CSCI 241: Data Structures

Lecture 1

Introduction

Course Overview

Intro to Sorting

Today

1. About Me

2. Course Overview and a few notes on the syllabus

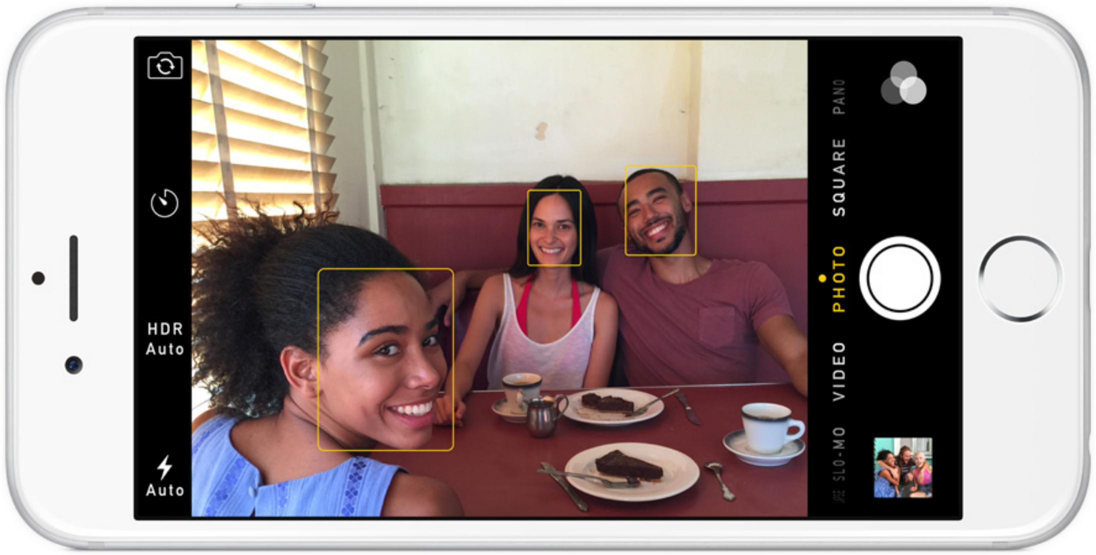
3. Insertion Sort and Selection Sort

About Me

Scott Wehrwein

📍 🍷

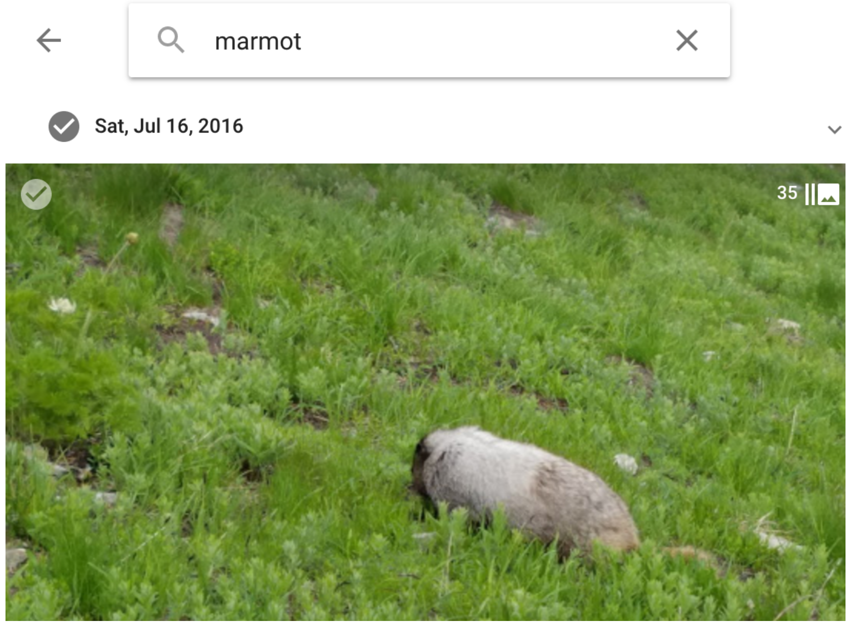
Computer Vision: Familiar Examples



In-Camera Face Detection

Autonomous Driving

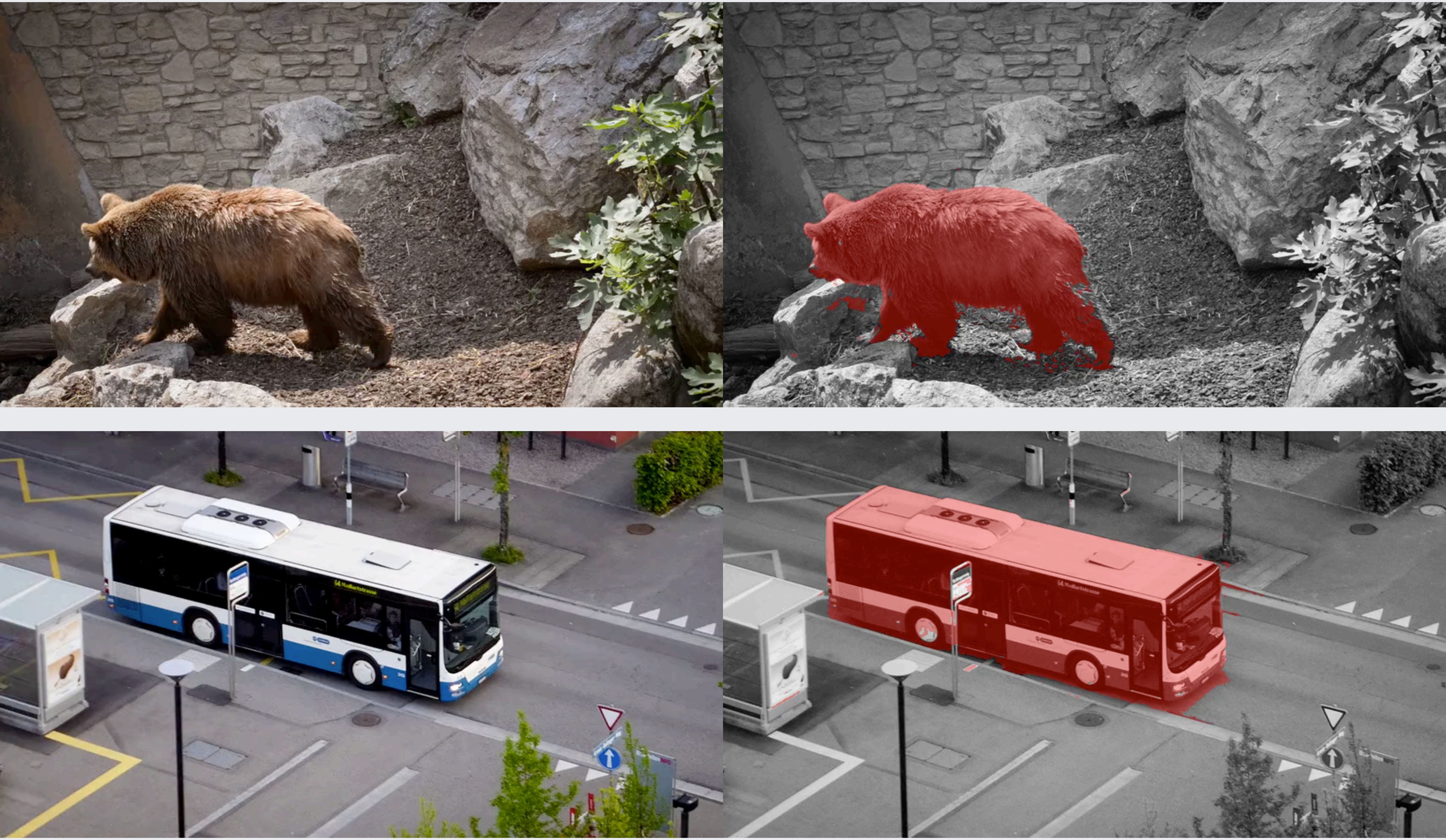
Panorama Stitching



marmot

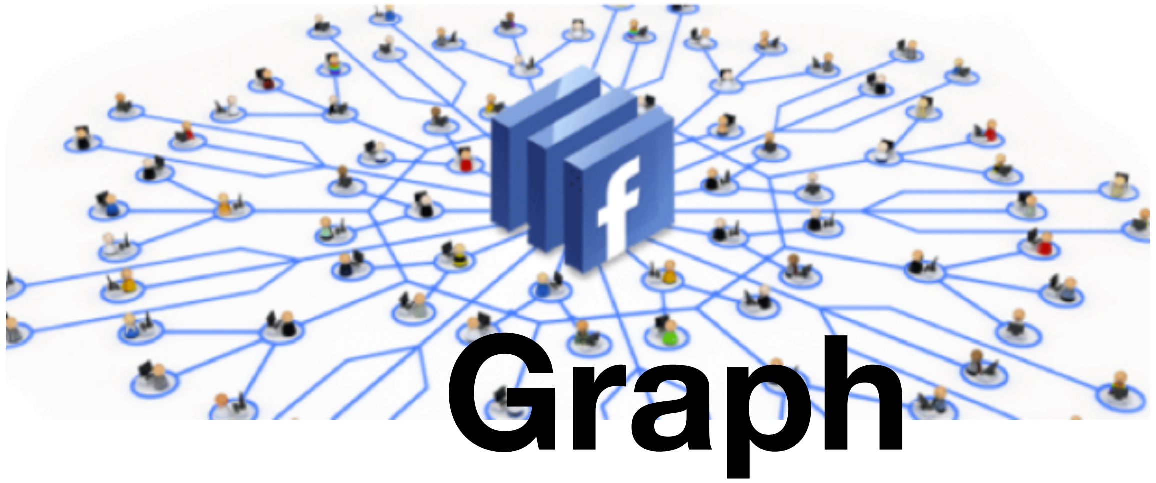
Sat, Jul 16, 2016

Image Search

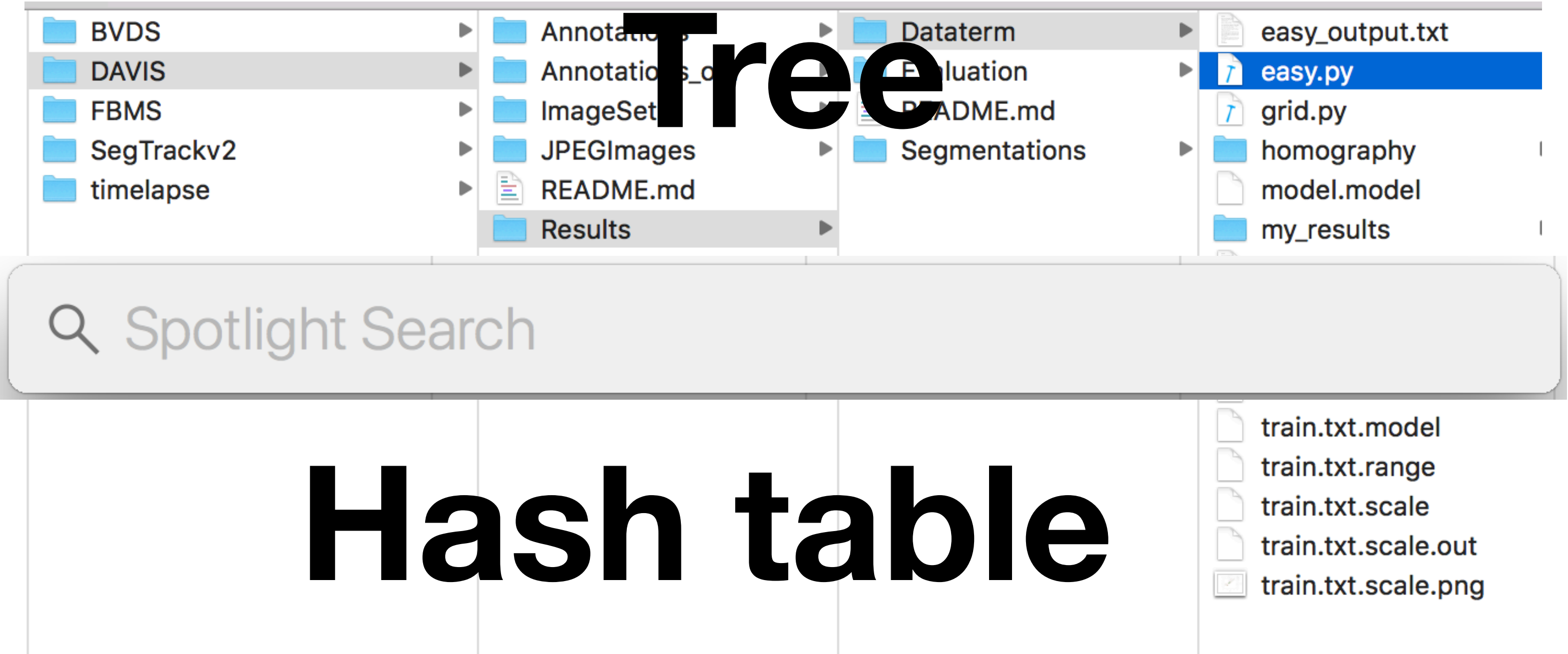


Sage Chapel
147 Ho Plaza

Data Structures: Why?



Graph



Tree

BVDS
DAVIS
FBMS
SegTrackv2
timelapse

Annotatio
Annotatio s_o
ImageSet
JPEGImages
README.md
Results

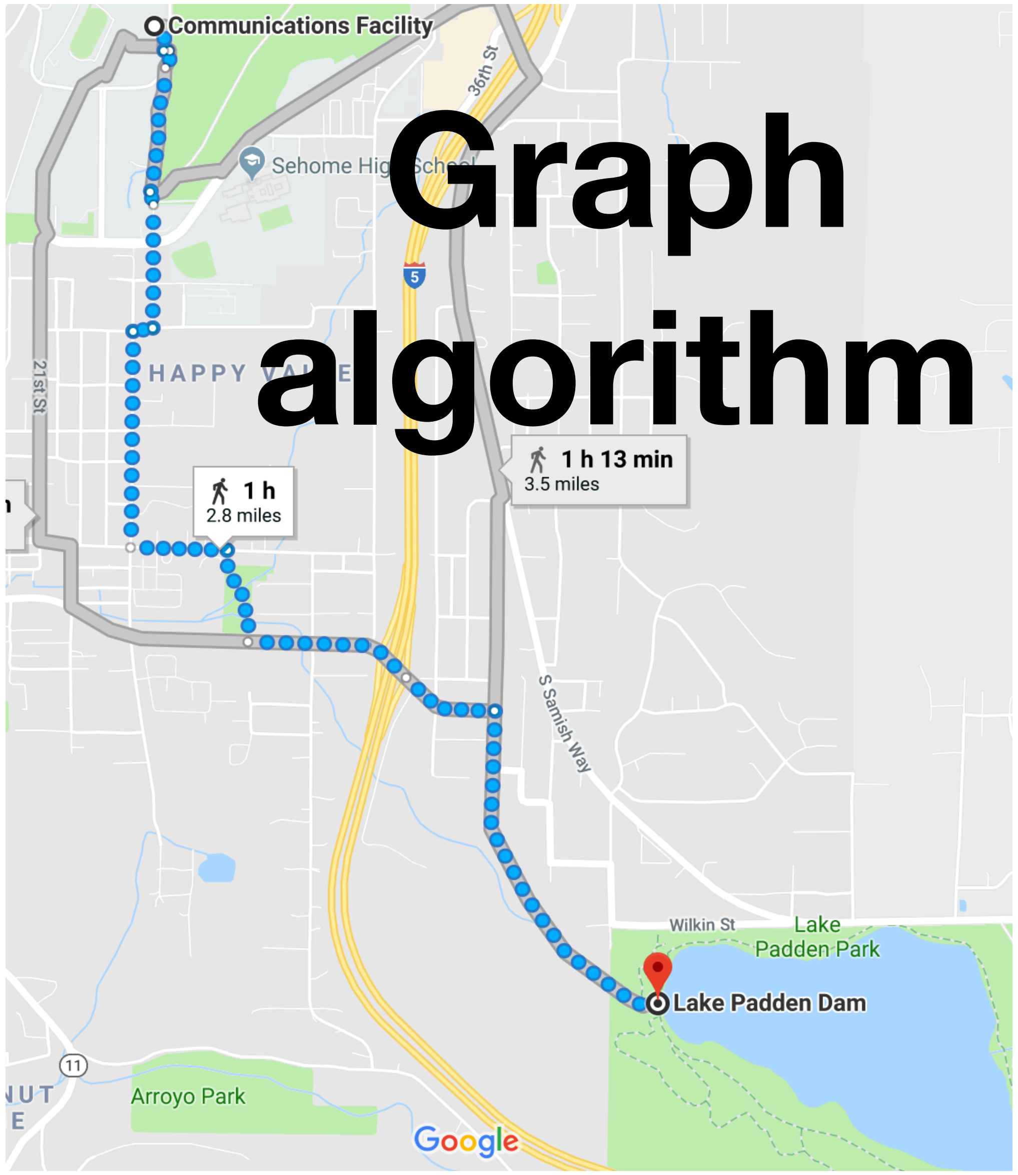
Dataterm
E luation
ADME.md
Segmentations

easy_output.txt
easy.py
grid.py
homography
model.model
my_results

Spotlight Search

train.txt.model
train.txt.range
train.txt.scale
train.txt.scale.out
train.txt.scale.png

Hash table



Graph algorithm

Syllabus Overview

Course website:

https://facultyweb.cs.wwu.edu/~wehrwes/courses/csci241_19w

Also linked from the Syllabus section on Canvas.

Goals

- Understand the range index convention a..b
- Know the definition of specification, precondition, postcondition, and invariant.
- Be able to execute insertion sort and selection sort on paper.
- Be able to implement insertion sort and selection sort.

Sorting Algorithms

Why?

- Arrays are the simplest and most ubiquitous data structure available to us.
- Sorting algorithms are a fundamental piece of knowledge for computer scientists
- An entry point into the practice of developing, and analyzing algorithms.

Preliminaries:
Tools for Talking about Algorithms

Range Indices

`a..b` denotes the range of consecutive integers from (and **including**) a up to (but **excluding**) b.

Examples:

- 0..5 is the range 0, 1, 2, 3, 4
- A[4..6] denotes the 4th and 5th elements of A
- 7..8 is a range containing only 7
- 6..6 is a valid range but contains no elements

Range Indices

`a..b` denotes the range of consecutive integers from (and **including**) a up to (but **excluding**) b.

- How many elements are in the range `a..b`?

```
A. b-a-1

B. a-b-1

C. b-a+1

D. B-a
```

Range Indices

`a..b` denotes the range of consecutive integers from (and **including**) a up to (but **excluding**) b.

- Recall that `A.length` gives A’s length. What range denotes all elements of A?

```
A. A[0..A.length]

B. A[0..A.length-1]

C. A[0..A.length+1]

D. A[1..A.length-1]
```

Specification

```
/** return the max value in A
  * precondition: A is nonempty
  * postcondition: max value of A is returned */
public int findMax(int[] A) {
  int max = A[0];
  // invariant: max is the largest value in A[0..i]
  for (int i = 1; i < A.length; i++) {
    if (A[i] > max) {
      Max = A[i];
    }
  }
  return max;
}
```

A **method specification** is a comment above the method that details the precise behavior of the method.

Precondition, Postcondition

```
/** return the max value in A
  * precondition: A is nonempty
  * postcondition: max value of A is returned */
public int findMax(int[] A) {
  int max = A[0];
  // invariant: max is the largest value in A[0..i]
  for (int i = 1; i < A.length; i++) {
    if (A[i] > max) {
      max = A[i];
    }
  }
  return max;
}
```

The precondition is true **before** method execution.
The postcondition is true **after** method execution.

(Loop) Invariant

```
/** return the max value in A
  * precondition: A is nonempty
  * postcondition: max value of A is returned */
public int findMax(int[] A) {
  int max = A[0];
  // invariant: max is the max of A[0..i]
  for (int i = 1; i < A.length; i++) {
    if (A[i] > max) {
      max = A[i];
    }
  }
  return max;
}
```

Max is the largest value in:

A[0..1]

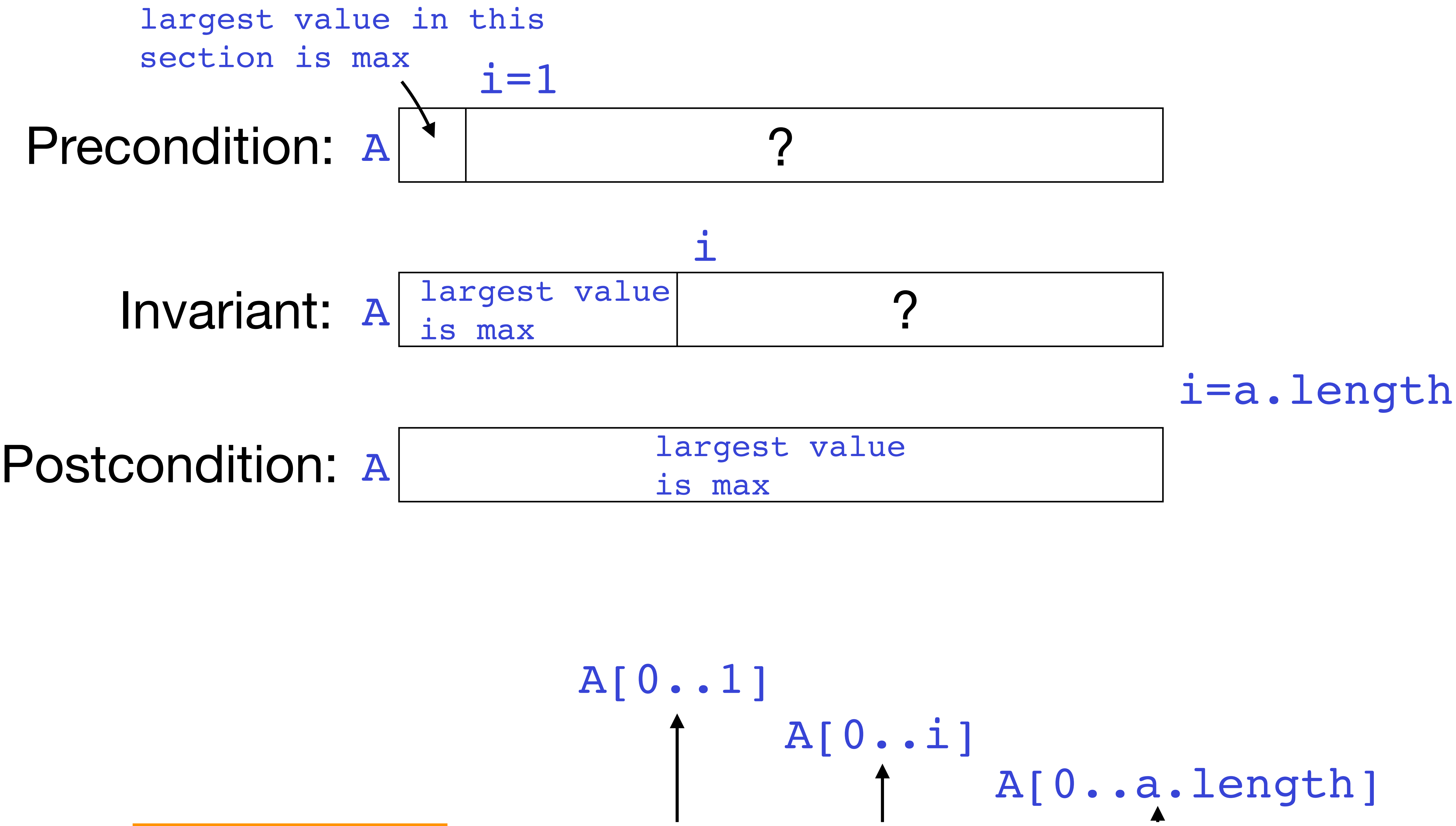
A[0..i]

A[0..a.length]

A loop invariant is true **before**, **during**, and **after** the loop.

(at the *end* of each iteration)

Loop Invariant



largest value in this section is max

i=1

Precondition: A

?

i

Invariant: A

largest value is max

?

i=a.length

Postcondition: A

largest value is max

A[0..1]

A[0..i]

A[0..a.length]

The loop invariant is true **before**, **during**, and **after** the loop.

Onward to sorting!

Insertion Sort

Insert A[i] into the sorted sublist A[0..i-1].

Selection Sort

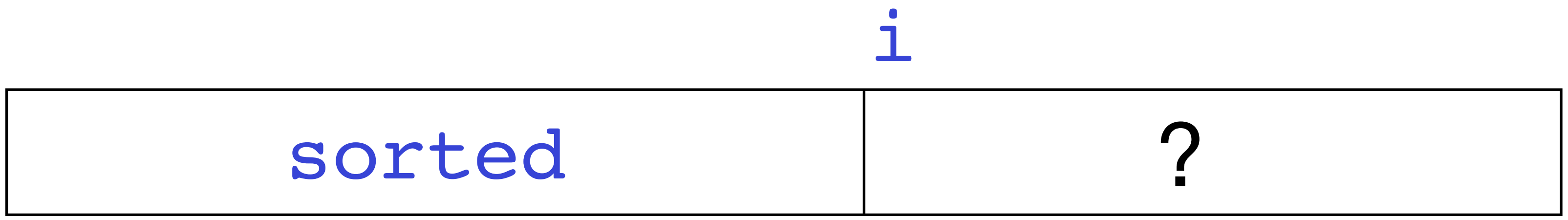
Find the smallest element in A[i..n] and place it at A[i].

https://visualgo.net/bn/sorting

Insertion Sort

Insert A[i] into the sorted sublist A[0..i-1].

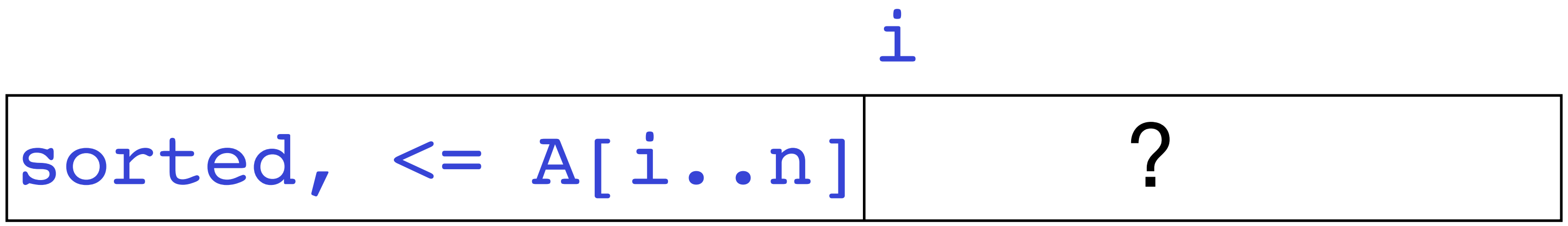
Invariant: `A`



Selection Sort

Find the smallest element in A[i..n] and place it at A[i].

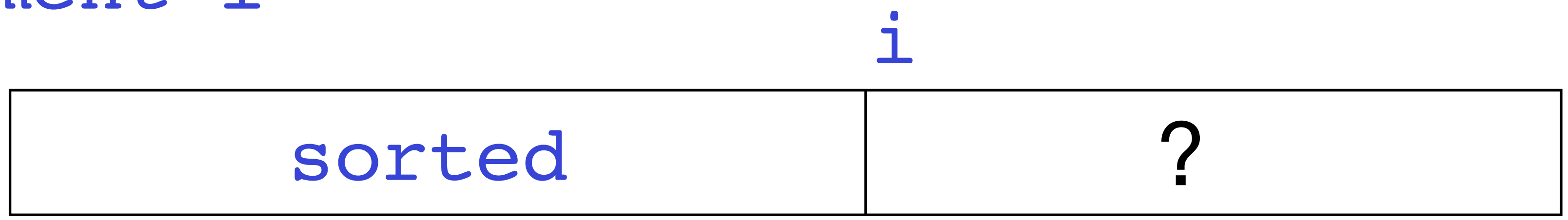
Invariant: `A`



https://visualgo.net/bn/sorting

```
insertionSort(A):
  i = 0;
  while i < A.length:
    // push A[i] to its sorted position by repeatedly
    //   swapping with the element to its left
    // increment i
```

Invariant: A



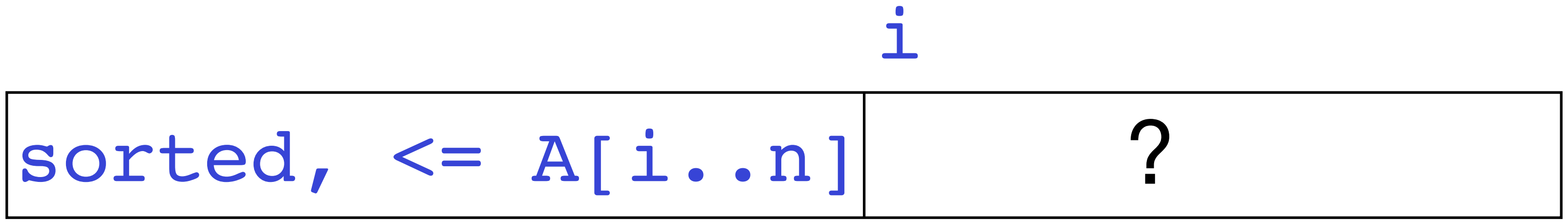
i

sorted

?

```
selectionSort(A):
  i = 0;
  while i < A.length:
    // find min of A[i..A.length]
    // swap it with A[i]
    // increment i
```

Invariant: A



i

sorted, <= A[i..n]

?

Insertion sort: Pseudocode

```
// Sorts A using insertion sort
insertionSort(A):
  i = 0;
  while i < A.length:
    j = i;
    while j > 0 and A[j] > A[j-1]:
      swap(A[j], A[j-1])
      j--
    i++
```

Invariant: A