

# Arrays, Headers & Microwaves



UAB ASSOCIATION FOR COMPUTING  
MACHINERY & SHIPT PRESENT:

# SHIPT DINNER & PRESENTATION

ENJOY DINNER AND LEARN MORE ABOUT  
UPCOMING OPPORTUNITIES AT SHIPT  
DIRECTLY FROM SHIPT RECRUITERS AND  
SOFTWARE ENGINEERS AT **SHIPT'S HQ**

5:30PM  
WEDNESDAY, FEBRUARY 19  
**SHIPT TOWER**

BY INVITE ONLY, FILL OUT  
THE FORM:  
**[UABACM.ORG/SHIPT](https://uabacm.org/shipt)**



# Lab 2

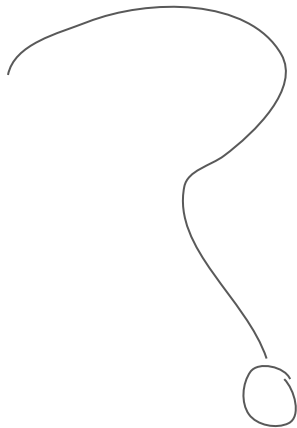
What's the runtime of `push()` and `pop()`?

$O(n)$

$O(1)$

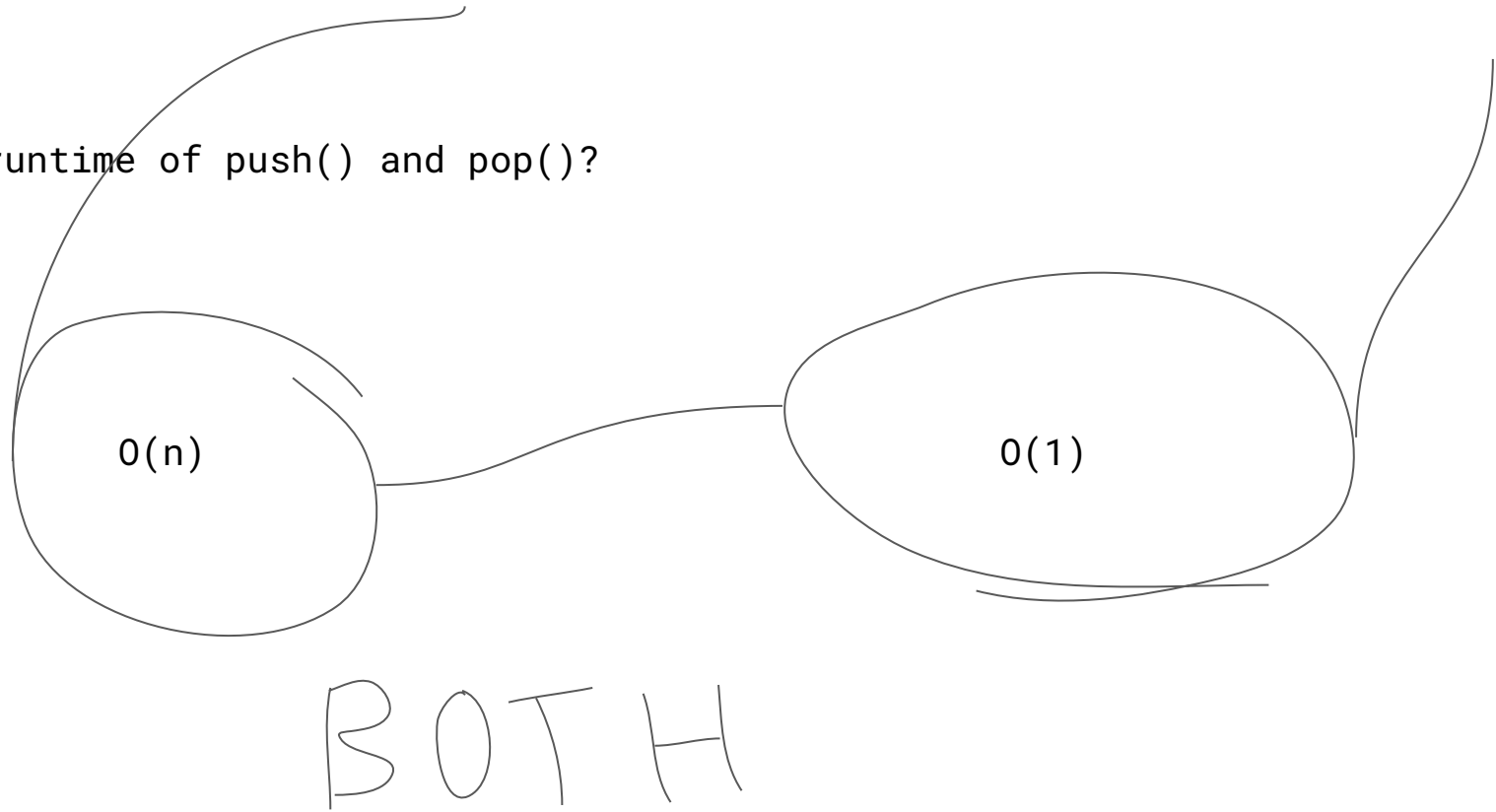
$O(n \log n)$

$O(\log n)$



# Lab 2

What's the runtime of push() and pop()?



# Lab 2

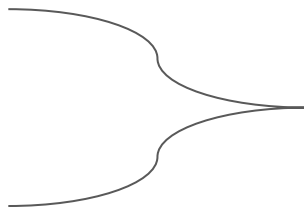
What's the runtime of `push()` and `pop()`?

**Push Operations:**

- Most are  $O(1)$ : Simply add the element
- Occasionally  $O(n)$ : When resizing is needed

**Pop Operations:**

- Always  $O(1)$ : Remove the last element
- Occasionally  $O(n)$ : When downsizing the array



**Amortized Analysis:** When you take the average runtime of an operation.

- Lots of  $O(1)$  operations with an occasional  $O(n)$  operation can be regarded as an  $O(1)$  operation unless you are writing latency sensitive programs

# So what happens during resizing

- Python goes and over-allocates space in memory for new items
- It shallow copies over the references of the old items to the new memory block
- Update the list metadata to point to new location
- Deallocate old memory location
- Let's you continue on adding items

**Old Memory Block (Capacity: 4)**

[1, 2, 3, 4]

**New Memory Block (Capacity: 8)**

[1, 2, 3, 4, 5, None, None, None]

# Lab 3

- **Header Files:** Tells the compiler the function signatures, calling convention, the number and type of parameters, and return type.
  - This is what your compiler looks at to understand what your program does
  - Separates the interface (hpp/h files) from the implementation (cpp/c files)

```
// A.CPP
void doSomething()
{
    doSomethingElse(); // Defined in B.CPP
}

// B.CPP
void doSomethingElse()
{
    // Etc.
}
```

```
// A.CPP
void doSomethingElse() ; // From B.CPP

void doSomething()
{
    doSomethingElse() ; // Defined in B.CPP
}
```

```
// B.HPP (here, we decided to declare every symbol defined in B.CPP)
void doSomethingElse() ;

// A.CPP
#include "B.HPP"

void doSomething()
{
    doSomethingElse() ; // Defined in B.CPP
}

// B.CPP
#include "B.HPP"

void doSomethingElse()
{
    // Etc.
}

// C.CPP
#include "B.HPP"

void doSomethingAgain()
{
    doSomethingElse() ; // Defined in B.CPP
}
```

# Lab 3 - Creating Header Files

- Create a header file for each cpp file you have
- Define the function signatures of all the functions you intend to implement in your cpp/c file
- Include said file at the top of your cpp/c file

```
// factorial.h
#pragma once // ensure this file is only included once

/**
 * Calculates factorial of a number using iteration
 * @param num The number to calc factorial for
 * @return The factorial of a num, or -1 if the input is invalid
 */
int iterativeFactorial(int num);

/**
 * Calculates factorial of a number using recursion
 * @param num The number to calc factorial for
 * @return The factorial of a num, or -1 if the input is invalid
 */
int recursiveFactorial(int num);
```

```
// factorial.c
#include "factorial.h"

int iterativeFactorial(int num) {
    // your implementation of this
}

int recursiveFactorial(int num) {
    // your implementation of this
}
```



Extra Learning

# Latency Sensitive Programs

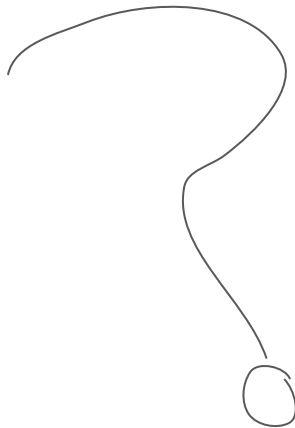
- Mostly found in High Frequency Trading
- Imagine you want to send a signal between Chicago and New York. What's the fastest possible way to do this?

Satellites

Fibre Optics

Microwave Nets

Internet



# Latency Sensitive Programs

- Mostly found in High Frequency Trading
- Imagine you want to send a signal between Chicago and New York. What's the fastest possible way to do this?

Satellites

Fibre Optics

Microwave Nets

Internet

120 milliseconds

12-15 milliseconds

4-6 milliseconds

12-15 milliseconds

# Latency Sensitive Programs

- Microwave Networks is how Quant Firms transmit data between major data centers
- An example: CME Data Center, Chicago to NYSE Data Center, NY

## The Fast Lane

McKay's microwave network



Data: McKay Brothers



More Reading: <https://arstechnica.com/information-technology/2016/11/private-microwave-networks-financial-hft/>

# Credits

First page image: <https://wall.alphacoders.com/big.php?i=773021>