# Getting Started in C++

# Outline for Today

- ***Functions in C++***
  - How C++ organizes code, and some Endearing C++ Quirks.
- ***Writing Functions***
  - Getting comfortable with the language.
- ***Strings in C++***
  - Working with text.

# Functions in C++

```cpp
/*              C++ Version              */
double areaOfCircle(double r) {
    return M_PI * r * r;
}

int maxOf(int first, int second) {
    if (first > second) {
        return first;
    }
    return second;
}

void printNumber(int n) {
    cout << "I like " << n << endl;
}
```

```python
"""        Python Version        """
def areaOfCircle(r):
    return math.pi * r * r


def maxOf(first, second):
    if first > second:
        return first
    return second



def printNumber(n):
    print("I like " + str(n))
```

```java
/*              Java Version              */
private double areaOfCircle(double r) {
    return Math.PI * r * r;
}

private int maxOf(int first, int second) {
    if (first > second) {
        return first;
    }
    return second;
}

private void printNumber(int n) {
    System.out.println("I like " + n);
}
```

```javascript
//      JavaScript Version
function areaOfCircle(r) {
   return Math.PI * r * r;
}

function maxOf(first, second) {
   if (first > second) {
       return first;
   }
   return second;
}

function printNumber(n) {
   console.log("I like " + n);
}
```

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double areaOfCircle(double r) {
    return M_PI * r * r;
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int maxOf(int first, int second) {
    if (first > second) {
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void printNumber(int n) {
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}
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/*                Jav
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    return Math.P
}

private int maxOf(
    if (first > s
        return fi
    }
    return second
}

private void prin
    System.out.println("I like " + n);
}
```

```javascript
console.log("I like " + n);
}
```

Functions in C++ work like functions in Python/JavaScript or like methods in Java. They (optionally) take in parameters, perform a calculation, then (optionally) return a value.

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    if (first > second) {
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void printNumber(int n) {
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    if (first > sec
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    }
    return second;
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private void printN
    System.out.println("I like " + n);
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```

```javascript
console.log("I like " + n);
}
```

All variables in C++ need a type. Some common types include **int** (integer), **double** (real number), and **bool** (true/false),

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```javascript
console.log("I like " + n);
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```

You define a function by writing

```
return-type fn-name(args) {
    // … code goes here …
}
```

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console.log("I like " + n);
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```

If a function does not return a value, its return type should be the cool-but-scary-sounding **void**.

# The `main` Function

- A C++ program begins execution in a function called `main` with the following signature:

```
int main() {
    /* … code to execute … */
    return 0;
}
```

- By convention, `main` should return `0` unless the program encounters an error.
- Curious why `main` returns an `int` and why it should be `0`? Come chat with me after class today!

# A Simple C++ Program

Hip hip, hooray!

Hip hip, hooray!
Hip hip, hooray!
Hip hip, hooray!

# What Went Wrong?

# One-Pass Compilation

- When you compile a C++ program, the compiler reads your code from top to bottom.
- If you call a function that you haven't yet written, the compiler will get Very Upset and will say mean things to you.
- You will encounter this issue. What should you do?

*Dramatic Reenactment*

# Forward Declarations

- A ***forward declaration*** is a statement that tells the C++ compiler about an upcoming function.
  - The textbook calls these ***function prototypes***. It's different names for the same thing.
- Forward declarations look like this:

  ***return-type function-name***`(`***parameters***`);`

- Essentially, start off like you're defining the function as usual, but put a semicolon instead of the function body.
- Once the compiler has seen a forward declaration, you can go and call that function as normal.

# Some More Functions

# Summing Up Digits

- Ever seen that test for divisibility by three?

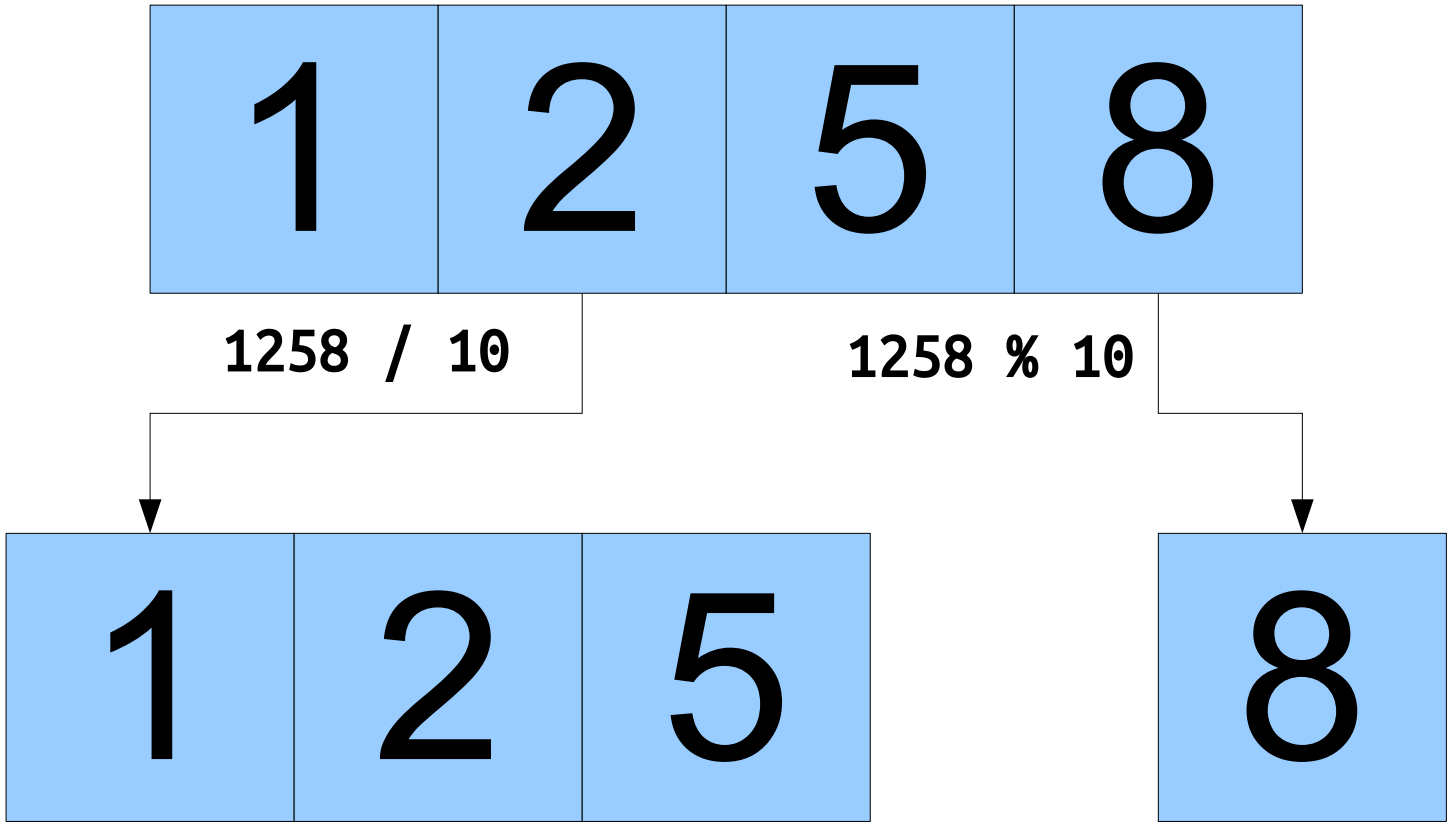
  ***Add the digits of the number; if the sum is divisible by three, the original number is divisible by three (and vice-versa).***

- Let's write a function

```
int sumOfDigitsOf(int n)
```

  that takes in a number and returns the sum of its digits.

# Working One Digit at a Time




Dividing two integers in C++ ***always*** produces an integer by dropping any decimal value. Check Chapter 1.7 of the textbook for how to override this behavior.

# Functions in Action

```
int main() {
   int n = getInteger("Enter an integer: ");
   int digitSum = sumOfDigitsOf(n);
   cout << n << " sums to " << digitSum << endl;

   return 0;
}
```

# Functions in Action

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137

int n

# Functions in Action

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137

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The variable n actually is an honest-to-goodness integer, not a pointer to an integer that lives somewhere else. In C++, all variables stand for actual objects unless stated otherwise. (More on that later.)

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# Functions in Action

```
int sumOfDigitsOf(int n) {
    int result = 0;

    while (n > 0) {
        result += (n % 10);
        n /= 10;
    }

    return result;
}
```

137

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```

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When we call `sumOfDigitsOf`, we get our own variable named `n`. It's separate from the variable `n` in `main()`, and changes to this variable `n` don't reflect back in `main`.

# Functions in Action

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# Functions in Action

```
int main() {
    int n = getInteger("Enter an integer: ");
    int digitSum = sumOfDigitsOf(n);
    cout << n << " sums to " << digitSum << endl;

    return 0;
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```

137

int n

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    cout << n << " sums to " << digitSum << endl;

    return 0;
}
```

137

int n

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int digitSum

Note that the value of `n` in `main` is unchanged, because `sumOfDigitsOf` got its own copy of `n` that only coincidentally has the same name as the copy in `main`.

# Functions in Action

```
int main() {
   int n = getInteger("Enter an integer: ");
   int digitSum = sumOfDigitsOf(n);
   cout << n << " sums to " << digitSum << endl;

   return 0;
}
```

137

int n

11

int digitSum

Time-Out for Announcements!

# The `considering_cs` List

- The CS department has a mailing list announcing events, programs, and opportunities for folks considering majoring in CS.
- Sign up using ***this link***, and please spread the word that this exists! It's a fantastic resource.

# Section Signups

- Section signups go live tomorrow at 5:00PM and are open until Sunday at 5:00PM.
- Sign up using this link:

  **https://cs198.stanford.edu/cs198/auth/default.aspx**

- You need to sign up here even if you're already enrolled on Axess; *we don't use Axess for sections in this class*.

# Qt Creator Help Session

- Having trouble getting Qt Creator set up? Neel will be running a Qt Creator help session this Thursday from 7:00PM – 9:00PM in Room 353 of the Durand building.
- A request: Before showing up, use the ***troubleshooting guide*** and make sure you followed the directions precisely. It's easy to get this wrong, but easy to correct once you identify where you went off-script.

Back to CS106B!

# Strings in C++

# C++ Strings

- To use strings, you need to add the line

```
#include <string>
```

  to the top of your program to import the strings library. You'll get Cruel and Unusual Error Messages if you forget to do this.

- Then, you can do whatever stringy things you want! Here's some examples...

```cpp
/*          C++ Version          */
string s = "Elena Kagan";
s += ", joined " + to_string(2010);

char start = s[0];
char end   = s[s.length() - 1];

if (s.find("e") != string::npos) {
  string first = s.substr(0, 5);
  string last  = s.substr(6);
}

if (s == "Sonia Sotomayor") {
  cout << "John Roberts" << endl;
}
```

```python
"""      Python Version      """
s = "Elena Kagan"
s += ", joined " + str(2010)

start = s[0]
end   = s[-1]

if 'e' in s:
    first = s[0:5]
    last  = s[6:]


if s == "Sonia Sotomayor":
    print("John Roberts")
```

```java
/*          Java Version          */
String s = "Elena Kagan";
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char start = s.charAt(0);
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if (s.indexOf("e") != -1) {
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}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

```javascript
//    JavaScript Version
let s = "Elena Kagan";
s += ", joined " + 2010;

let start = s[0];
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if (s.indexOf("e") != -1) {
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}

if (s === "Sonia Sotomayor") {
  console.log("John Roberts");
}
```

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if

if
```

C++ strings must be declared using double quotes rather than single quotes.

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s += ", joined " + str(2010)

start = s[0]
end   = s[-1]

if 'e' in s:
```

You can use + and += to append to a string. You can only append other strings or characters. Use the to_string function to convert data to strings.

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s += ", joined " + 2010;

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```js
let start = s[0];
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String s = "Elena Kagan";
s += ", joined " + 2010;

char start = s.charAt(0);
char end   = s.charAt(s.length() - 1);

if (s.indexOf("e") != -1) {
  String first = s.substring(0, 5);
  String last  = s.substring(6);
}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

You can select an individual character out of a string by using square brackets. Indices start at zero.

C++ has different types for individual characters (char) and for strings of zero or more characters (string). Check Chapter 1.5 of the textbook for details.

```cpp
/*          C++ Version          */
string s = "Elena Kagan";
s += ", joined " + to_string(2010);

char start = s[0];
char end   = s[s.length() - 1];

if (s.find("e") != string::npos) {
  string first = s.substr(0, 5);
  string last  = s.substr(6);
}

if (s == "Sonia Sotomayor") {
  cout << "John Roberts" << endl;
}
```

```python
"""       Python Version       """
s = "Elena Kagan"
s += ", joined " + str(2010)

start = s[0]
end   = s[-1]

if 'e' in s:
    first = s[0:5]
    last  = s[6:]

if s == "Sonia Sotomayor":
    print("John Roberts")
```

C++ doesn't support negative array indices the way that Python does. You can pick the last character of the string by getting its length and subtracting one.

```java
/*          Java Version          */
String s = "Elena Kagan";
s += ", joined " + 2010;

char start = s.charAt(0);
char end   = s.charAt(s.length() - 1);

if (s.indexOf("e") != -1) {
  String first = s.substring(0, 5);
  String last  = s.substring(6);
}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

```javascript
  let last  = s.substring(6);
}

if (s === "Sonia Sotomayor") {
  console.log("John Roberts");
}
```

```cpp
/*          C++ Version          */
string s = "Elena Kagan";
s += ", joined " + to_string(2010);

char start = s[0];
char end   = s[s.length() - 1];

if (s.find("e") != string::npos) {
  string first = s.substr(0, 5);
  string last  = s.substr(6);
}

if (s == "Sonia Sotomayor") {
  cout << "John Roberts" << endl;
}
```

```python
"""      Python Version      """
s = "Elena Kagan"
s += ", joined " + str(2010)

start = s[0]
end   = s[-1]

if 'e' in s:
    first = s[0:5]
    last  = s[6:]

if s == "Sonia Sotomayor":
    print("John Roberts")
```

```java
/*          Java Version          */
String s = "Elena Kagan";
s += ", joined " + 2010;

char start = s.charAt(0);
char end   = s.charAt(s.length() - 1);

if (s.indexOf("e") != -1) {
  String first = s.substring(0, 5);
  String last  = s.substring(6);
}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

The find member function returns the index of the given pattern if it exists, and the verbosely-named constant string::npos otherwise. This pattern kinda sorta is like the "in" keyword from Python.

```cpp
/*          C++ Version          */
string s = "Elena Kagan";
s += ", joined " + to_string(2010);

char start = s[0];
char end   = s[s.length() - 1];

if (s.find("e") != string::npos) {
  string first = s.substr(0, 5);
  string last  = s.substr(6);
}

if (s == "Sonia Sotomayor") {
  cout << "John Roberts" << endl;
}
```

```python
"""      Python Version      """
s = "Elena Kagan"
s += ", joined " + str(2010)

start = s[0]
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    print("John Roberts")
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/*          Java Version          */
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  String first = s.substring(0, 5);
  String last  = s.substring(6);
}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

```javascript
//    JavaScript Version
```

You can get substrings by using the .substr member function. If you give two parameters, the first is a start index, and the second is a length, not an end index.

```cpp
/*          C++ Version          */
string s = "Elena Kagan";
s += ", joined " + to_string(2010);

char start = s[0];
char end   = s[s.length() - 1];

if (s.find("e") != string::npos) {
  string first = s.substr(0, 5);
  string last  = s.substr(6);
}

if (s == "Sonia Sotomayor") {
  cout << "John Roberts" << endl;
}
```

```python
"""      Python Version      """
s = "Elena Kagan"
s += ", joined " + str(2010)

start = s[0]
end   = s[-1]

if 'e' in s:
    first = s[0:5]
    last  = s[6:]


if s == "Sonia Sotomayor":
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/*          Java Version          */
String s = "Elena Kagan";
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char start = s.charAt(0);
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if (s.indexOf("e") != -1) {
  String first = s.substring(0, 5);
  String last  = s.substring(6);
}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

```javascript
//    JavaScript Version
```

You can compare strings for equality using ==. If you're coming from Python, great! This will feel normal. If you're coming from Java, hopefully this will be a welcome relief.

```cpp
/*          C++ Version          */
string s = "Elena Kagan";
s += ", joined " + to_string(2010);

char start = s[0];
char end   = s[s.length() - 1];

if (s.find("e") != string::npos) {
  string first = s.substr(0, 5);
  string last  = s.substr(6);
}

if (s == "Sonia Sotomayor") {
  cout << "John Roberts" << endl;
}
```

```python
"""      Python Version      """
s = "Elena Kagan"
s += ", joined " + str(2010)

start = s[0]
end   = s[-1]

if 'e' in s:
    first = s[0:5]
    last  = s[6:]


if s == "Sonia Sotomayor":
    print("John Roberts")
```

```java
/*          Java Version          */
String s = "Elena Kagan";
s += ", joined " + 2010;

char start = s.charAt(0);
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if (s.indexOf("e") != -1) {
  String first = s.substring(0, 5);
  String last  = s.substring(6);
}

if (s.equals("Sonia Sotomayor")) {
  System.out.println("John Roberts");
}
```

```javascript
ion
0;

- 1];
-1) {
ing(0, 5);
  let last  = s.substring(6);
}

if (s === "Sonia Sotomayor") {
  console.log("John Roberts");
}
```

You can print strings the same way you print anything else.

# Recap from Today

- The C++ compiler reads from the top of the program to the bottom. You cannot call a function that hasn't either been prototyped or defined before the call site.
- Variables in C++ represent the actual values they describe, rather than pointers or references to those values.
- Each time you call a function, C++ gives you a fresh copy of all the local variables in that function. Those variables are independent of any other variables with the same name found elsewhere.
- You can split a number into "everything but the last digit" and "the last digit" by dividing and modding by 10.
- C++ strings support most of the "stringy" operations you expect from other programming languages, and have their share of quirks.

# Your Action Items

- ***Read Chapter 2 and Chapter 3.***
  - We're still easing into C++. These chapters talk about the basics and the mechanics of function call and return.
- ***Sign up for a Discussion Section.***
  - The link goes out tomorrow afternoon.
- ***Work on Assignment 0.***
  - Just over a third of you are already done! Exciting!

# Next Time

- ***Recursion***
  - Solving problems by solving smaller copies of the same problem.

# ***Appendix:*** Cyclic Shifts

# Cyclic Equality

- You can ***cyclically shift*** a word by moving a block of characters from the back of the word to the front.

| | | | | |
|---|---|---|---|---|
| T | A | P | A | S |

- Sometimes, the result is a new word.

# Cyclic Equality

- You can ***cyclically shift*** a word by moving a block of characters from the back of the word to the front.

| | | | | | | |
|---|---|---|---|---|---|---|
| O | F | F | H | A | N | D |

- Sometimes, the result is a new word.

# Cyclic Equality

- You can ***cyclically shift*** a word by moving a block of characters from the back of the word to the front.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S | W | O | R | D | P | L | A | Y |

- Sometimes, the result is a new word.

# Our Strategy

Check if `one == two`.

Cycle the string.

Check if `one == two`.

Cycle the string.

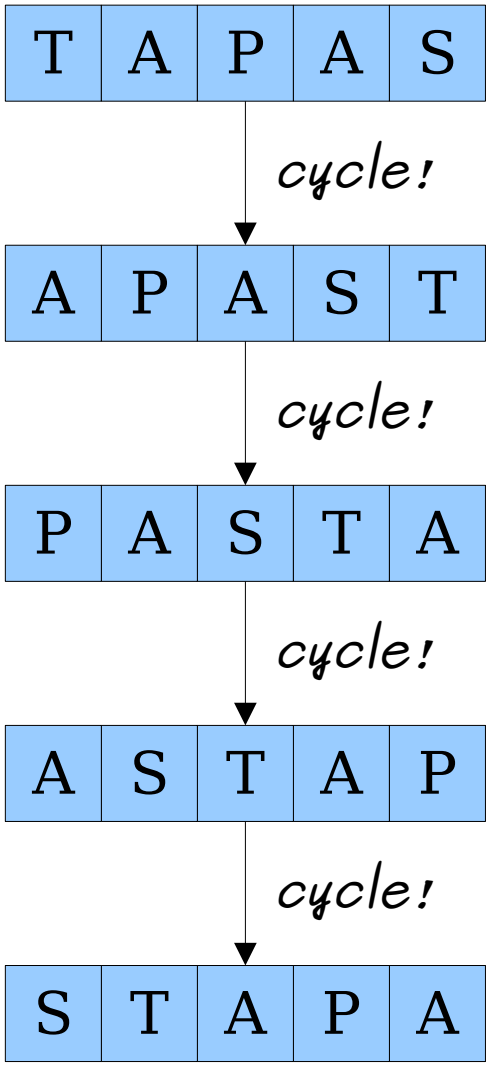
Check if `one == two`.

Cycle the string.

Check if `one == two`.

Cycle the string.

Check if `one == two`.



# Our Strategy

Do these steps in a loop

Handle this by itself.

Check if one == two.

Cycle the string.

Check if one == two.

Cycle the string.

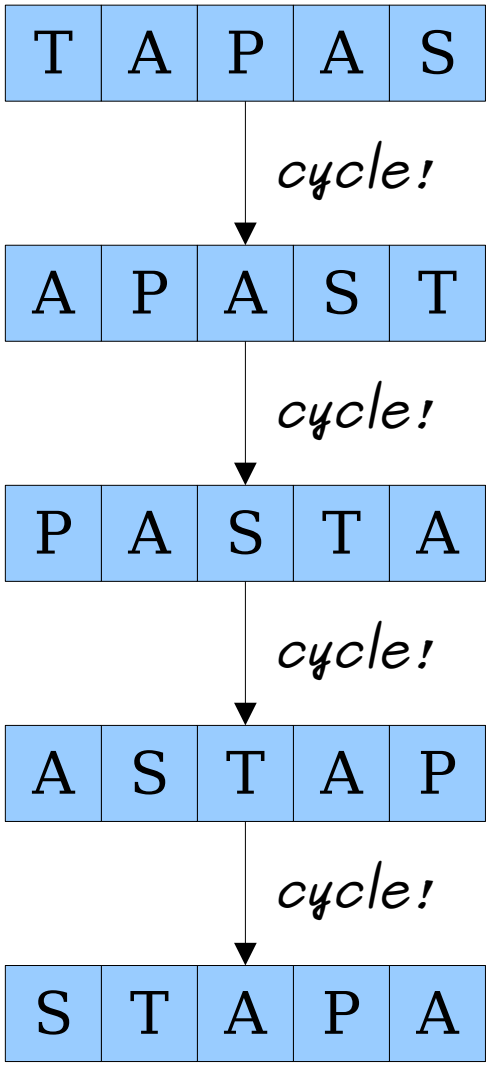
Check if one == two.

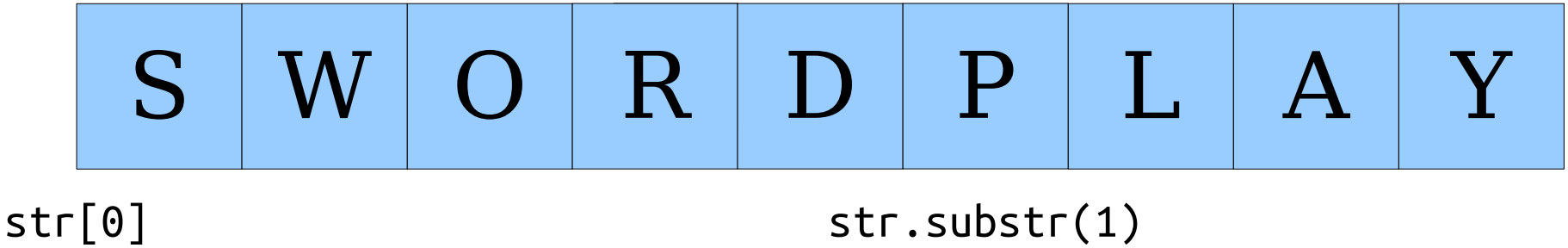
Cycle the string.

Check if one == two.

Cycle the string.

Check if one == two.




S W O R D P L A Y
str[0]
str.substr(1)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| W | O | R | D | P | L | A | Y | S |

```
str.substr(1) + str[0]
```

# Tracing Function Calls

```
int main() {
    string one = getLine("First:  ");
    string two = getLine("Second: ");

    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
    } else {
        cout << "Nah." << endl;
    }

    return 0;
}
```

# Tracing Function Calls

```
int main() {
    string one = getLine("First:  ");
    string two = getLine("Second: ");

    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
    } else {
        cout << "Nah." << endl;
    }

    return 0;
}
```

# Tracing Function Calls

```
int main() {
    string one = getLine("First:  ");
    string two = getLine("Second: ");

    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
    } else {
        cout << "Nah." << endl;
    }

    return 0;
}
```

**pasta**

one

# Tracing Function Calls

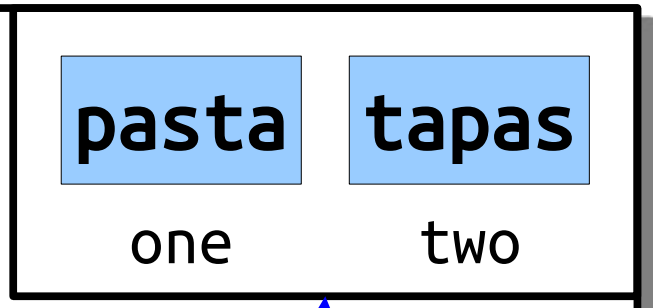
```
int main() {
    string one = getLine("First:  ");
    string two = getLine("Second: ");

    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
    } else {
        cout << "Nah." << endl;
    }

    return 0;
}
```

**pasta**

one

# Tracing Function Calls

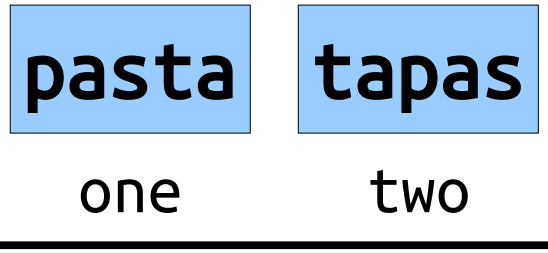
```
int main() {
    string one = getLine("First:  ");
    string two = getLine("Second: ");

    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
    } else {
        cout << "Nah." << endl;
    }

    return 0;
}
```




String variables in C++ represent actual strings, rather than pointers to strings stored elsewhere.

# Tracing Function Calls

```
int main() {
    string one = getLine("First:  ");
    string two = getLine("Second: ");

    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
    } else {
        cout << "Nah." << endl;
    }

    return 0;
}
```



# Tracing Function Calls

```
int main() {

}
```

pasta tapas

```
bool areCyclicallyEqual(string one,
                        string two) {

    for (int i = 1; i < one.length(); i++) {
        if (one == two) {
            return true;
        }

        two = two.substr(1) + two[0];
    }

    return one == two;
}
```

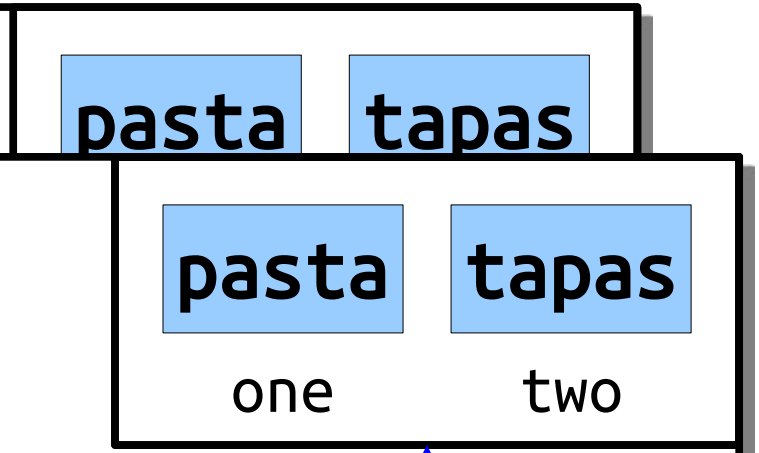
pasta tapas

one two

# Tracing Function Calls

```
int main() {

}
```

```
bool areCyclicallyEqual(string one,
                        string two) {

    for (int i = 1; i < one.length(); i++) {
        if (one == two) {
            return true;
        }

        two = two.substr(1) + two[0];
    }

    return one == two;
}
```




We get our own fresh copies of one and two.

# Tracing Function Calls

```
int main() {

}
```

pasta tapas

```
bool areCyclicallyEqual(string one,
                        string two) {

    for (int i = 1; i < one.length(); i++) {
        if (one == two) {
            return true;
        }

        two = two.substr(1) + two[0];
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    return one == two;
}
```

pasta tapas

one two

# Tracing Function Calls

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pasta tapas

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bool areCyclicallyEqual(string one,
                        string two) {
    for (int i = 1; i < one.length(); i++) {
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        }
        two = two.substr(1) + two[0];
    }
    return one == two;
}
```

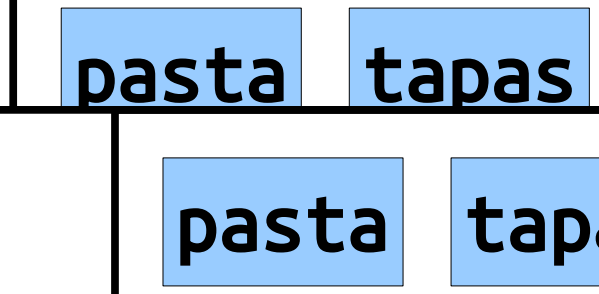
pasta tapas

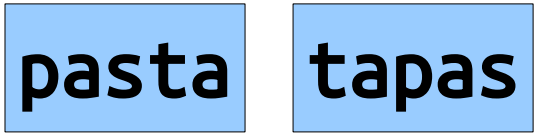
one two

# Tracing Function Calls

```
int main() {

}
```

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}
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```
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pasta tapas

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pasta tapas

one two

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int main() {

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pasta tapas

pasta apast

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pasta apast

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        }
        two = two.substr(1) + two[0];
    }
    return one == two;
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pasta apast

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int main() {

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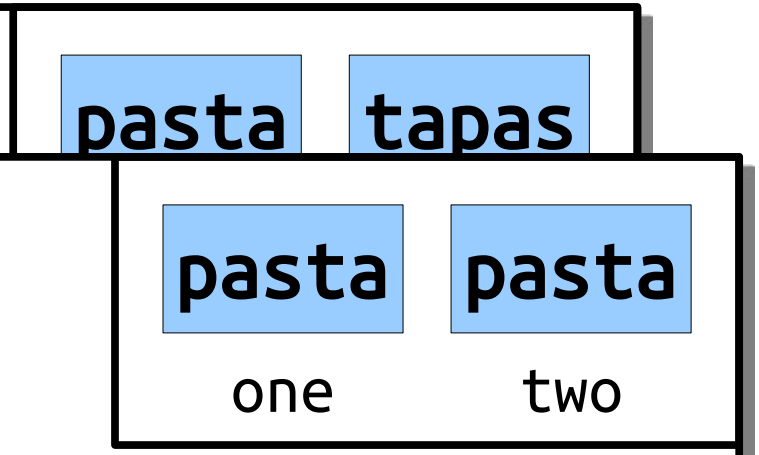


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pasta pasta

one two

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pasta tapas

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pasta pasta

one two

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int main() {

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pasta pasta

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pasta tapas

pasta pasta

one two

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    string one = getLine("First:  ");
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    if (areCyclicallyEqual(one, two)) {
        cout << "Yep!" << endl;
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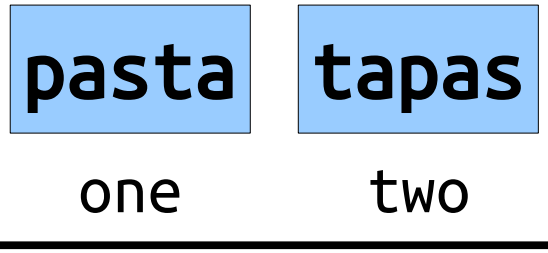
        cout << "Nah." << endl;
    }

    return 0;
}
```



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    return 0;
}
```

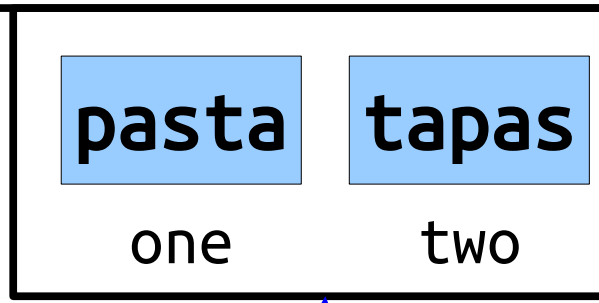


Notice that our original copies of one and two are unmodified.

# Tracing Function Calls

```
int main() {
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    }

    return 0;
}
```

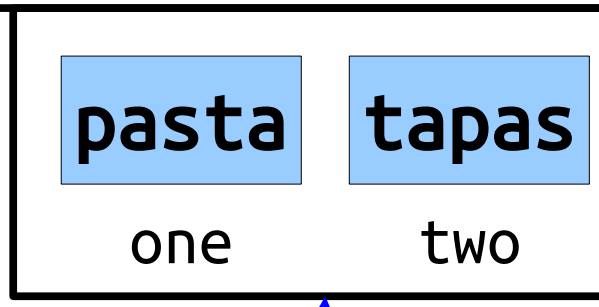


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