C++ Fundamentals

Elyse Cornwall

June 27th, 2023

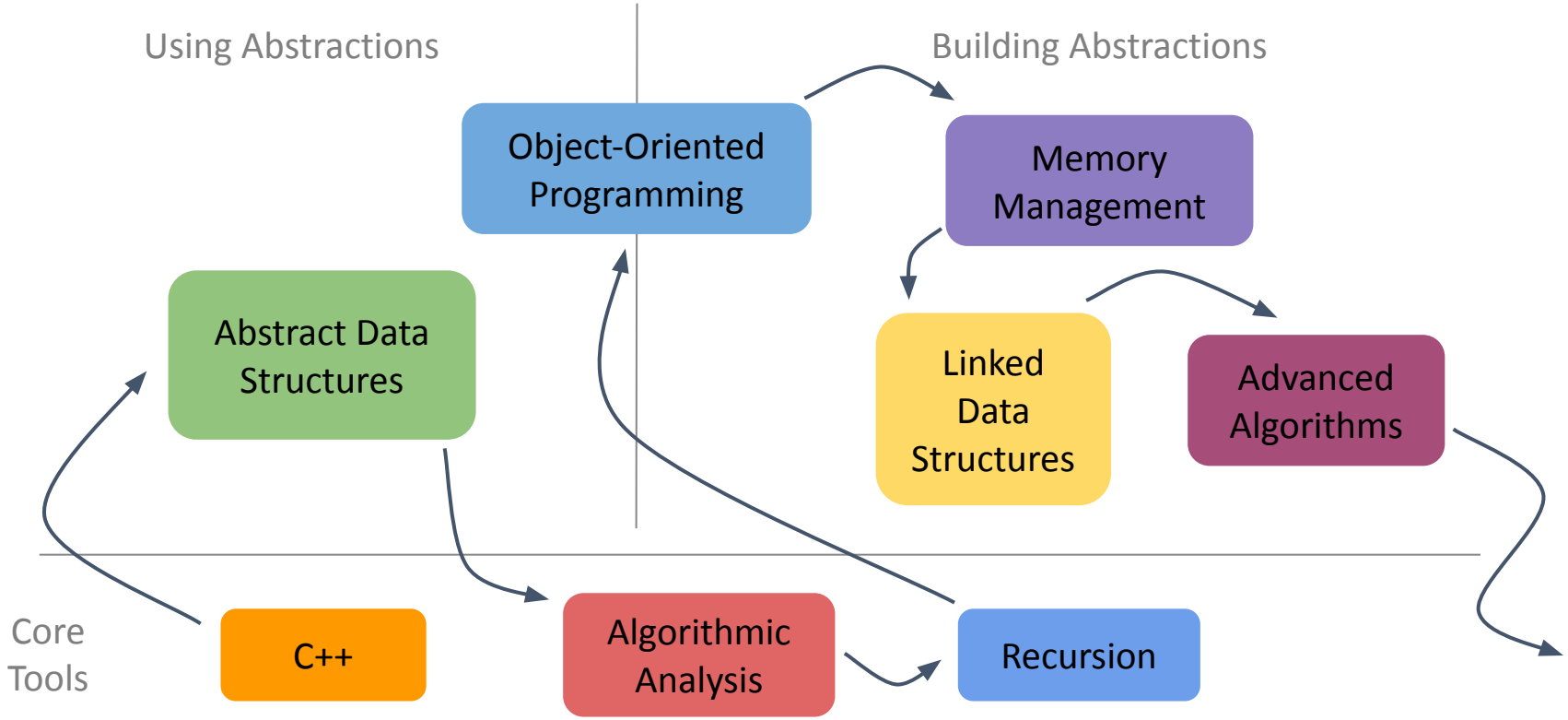
Contributions made from previous CS106B Instructors

Stanford University

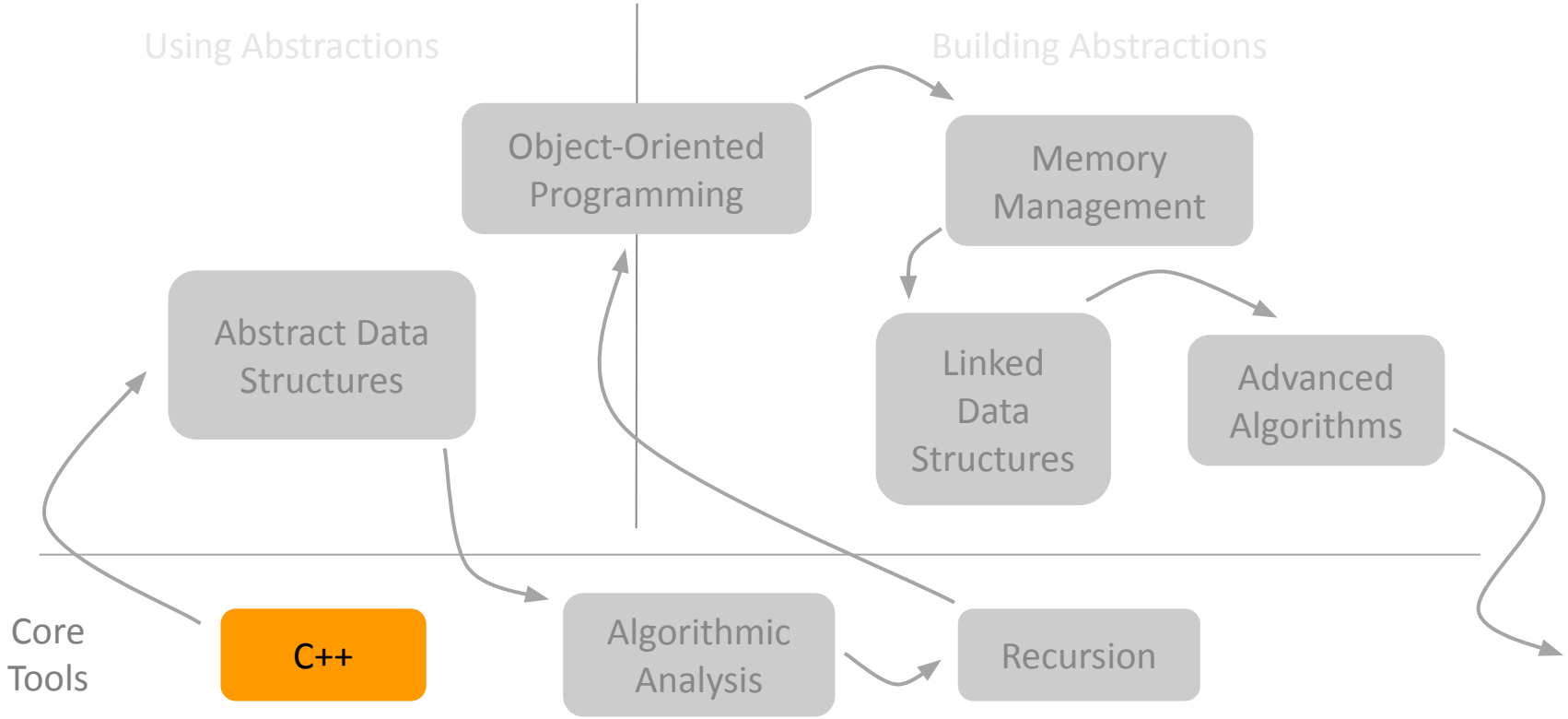
Announcements and Reminders

- **Sign up for section by today at 5pm!**
  - Also, attend section this week
- Send OAE letters to Amrita and Elyse
- Assignment 0 due Friday at 11:59pm
- We'll have our first attendance ticket in lecture today…

CS106B Roadmap

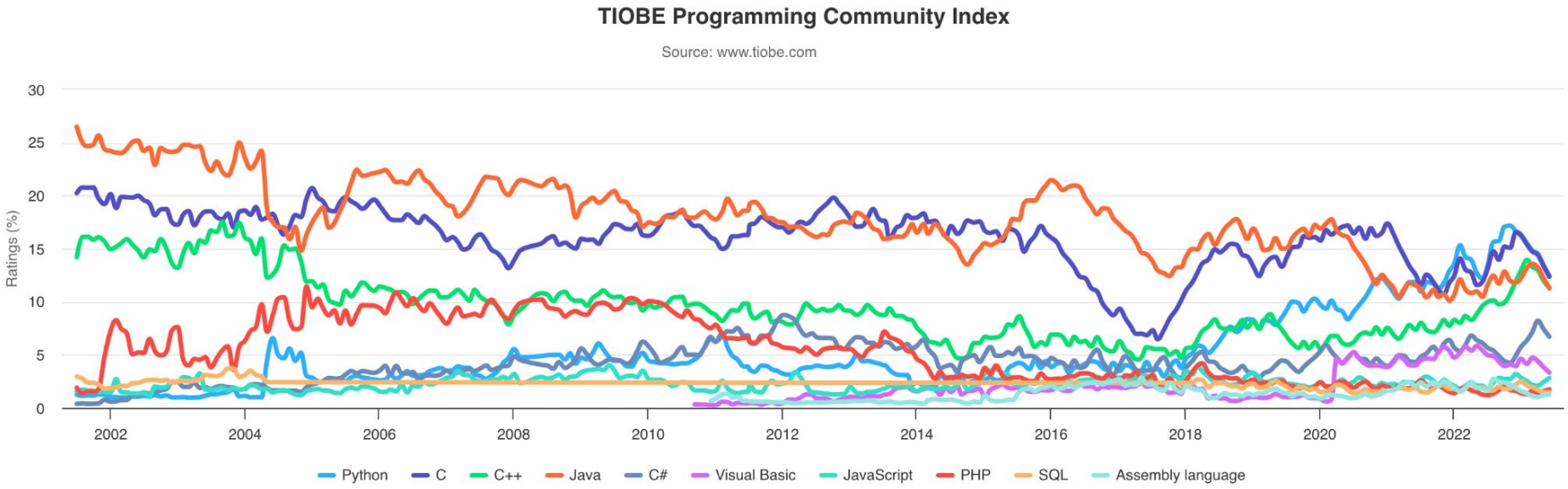


CS106B Roadmap

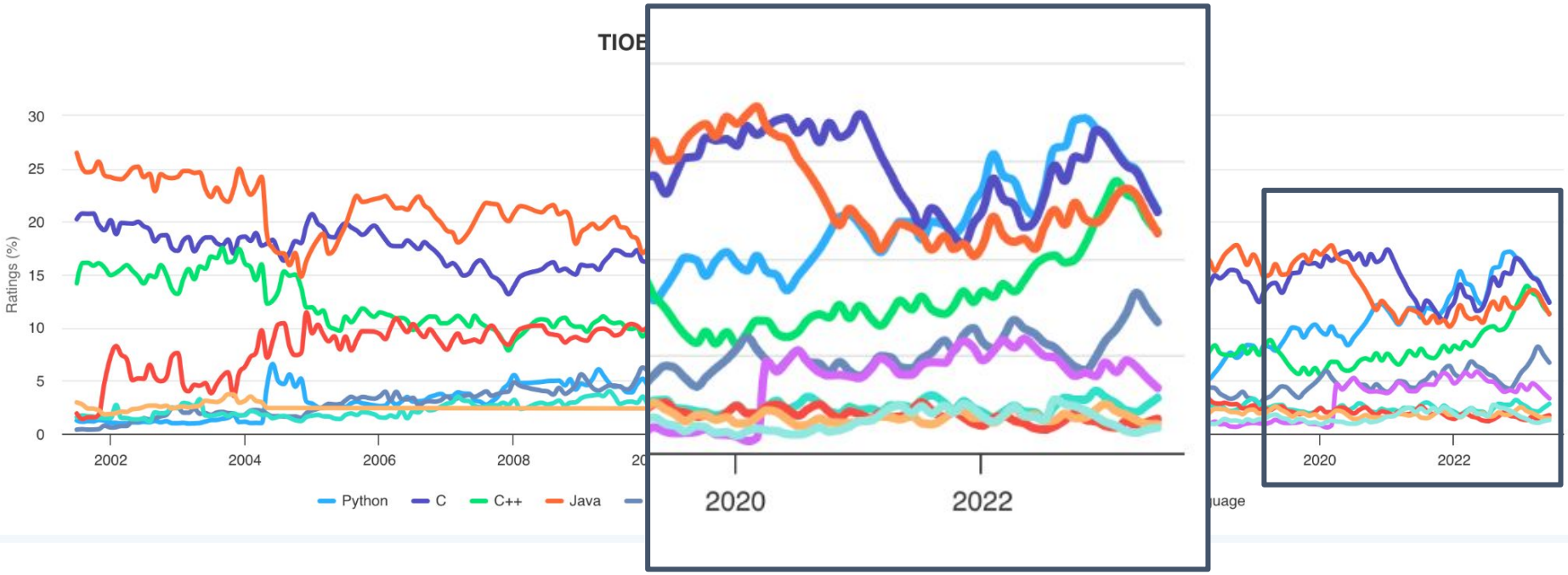


What programming languages have you used before?

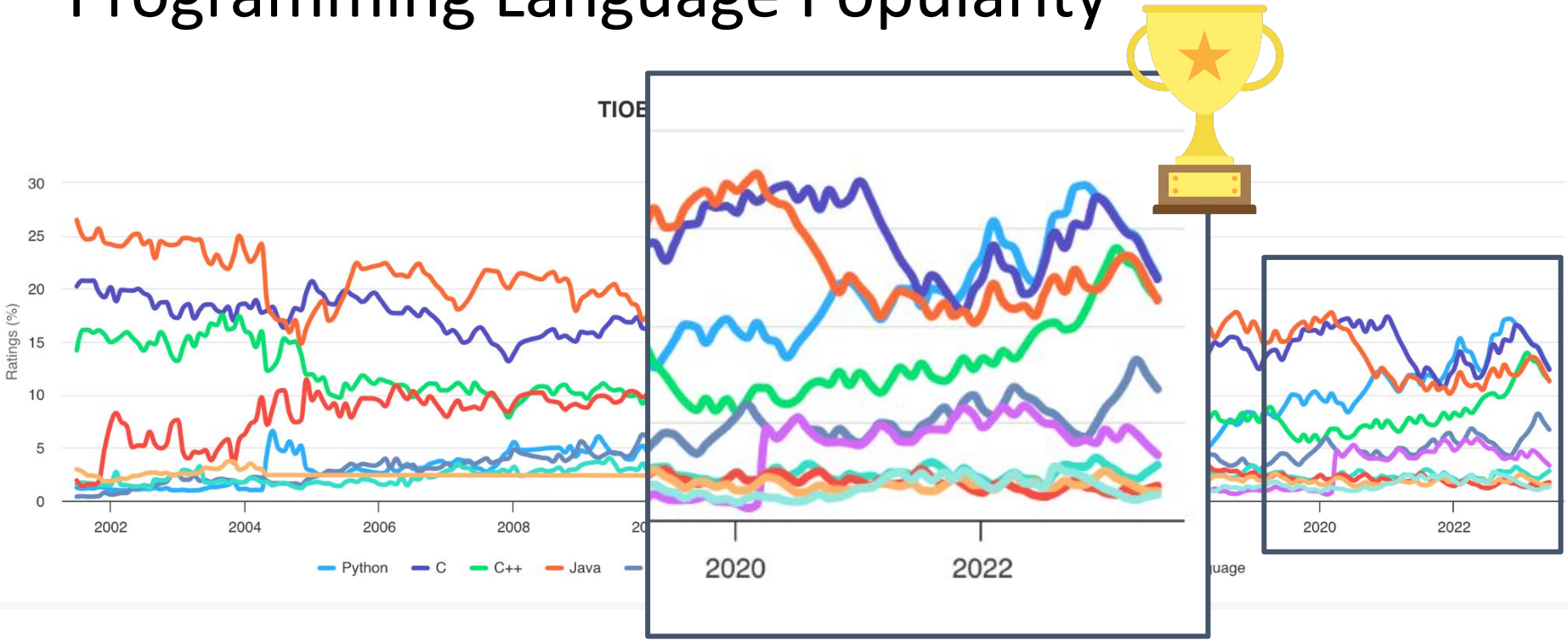
Programming Language Popularity



Programming Language Popularity



Programming Language Popularity



What is C++?

- High performance programming language, based on C
- Object-oriented language (we'll explore this later in our roadmap)
  - "C with Classes"
- Huge! Complex!

Pros and Cons of C++

Pros

- C++ is fast
  - Between 10 and 100 times faster than Python!
- C++ is powerful
  - Allows more control over your computer's resources
- C++ is popular
  - Coding interviews, research, industry

Pros and Cons of C++

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- C++ is popular
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Cons

- C++ is complex
  - We'll be using some Stanford-specific libraries to make the interface friendlier (think abstraction)
- C++ can be dangerous
  - We can make memory errors and cause more severe crashes!

Let’s look at some C++ code!

Our First C++ Program

```
#include "console.h"
#include <iostream>
using namespace std;


int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

Our First C++ Program

```
#include "console.h"
#include <iostream>
using namespace std;
```

Including libraries allows us to use code that was written elsewhere by somebody else

```
int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

Our First C++ Program

```
#include "console.h"
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int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

Directs user input / output to console

Standard input / output library

Our First C++ Program

```
#include "console.h"
#include <iostream>
using namespace std;

int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

Compiler looks for a function called main and starts program from there

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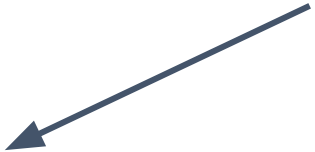
int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

Code statements end in semicolons



Our First C++ Program

```
#include "console.h"
#include <iostream>
using namespace std;


int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

This is how we print to the console for the user to see

Our First C++ Program

```
#includ
#includ
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}
```

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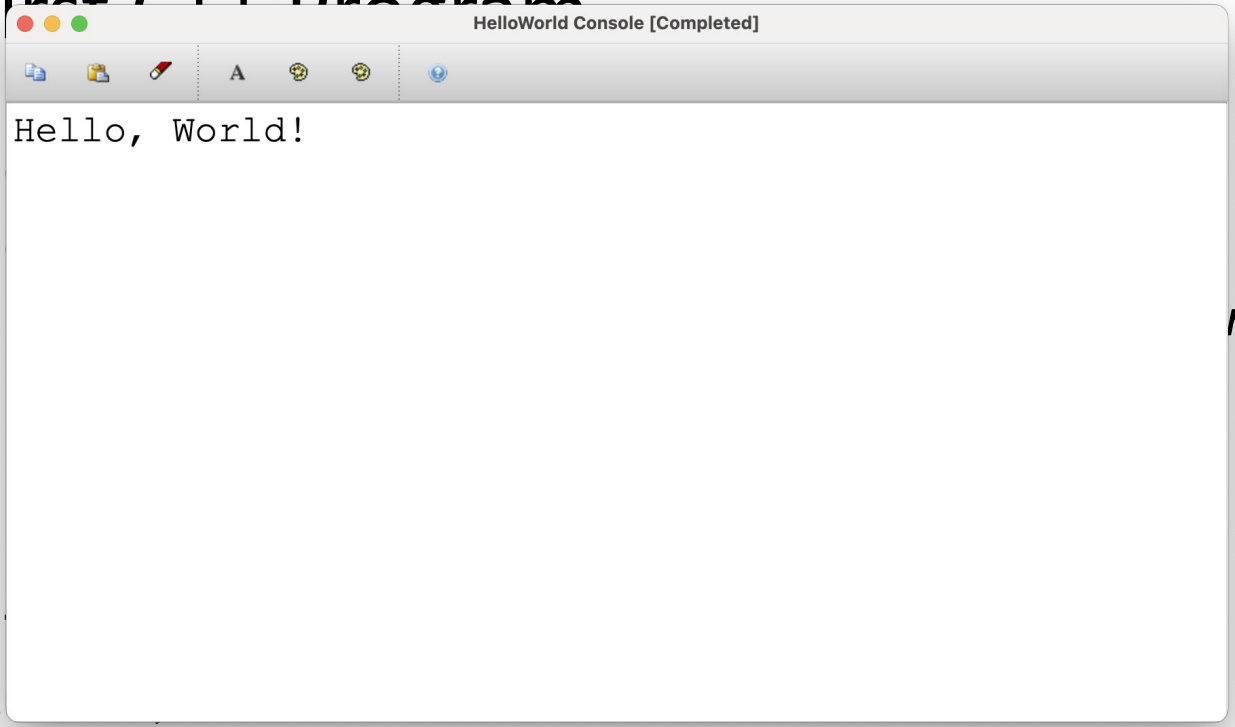

Brief Detour: Console Output

- We use `cout` and `<<` to print information to the user
- To start printing on a new line, we use `endl`

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}
```

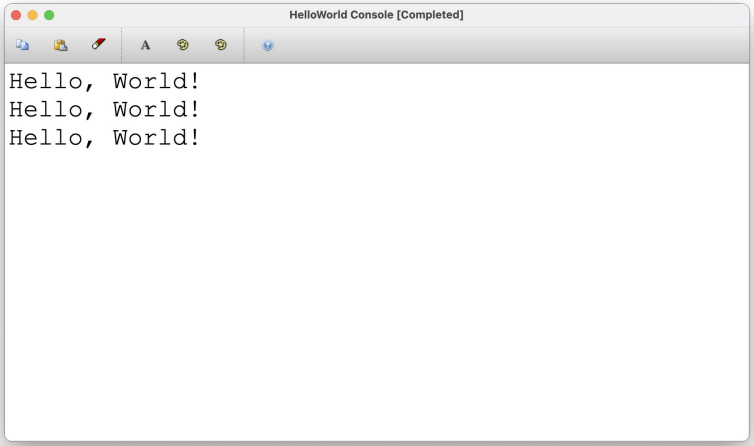

Brief Detour: Console Output

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- To start printing on a new line, we use `endl`

```
int main()
{
    cout << "Hello, World!";
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    cout << "Hello, World!";
    return 0;
}
```
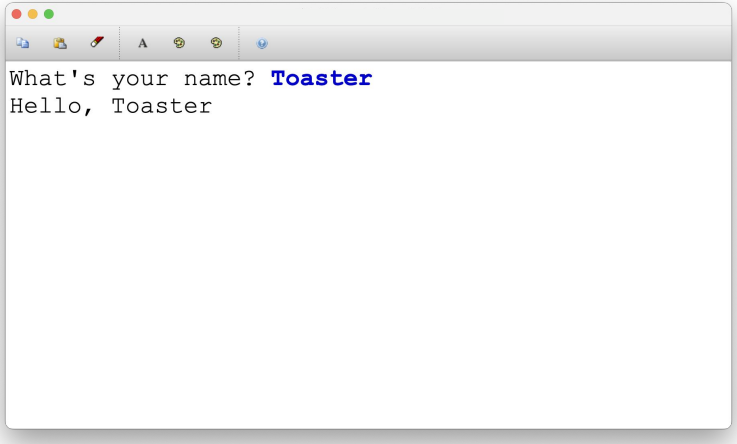

Brief Detour: Console Input

- We use `getLine()` with a prompt to get information from the user
- `getLine()` returns a string, which we often store in a variable

```
int main()
{
    string name = getLine("What's your name?");
    cout << "Hello, " << name << endl;
    return 0;
}
```



Brief Detour: Console Programs

- In combination, `cout` and `getLine()` let us communicate with the user via the console
- Programs that do this are called “console programs”

Our First C++ Program

```
#include "console.h"
#include <iostream>
using namespace std;


int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

The main function returns 0 to indicate success

Variables and Types

Variables

- We use variables to store information in our programs
- Variables have a *type* and a *name*

```
int enrollment;

string className;
```

Variables

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int enrollment;

string className;
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We name variables using "camelCase" capitalization

Variable Types

- When we declare a variable, we must specify its type
- A variable cannot change type

```
int enrollment;      // create integer variable
enrollment = 190;    // set its value to 190
enrollment = 191;    // reassign its value to 191
```

Variable Types

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Before we set its value, this variable holds "garbage" data. It's not initialized to 0 or cleared out for us.

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int enrollment;      // create integer variable
enrollment = 190;    // set its value to 190
enrollment = 191;    // reassign its value to 191
```

Variable Types

- When we declare a variable, we must specify its type
- A variable cannot change type

```
int enrollment;      // create integer variable
enrollment = 190;    // set its value to 190
enrollment++;        // reassign its value to 191
```

Variable Types

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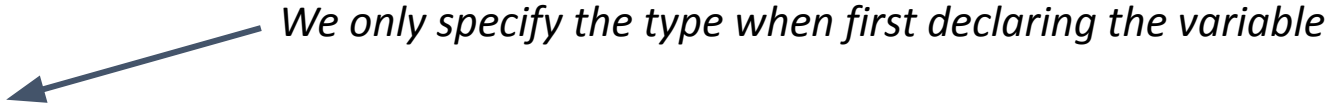


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```

Variable Types

- When we declare a variable, we must specify its type
- A variable cannot change type

```
int enrollment;      // create integer variable
enrollment = 190;    // set its value to 190
enrollment = “full”;   // ERROR!
```

C++ Types

Numbers

- `int, long` `// 100`
- `float, double` `// 3.14`

Text

- `char, string` `// ‘a’, “apple”`

Booleans

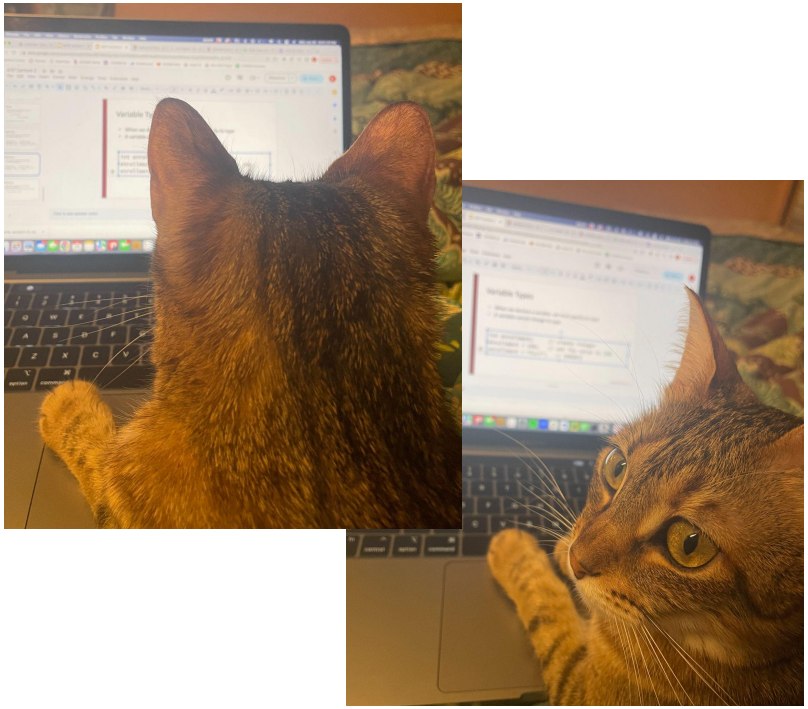
- `bool` `// true, false`

Attendance ticket: complete by next class

What is the value stored in the variable `mystery` after the following two lines of code execute?

```
int mystery = 4;
mystery = 12;
```

Enter your answer on Gradescope by next class (SCPD students have until Sunday 11:59pm)



Functions, Parameters, and Returns

Functions

Parameters

Function

Return

Parameters and Returns

- Parameters: what information needs to be given to this function when it's called?
- Return: what information should this function give back to whoever called it?
  - Often the result of a computation or the "final answer"
- Some functions don't have parameters or returns

Example: function that sums two numbers

Parameters Function Return

Defining Functions in C++

- Choose a function name
  - We use camelCase just like variable names
- Define the name and type of any parameters
- Define the return type
  - Return type is `void` if the function doesn't return anything

```
int sum(int val1, int val2);
```

Defining Functions in C++

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Defining Functions in C++

- Choose a function name
  - We use camelCase just like variable names
- Define the name and type of any parameters
- Define the return type
  - Return type is `void` if the function doesn't return anything

```
int sum(int val1, int val2) {
   int result = val1 + val2;
   return result;
}
```

Function Order

- The order in which functions are defined matters in C++
- You cannot call a function before it's been *defined* or *declared*

```
int sum(int val1, int val2) {
    int result = val1 + val2;
    return result;
}

int main() {
    int mySum = sum(4, 5);
    cout << mySum << endl;
    return 0;
}
```

We define sum here

Before we call it down here

Function Order

- The order in which functions are defined matters in C++
- You cannot call a function before it's been *defined* or *declared*

```
int main() {
    int mySum = sum(4, 5);
    cout << mySum << endl;
    return 0;
}

int sum(int val1, int val2) {
    int result = val1 + val2;
    return result;
}
```

We call sum here

But we don't define it until down here… ERROR

Function Order

- The order in which functions are defined matters in C++
- You cannot call a function before it's been *defined* or ***declared***

```
int sum(int val1, int val2);

int main() {
    int mySum = sum(4, 5);
    cout << mySum << endl;
    return 0;
}

int sum(int val1, int val2) {
    int result = val1 + val2;
    return result;
}
```

Function declaration for sum

All good, as long as the declaration happens before we call sum

Function definition for sum, can be written later

What gets printed? 👥

```
int doubleValue(int x) {
    x *= 2;
    return x;
}
int main() {
    int myValue = 5;
    int result = doubleValue(myValue);
    cout << "myValue: " << myValue << " ";
    cout << "result: " << result << endl;
    return 0;
}
```

myValue: ?? result: ??

What gets printed?

```
int doubleValue(int x) {
     x *= 2;
     return x;
}
int main() {
     int myValue = 5;
     int result = doubleValue(myValue);
     cout << "myValue: " << myValue << " ";
     cout << "result: " << result << endl;
     return 0;
}
```

myValue: 5 result: 10

What gets printed?

```
int doubleValue(int x) {
    x *= 2;
    return x;
}
int main() {
    int myValue = 5;
    int result = doubleValue(myValue);
    cout << "myValue: " << myValue << " ";
    cout << "result: " << result << endl;
    return 0;
}
```

Callee function

`myValue: 5 result: 10`

Caller function

Passing by Value

- By default, we pass parameters to functions *by value*
- This means the callee function gets a copy of our variable
- Changes made to that parameter variable in the callee function won't affect our variable in the caller function

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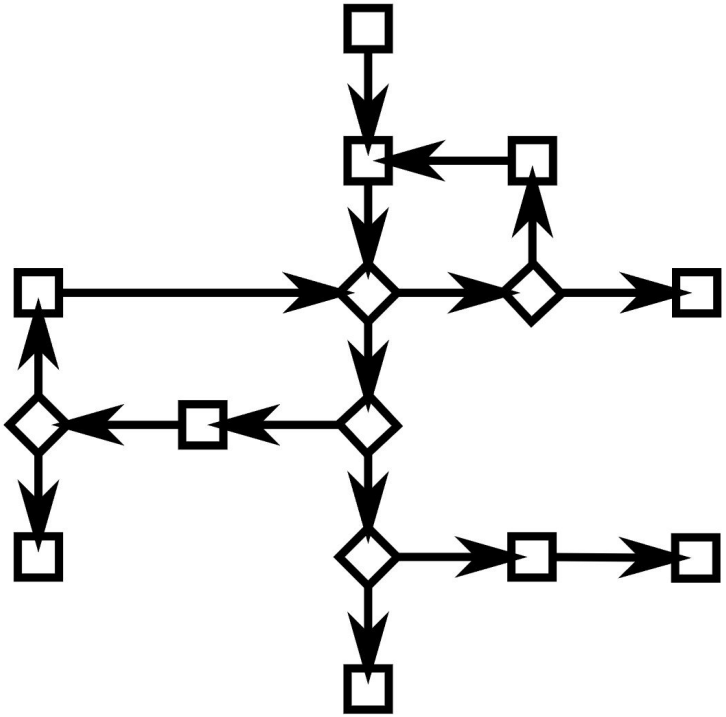
We'll learn another way to pass parameters later on!

Control Flow



Way to Control the Flow

- Conditionals (if/else)
- Loops (for/while)

Way to Control the Flow

- Conditionals (if/else)
- Loops (for/while)
- These are used with a boolean expression:

Expression	Meaning
`a < b`	**a** is less than **b**
`a <= b`	**a** is less than or equal to **b**
`a > b`	**a** is greater than **b**
`a >= b`	**a** is greater than or equal to **b**
`a == b`	**a** is equal to **b**
`a != b`	**a** is not equal to **b**

Operator	Meaning
`a && b`	Both **a** AND **b** are `true`
`a || b`	Either **a** OR **b** are `true`
`!a`	If **a** is `true`, returns `false`, and vice-versa

Conditionals

```
if (condition) {
    // code to execute if condition is true
}
```

Conditionals

```
if (condition) {
   // code to execute if condition is true
}
```

Note this syntax!
We put the condition in parentheses and the conditional body in curly braces.

Conditionals

```
if (condition) {
   // code to execute if condition is true
} else {
   // code to execute if the condition is false
}
```

Conditionals

```
// assuming age variable is already defined
if (age < 12) {
    cout << "Eligible for kids meal.";
} else {
    cout << "Must use regular menu.";
}
```

Conditionals

```
// assuming age variable is already defined
if (age < 12) {
   cout << "Eligible for kids meal.";
} else if (age > 65) {
   cout << "Eligible for senior discount.";
} else {
   cout << "Must use regular menu.";
}
```

While Loops

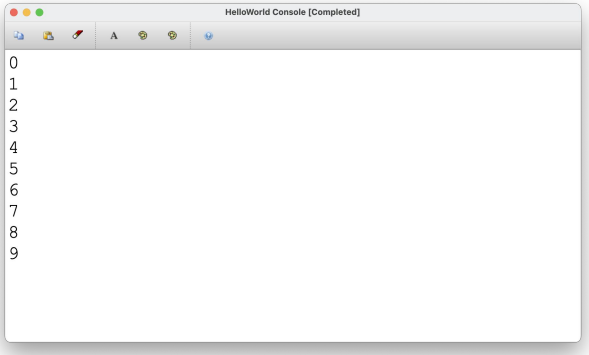
- “While this condition is true, do this”
- Use when you don’t know how many times you want to repeat

```
while (condition) {
    // code to repeat while condition is true
}
```

For Loops

- Use when you know how many times you want to repeat
- Typical for loop uses int counter `i` that starts at 0:

```
for (int i = 0; i < 10; i++) {
    cout << i << endl;
}
```



For Loops

- Use when you know how many times you want to repeat
- Typical for loop uses int counter `i` that starts at 0
- More generally, for loops take on this structure:

```
for (initialization; condition; update) {
   // code to be repeated
}
```

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- Typical for loop uses int counter `i` that starts at 0
- More generally, for loops take on this structure:

```
  initialization; condition; update
for (int i = 10; i <= 100; i += 10) {
   cout << i << endl;
}
```

For Loops

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- Typical for loop uses int counter `i` that starts at 0
- More generally, for loops take on this structure:

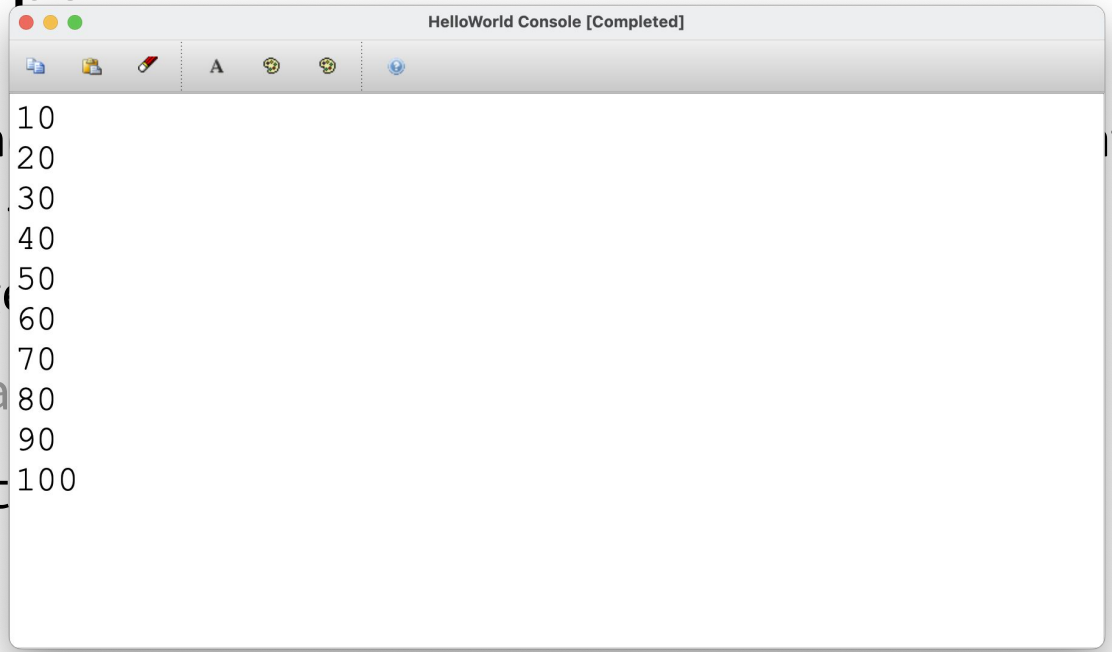
```
  initialization; condition; update
for (int i = 10; i <= 100; i += 10) {
   cout << i << endl;
}
```

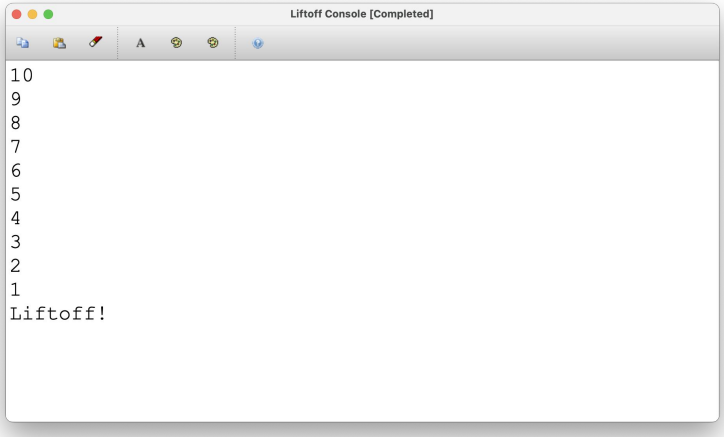
Talk to your neighbor: what gets printed?

For Loops

- Use wh
- Typical
- More g

```
  initia
for (int
    cout
}
```





Let’s write a program!

Try implementing with a while loop, then a for loop!