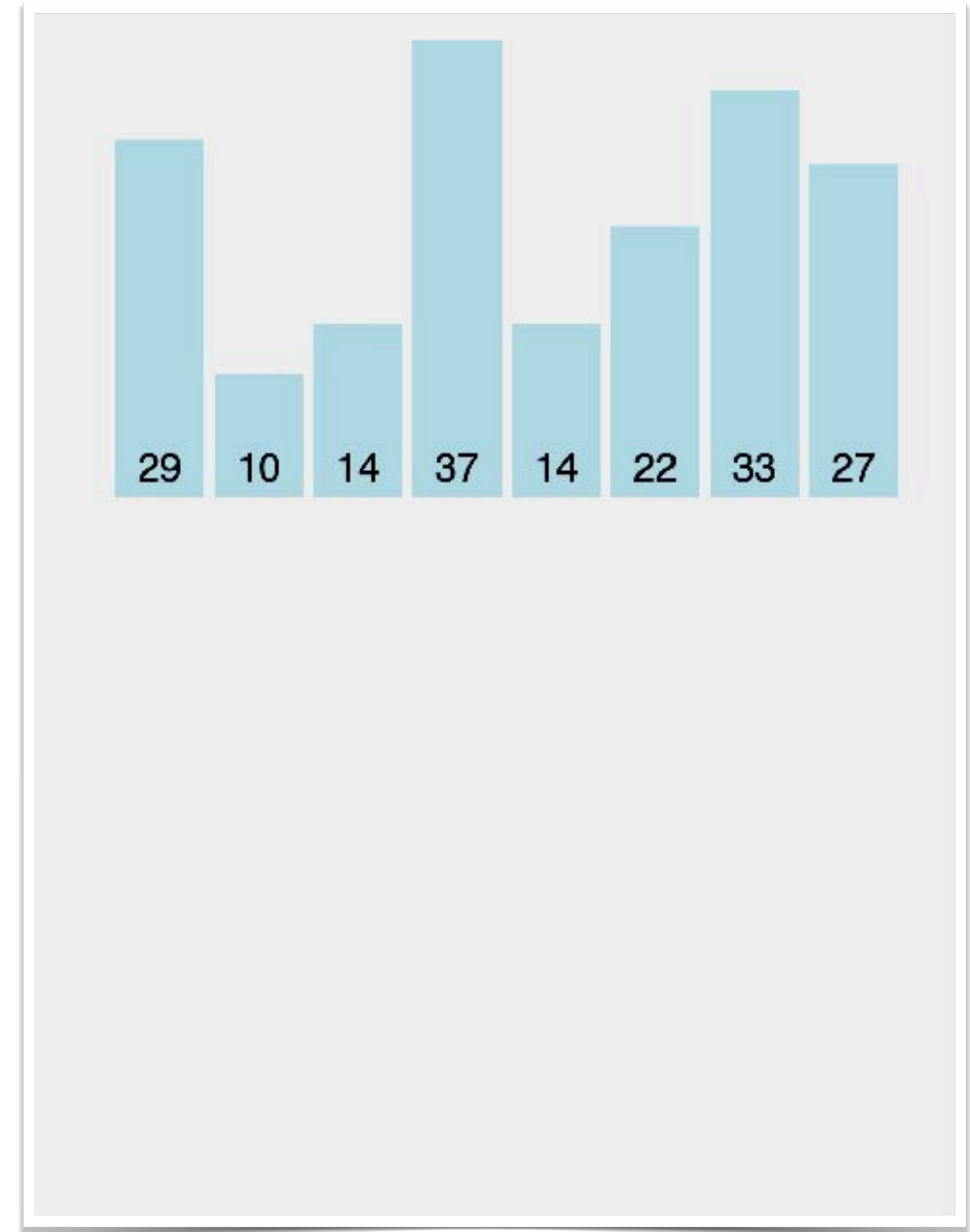

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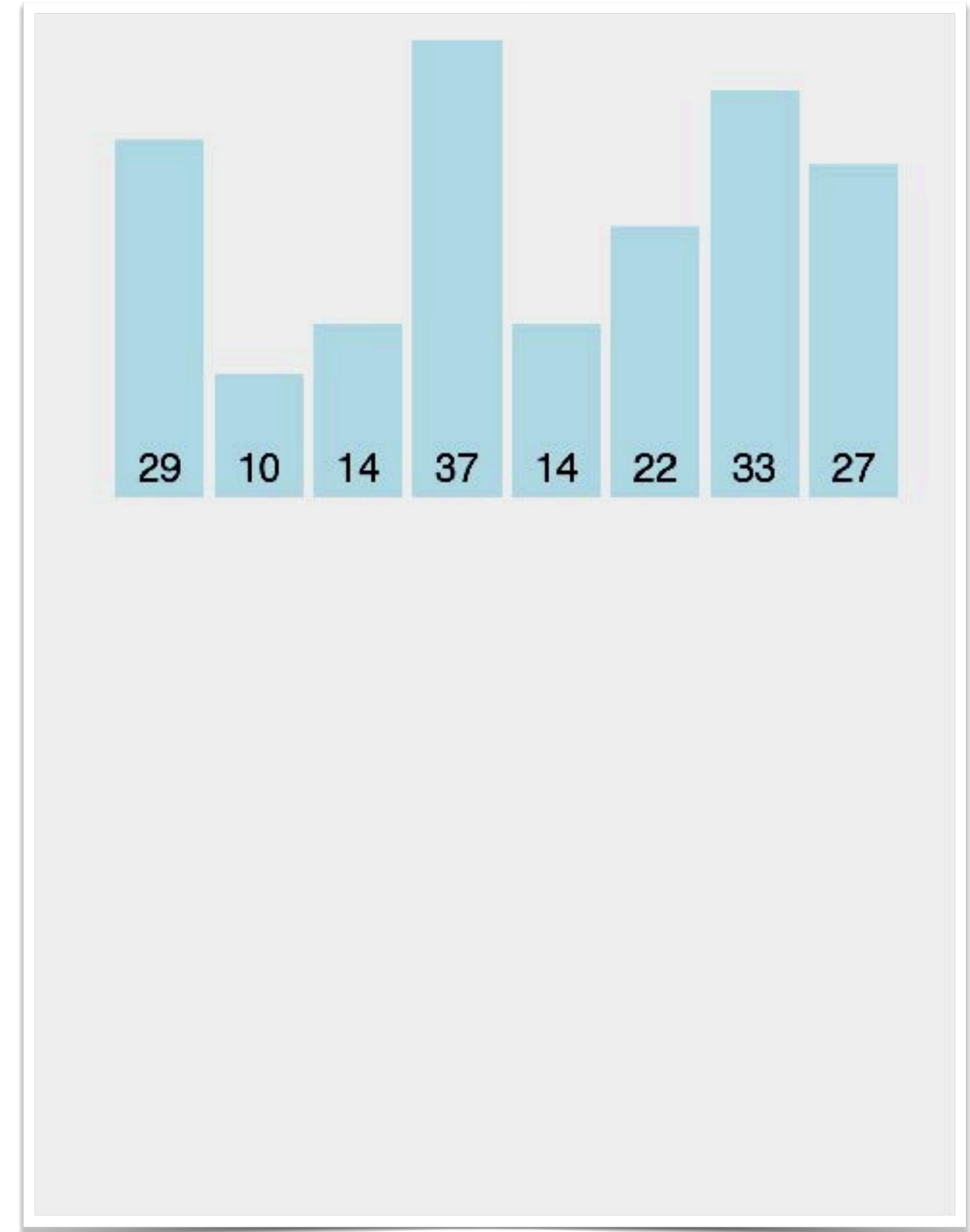

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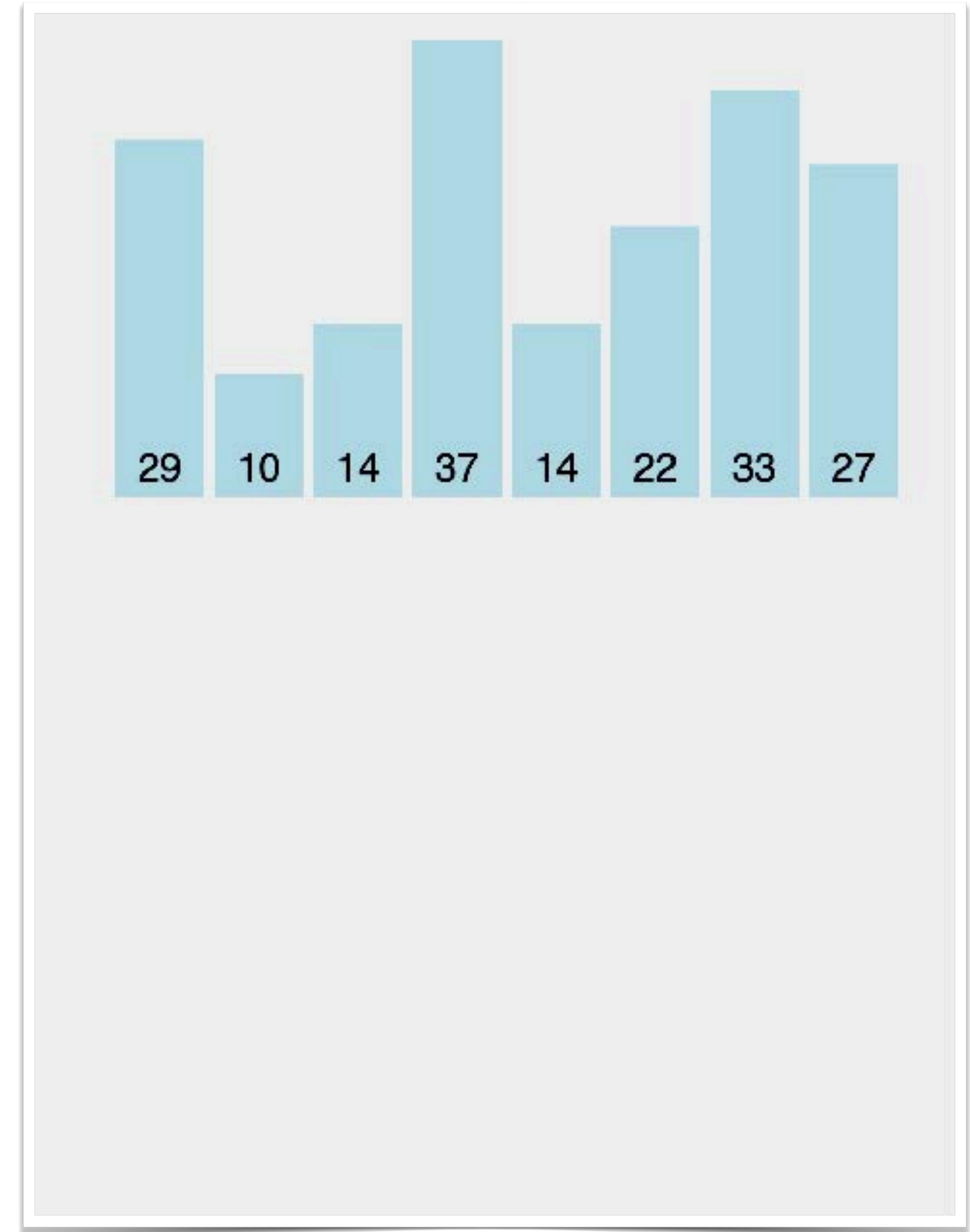

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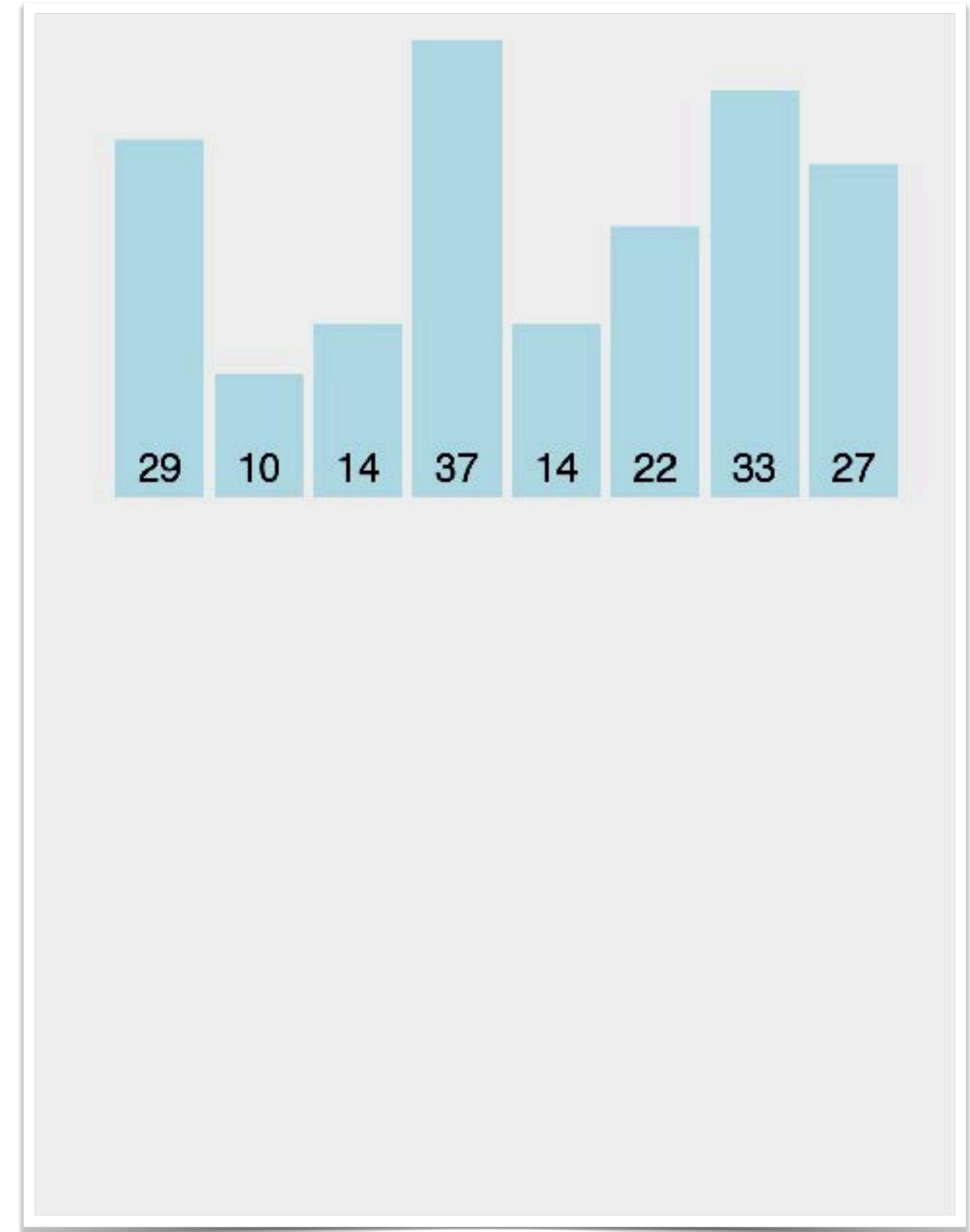

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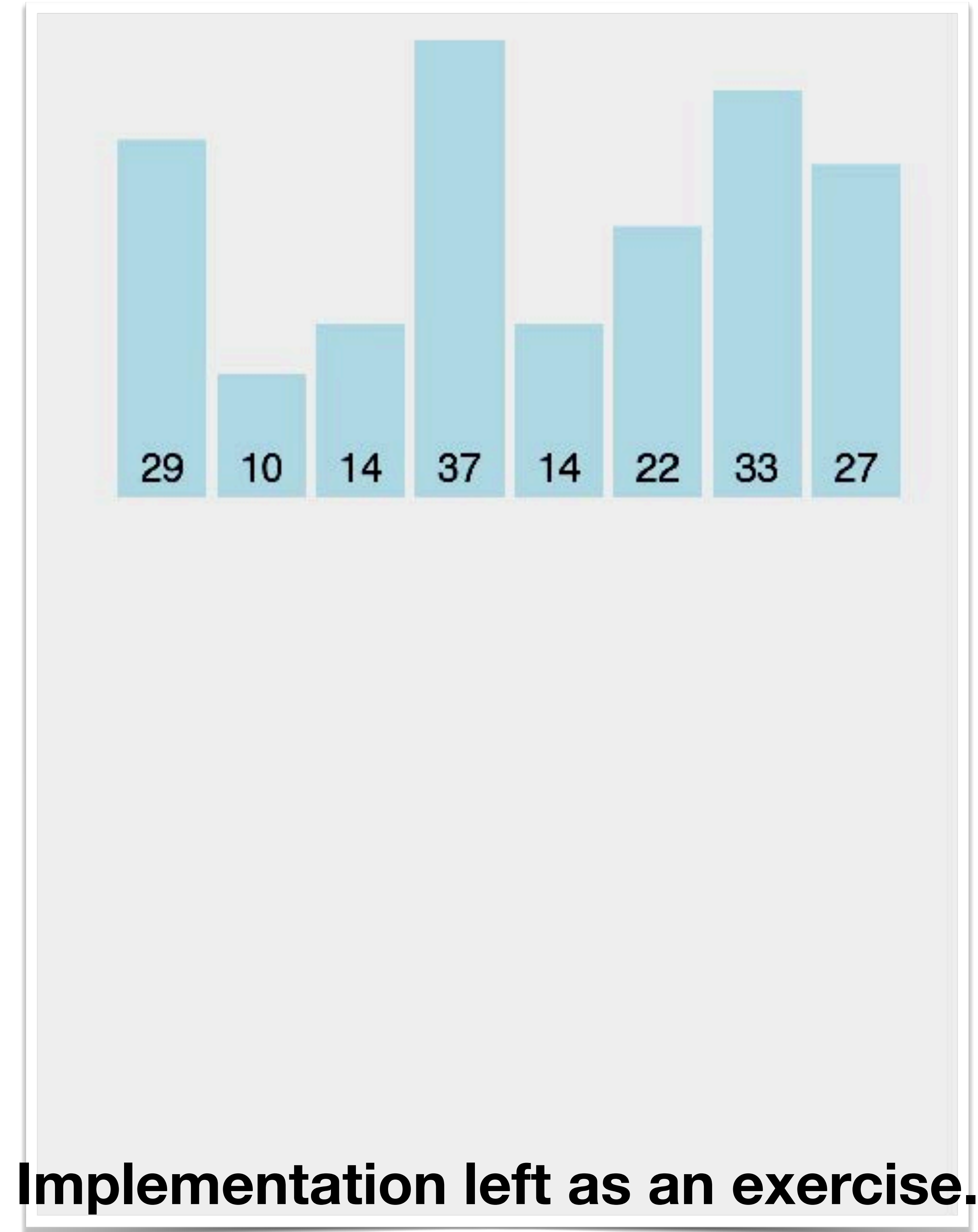

Implementation left as an exercise.

Quick sort

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  - How to pick pivot?
    - First, last, mid, random, etc.
  - Recursive vs. iterative.
- Main point: understand one variety and understand it well.

ECE 220

A special on Quicksort: Lecture x000B+

PDF-Link

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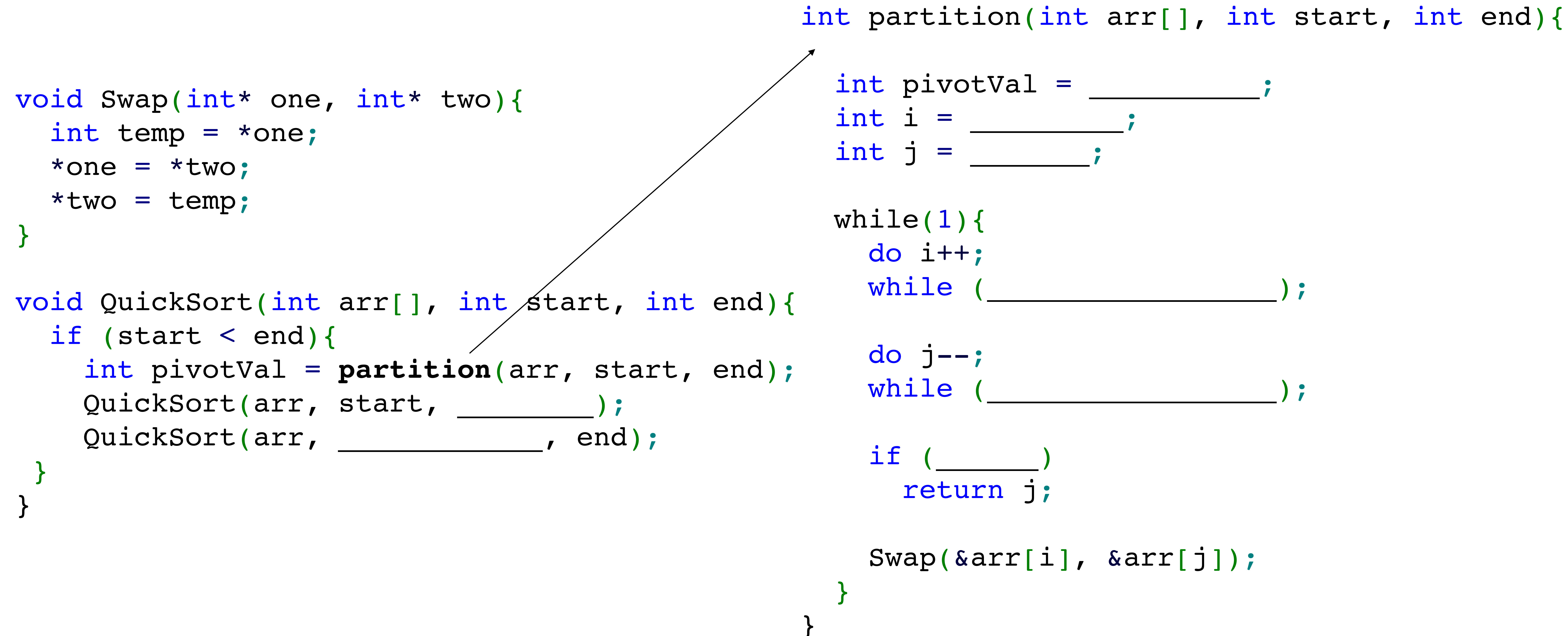
Implementation



Check Gitlab for reference material: https://gitlab.engr.illinois.edu/itabrah2/ece220-sp24

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