INTRODUCTION TO C PROGRAMMING

Welcome!

- This class is about more than computer programming!
- Indeed, this class is about problem-solving in a way that is exceedingly empowering! You will likely take the problem solving that you learn here will likely be instantly applicable to your work beyond this course and even your career as a whole!
- However, it will not be easy! You will be "drinking from the firehose" of knowledge during this course. You'll be amazed at what you will be able to accomplish in the coming weeks.

INTRODUCTION TO C PROGRAMMING

Welcome!

- This course is far more about you advancing “you” from “where you are today” than hitting some imagined standard.

- The most important opening consideration in this course: Give the time you need to learn through this course. Everyone learns differently. If something does not work out well at the start, know that with time you will grow and grow in your skill.

INTRODUCTION TO C PROGRAMMING

What's Ahead!

- Deep Dive into Basics
- Control Flow and Decision-Making
- Functions and Modular Programming
- Arrays and Pointers
- Strings and Advanced Data Types
- File Handling and Dynamic Memory Allocation
- Advanced Concepts
- Project Development
- Practice Sessions

INTRODUCTION TO C PROGRAMMING

What is C?

- C is a general-purpose programming language created by Dennis Ritchie at the Bell Laboratories in 1972.

- It has been used to develop operating systems, databases, applications, etc. It is a very popular language, despite being old. The main reason for its popularity is because it is a fundamental language in the field of computer science.

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Why learn C?

- It is one of the most popular programming language in the world
- If you know C, you will have no problem learning other popular programming languages such as Java, Python, C++, C#, etc., as the syntax is similar
- C is very fast, compared to other programming languages, like Java and Python
- C is very versatile; it can be used in both applications and technologies

INTRODUCTION TO C PROGRAMMING

Get Started with C

To start using C, you need two things:

- A text editor, like Notepad, to write C code
- A compiler, like GCC, to translate the C code into a language that the computer will understand

There are many text editors and compilers to choose from. In this tutorial, we will use an ***IDE.***

- An IDE (Integrated Development Environment) is used to edit AND compile the code.
- Popular IDE's include Code::Blocks, Eclipse, and Visual Studio. These are all free, and they can be used to both edit and debug C code.

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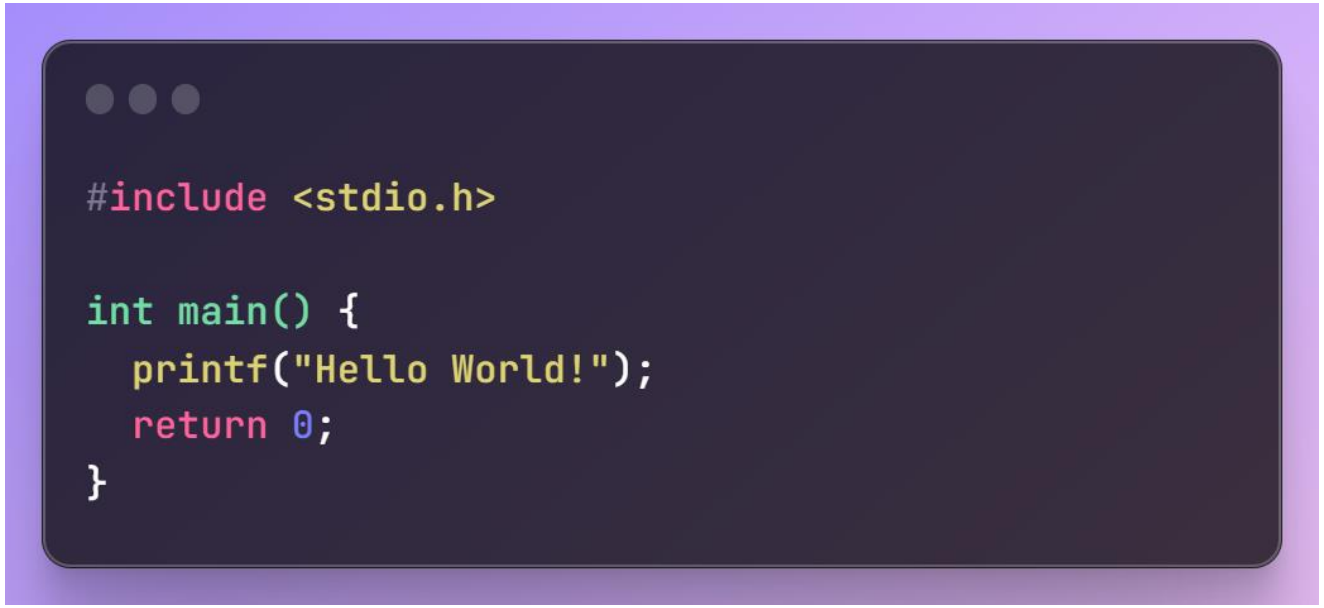
First Program



```c
#include <stdio.h>

int main() {
  printf("Hello World!");
  return 0;
}
```

Line 1: #include <stdio.h> is a **header file library** that lets us work with input and output functions, such as printf() (used in line 4). Header files add functionality to C programs.

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Syntax

Line 2: A blank line. C ignores white space. But we use it to make the code more readable.

Line 3: Another thing that always appear in a C program, is main(). This is called a **function**. Any code inside its curly brackets {} will be executed.

Line 4: printf() is a **function** used to output/print text to the screen. In our example it will output "Hello World!".

Line 5: return 0 ends the main() function.

Line 6: Do not forget to add the closing curly bracket } to actually end the main function.

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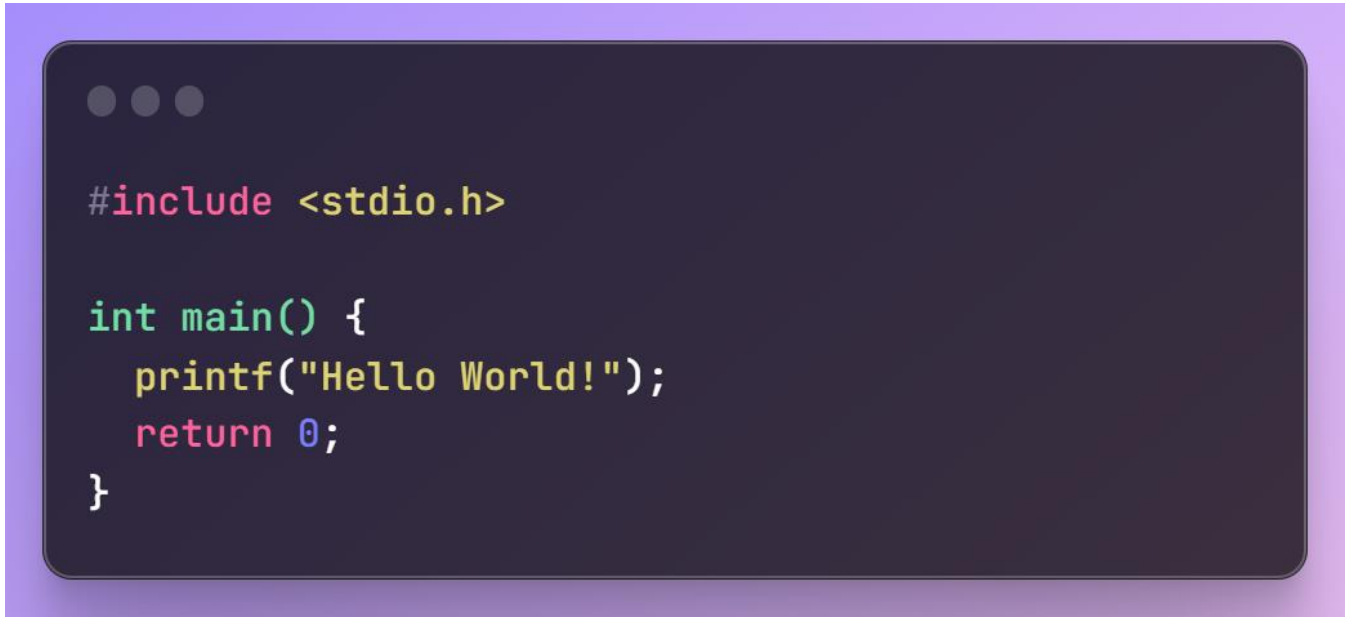
C Output

To output values or print text in C, you can use the printf() function:



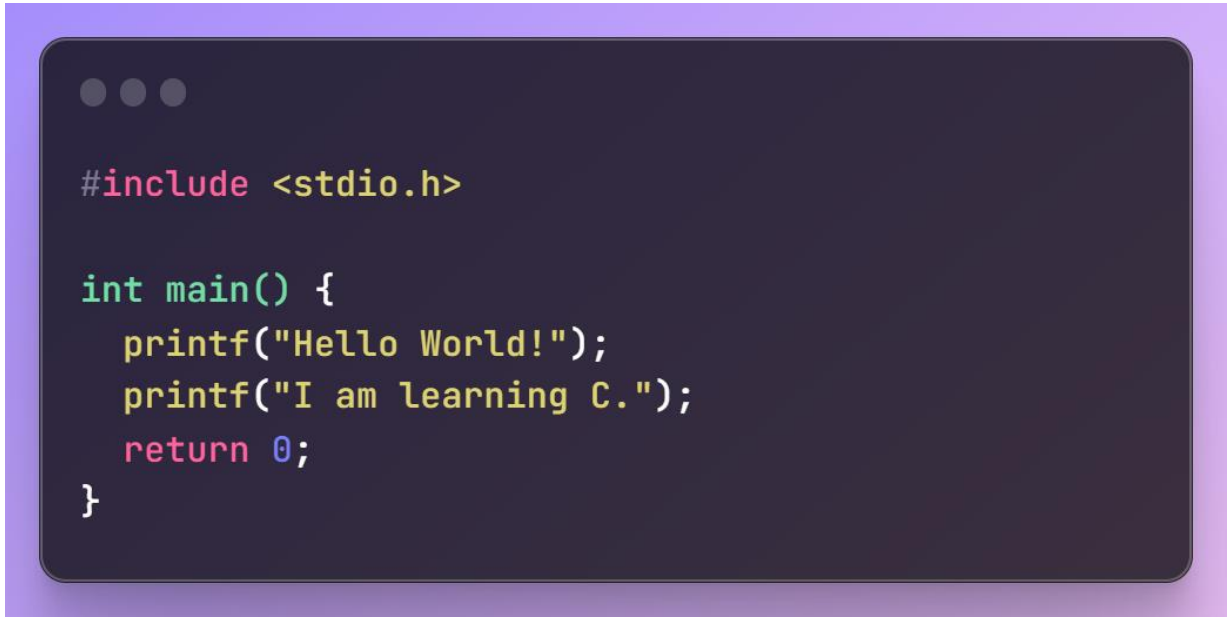
```c
#include <stdio.h>

int main() {
  printf("Hello World!");
  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

C Output

You can use as many printf() functions as you want. **However**, note that it does not insert a new line at the end of the output:



```c
#include <stdio.h>

int main() {
  printf("Hello World!");
  printf("I am learning C.");
  return 0;
}
```

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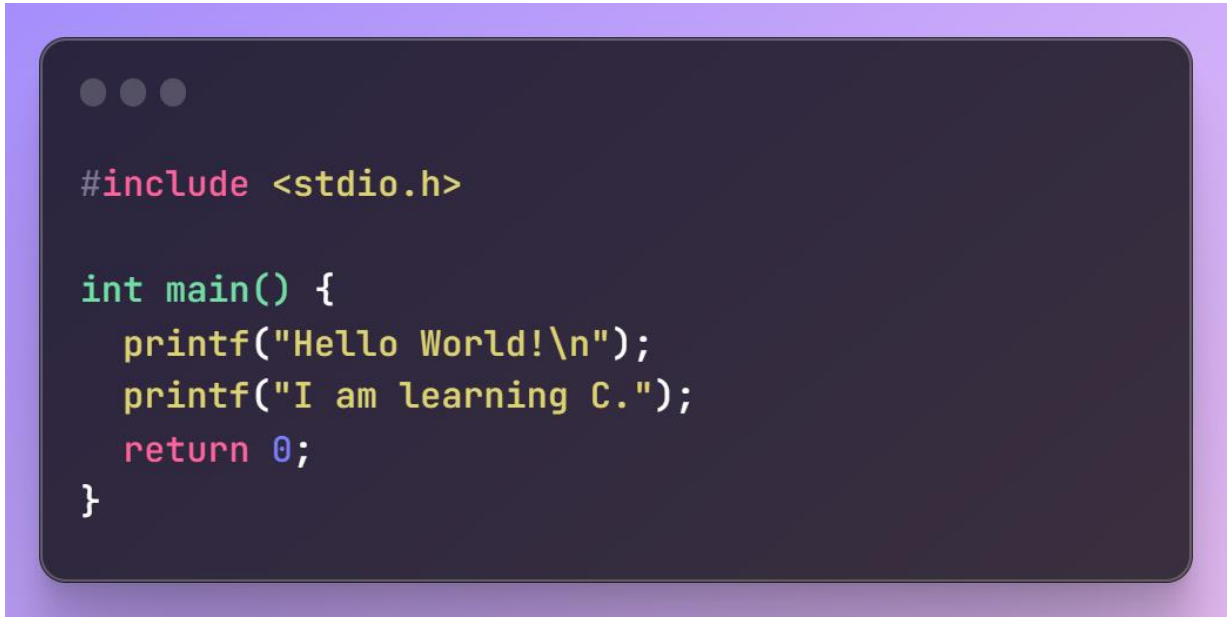
C Newlines

To insert a new line, you can use the \n character:



```c
#include <stdio.h>

int main() {
  printf("Hello World!\n");
  printf("I am learning C.");
  return 0;
}
```

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C Newlines

You can also output multiple lines with a single printf() function. However, this could make the code harder to read:

```c
#include <stdio.h>

int main() {
  printf("Hello World!\nI am learning C.\nAnd it is awesome!");
  return 0;
}
```

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C Comments

- Comments can be used to explain code, and to make it more readable. It can also be used to prevent execution when testing alternative code.
- Comments can be **singled-lined** or **multi-lined**

Single-line Comments

- Single-line comments start with two forward slashes (//).
- Any text between // and the end of the line is ignored by the compiler (will not be executed).
- This example uses a single-line comment before a line of code

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C Comments

Example

```
// This is a comment
printf("Hello World!");
```

Example

```
printf("Hello World!"); // This is a comment
```

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C Multi line Comments

- Multi-line comments start with /* and ends with */.
- Any text between /* and */ will be ignored by the compiler:

Example

```
/* The code below will print the words Hello World!
to the screen */
printf("Hello World!");
```

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C Variables

Variables are containers for storing data values, like numbers and characters.
In C, there are different **types** of variables (defined with different keywords), for example:

- int - stores integers (whole numbers), without decimals, such as 123 or -123
- float - stores floating point numbers, with decimals, such as 19.99 or -19.99
- char - stores single characters, such as 'a' or 'B'. Char values are surrounded by **single quotes**

To create a variable, specify the type and assign it a value:

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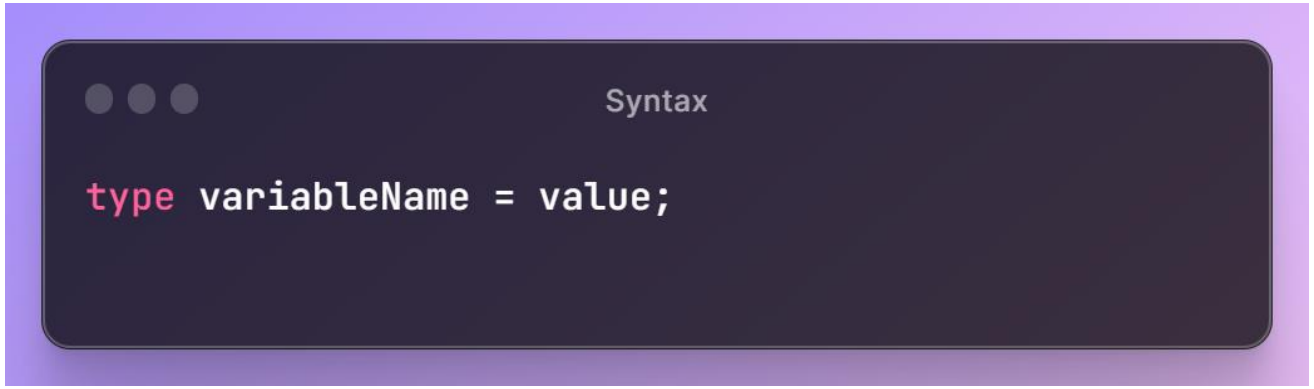
Declaring(Creating) Variables



- Where *type* is one of C types (such as int), and *variableName* is the name of the variable (such as **x** or **myName**). The **equal sign** is used to assign a value to the variable.

- So, to create **a variable that should store a number**, look at the following example:

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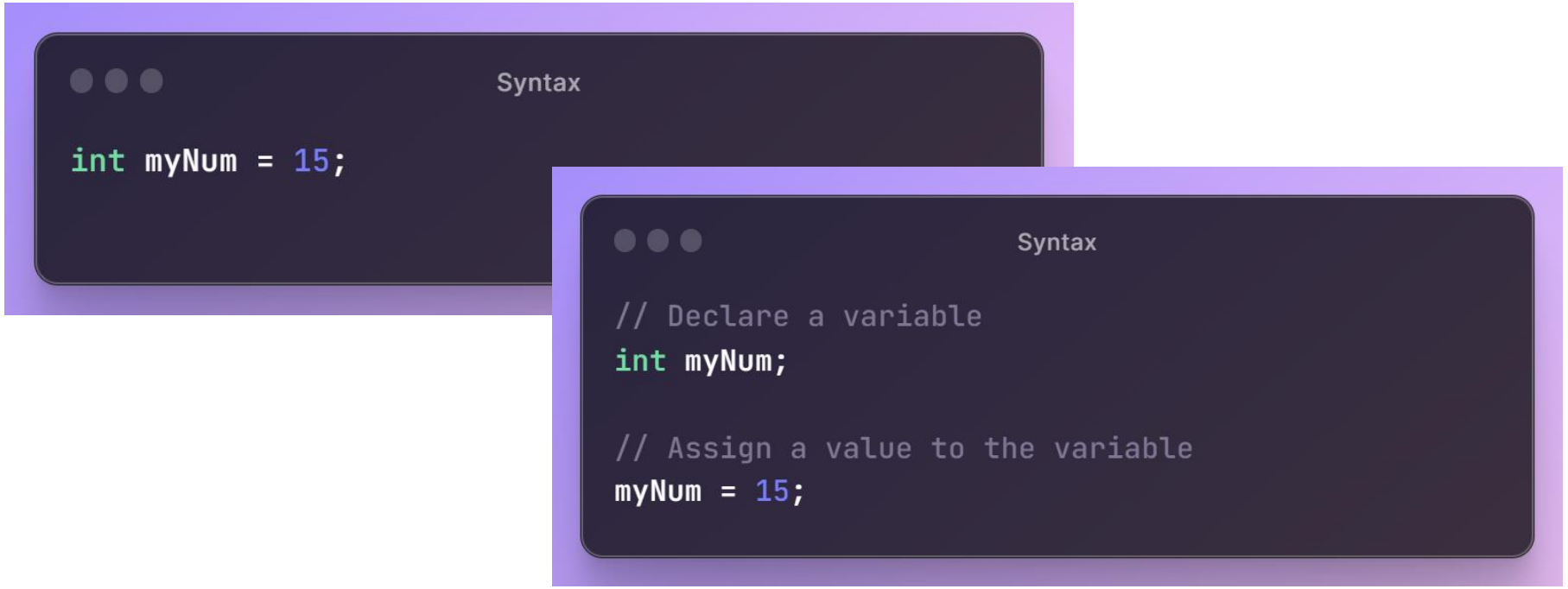
Declaring(Creating) Variables

You can also declare a variable without assigning the value, and assign the value later:



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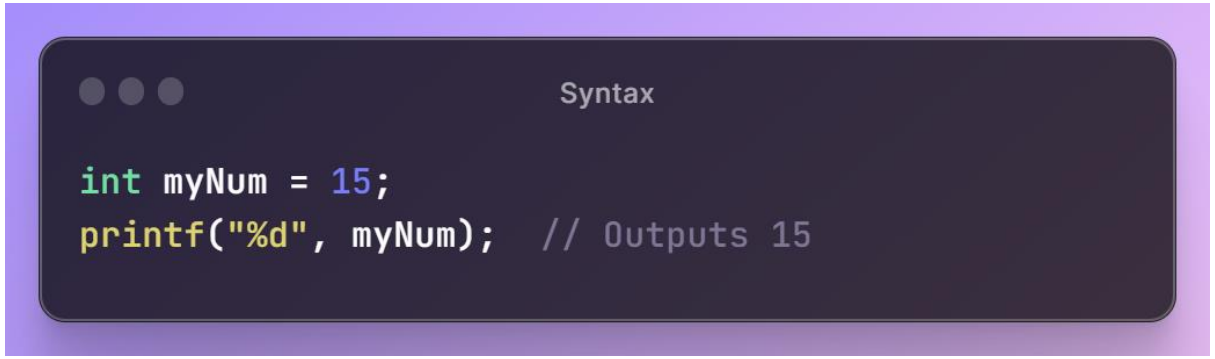
Format Specifiers

- Format specifiers are used together with the printf() function to tell the compiler what type of data the variable is storing. It is basically a placeholder for the variable value.

- A format specifier starts with a percentage sign %, followed by a character.

- For example, to output the value of an int variable, you must use the format specifier %d or %i surrounded by double quotes, inside the printf() function:



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Format Specifiers

To print other types, use %c for char and %f for float:

Example

```
// Create variables
int myNum = 15;              // Integer (whole number)
float myFloatNum = 5.99;     // Floating point number
char myLetter = 'D';         // Character

// Print variables
printf("%d\n", myNum);
printf("%f\n", myFloatNum);
printf("%c\n", myLetter);
```

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Format Specifiers

To combine both text and a variable, separate them with a comma inside the printf() function:

Example

```
int myNum = 15;
printf("My favorite number is: %d", myNum);
```

To print different types in a single printf() function, you can use the following:

Example

```
int myNum = 15;
char myLetter = 'D';
printf("My number is %d and my letter is %c", myNum, myLetter);
```

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Change Variable Values

Note: If you assign a new value to an existing variable, it will overwrite the previous value:

Example

```c
int myNum = 15;  // myNum is 15
myNum = 10;  // Now myNum is 10
```

Example

```c
int myNum = 15;

int myOtherNum = 23;

// Assign the value of myOtherNum (23) to myNum
myNum = myOtherNum;

// myNum is now 23, instead of 15
printf("%d", myNum);
```

INTRODUCTION TO C PROGRAMMING

Change Variable Values

Or copy values to empty variables:

Example

```c
// Create a variable and assign the value 15 to it
int myNum = 15;

// Declare a variable without assigning it a value
int myOtherNum;

// Assign the value of myNum to myOtherNum
myOtherNum = myNum;

// myOtherNum now has 15 as a value
printf("%d", myOtherNum);
```

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Change Variable Values

To add a variable to another variable, you can use the + operator:

Example

```
int x = 5;
int y = 6;
int sum = x + y;
printf("%d", sum);
```

Example

```
int x = 5, y = 6, z = 50;
printf("%d", x + y + z);
```

Example

```
int x, y, z;
x = y = z = 50;
printf("%d", x + y + z);
```

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C Variable Names

- All C **variables** must be **identified** with **unique names**.
- These unique names are called **identifiers**.
- Identifiers can be short names (like x and y) or more descriptive names (age, sum, totalVolume).
- **Note:** It is recommended to use descriptive names in order to create understandable and maintainable code:

Example

```
// Good
int minutesPerHour = 60;

// OK, but not so easy to understand what m actually is
int m = 60;
```

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C Variable Names

The **general rules** for naming variables are:

- Names can contain letters, digits and underscores
- Names must begin with a letter or an underscore (_)
- Names are case sensitive (myVar and myna are different variables)
- Names cannot contain whitespaces or special characters like !, #, %, etc.
- Reserved words (such as int) cannot be used as names

Real-Life Example

- Often in our examples, we simplify variable names to match their data type (myInt or myNum for int types, myChar for char types etc). This is done to avoid confusion.
- However, if you want a real-life example on how variables can be used, take a look at the following, where we have made a program that stores different data of a college student:

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C Variable Names

Example

```c
// Student data
int studentID = 15;
int studentAge = 23;
float studentFee = 75.25;
char studentGrade = 'B';

// Print variables
printf("Student id: %d\n", studentID);
printf("Student age: %d\n", studentAge);
printf("Student fee: %f\n", studentFee);
printf("Student grade: %c", studentGrade);
```

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Calculate the area of Rectangle

Example

```c
// Create integer variables
int length = 4;
int width = 6;
int area;

// Calculate the area of a rectangle
area = length * width;

// Print the variables
printf("Length is: %d\n", length);
printf("Width is: %d\n", width);
printf("Area of the rectangle is: %d", area);
```

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C Data Types

- As explained in the Variables chapter, a variable in C must be a specified **data type**, and you must use a **format specifier** inside the printf() function to display it:

Example

```
// Create variables
int myNum = 5;               // Integer (whole number)
float myFloatNum = 5.99;     // Floating point number
char myLetter = 'D';         // Character

// Print variables
printf("%d\n", myNum);
printf("%f\n", myFloatNum);
printf("%c\n", myLetter);
```

INTRODUCTION TO C PROGRAMMING

Basic Data Types

The data type specifies the size and type of information the variable will store.
In this tutorial, we will focus on the most basic ones:

Data Type	Size	Description
`int`	2 or 4 bytes	Stores whole numbers, without decimals
`float`	4 bytes	Stores fractional numbers, containing one or more decimals. Sufficient for storing 6-7 decimal digits
`double`	8 bytes	Stores fractional numbers, containing one or more decimals. Sufficient for storing 15 decimal digits
`char`	1 byte	Stores a single character/letter/number, or ASCII values

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Basic Format Specifiers

There are different format specifiers for each data type. Here are some of them:

Format Specifier	Data Type
`%d` or `%i`	`int`
`%f`	`float`
`%lf`	`double`
`%c`	`char`
`%s`	Used for **strings** **(text)**, which you will learn more about in a later chapter

INTRODUCTION TO C PROGRAMMING

Set Decimal Precision

If you want to remove the extra zeros (set decimal precision), you can use a dot (.) followed by a number that specifies how many digits that should be shown after the decimal point:

Example

```c
float myFloatNum = 3.5;

printf("%f\n", myFloatNum); // Default will show 6 digits after the decimal point
printf("%.1f\n", myFloatNum); // Only show 1 digit
printf("%.2f\n", myFloatNum); // Only show 2 digits
printf("%.4f", myFloatNum);   // Only show 4 digits
```

Example

```c
float myFloatNum = 3.5;
double myDoubleNum = 19.99;

printf("%f\n", myFloatNum); // Outputs 3.500000
printf("%lf", myDoubleNum); // Outputs 19.990000
```

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Real Life Example

Example

```c
// Create variables of different data types
int items = 50;
float cost_per_item = 9.99;
float total_cost = items * cost_per_item;
char currency = '$';

// Print variables
printf("Number of items: %d\n", items);
printf("Cost per item: %.2f %c\n", cost_per_item, currency);
printf("Total cost = %.2f %c\n", total_cost, currency);
```

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C Type Conversion

- Sometimes, you have to convert the value of one data type to another type. This is known as **type conversion**.
- For example, if you try to divide two integers, 5 by 2, you would expect the result to be 2.5. But since we are working with integers (and not floating-point values), the following example will just output 2:

Example

```c
int x = 5;
int y = 2;
int sum = 5 / 2;

printf("%d", sum); // Outputs 2
```

INTRODUCTION TO C PROGRAMMING

C Type Conversion

- To get the right result, you need to know how **type conversion** works.
- There are two types of conversion in C:
    - **Implicit Conversion** (automatically)
    - **Explicit Conversion** (manually)

Example

```c
// Automatic conversion: int to float
float myFloat = 9;

printf("%f", myFloat); // 9.000000
```

Example

```c
// Automatic conversion: float to int
int myInt = 9.99;

printf("%d", myInt); // 9
```

INTRODUCTION TO C PROGRAMMING

C Type Conversion

Example

```c
float sum = 5 / 2;

printf("%f", sum); // 2.000000
```

Example

```c
// Manual conversion: int to float
float sum = (float) 5 / 2;

printf("%f", sum); // 2.500000
```

Example

```c
int num1 = 5;
int num2 = 2;
float sum = (float) num1 / num2;

printf("%f", sum); // 2.500000
```

Example

```c
int num1 = 5;
int num2 = 2;
float sum = (float) num1 / num2;

printf("%.1f", sum); // 2.5
```

INTRODUCTION TO C PROGRAMMING

C Constants

- If you don't want others (or yourself) to change existing variable values, you can use the const keyword.

- This will declare the variable as "constant", which means **unchangeable** and **read-only**:

Example

```
const int myNum = 15;  // myNum will always be 15
myNum = 10;  // error: assignment of read-only variable 'myNum'
```

Example

```
const int minutesPerHour = 60;
const float PI = 3.14;
```

INTRODUCTION TO C PROGRAMMING

C Operators

- Operators are used to perform operations on variables and values.
- In the example below, we use the + **operator** to add together two values:
- Although the + operator is often used to add together two values, like in the example above, it can also be used to add together a variable and a value, or a variable and another variable

Example

```
int myNum = 100 + 50;
```

Example

```
int sum1 = 100 + 50;          // 150 (100 + 50)
int sum2 = sum1 + 250;        // 400 (150 + 250)
int sum3 = sum2 + sum2;       // 800 (400 + 400)
```

INTRODUCTION TO C PROGRAMMING

C Operators

- C divides the operators into the following groups:
  - **Arithmetic operators**
  - **Assignment operators**
  - **Comparison operators**
  - **Logical operators**
  - **Bitwise operators**

INTRODUCTION TO C PROGRAMMING

Arithmetic Operators

Arithmetic operators are used to perform common mathematical operations.

Operator	Name	Description	Example
+	Addition	Adds together two values	x + y
-	Subtraction	Subtracts one value from another	x - y
*	Multiplication	Multiplies two values	x * y
/	Division	Divides one value by another	x / y
%	Modulus	Returns the division remainder	x % y
++	Increment	Increases the value of a variable by 1	++x
--	Decrement	Decreases the value of a variable by 1	--x

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Assignment Operators

- Assignment operators are used to assign values to variables.
- In the example below, we use the **assignment** operator (=) to assign the value **10** to a variable called **x**:
- The **addition assignment** operator (+=) adds a value to a variable:

Example

```
int x = 10;
```

Example

```
int x = 10;
x += 5;
```

INTRODUCTION TO C PROGRAMMING

Assignment Operators

- A list of all assignment operators:

Operator	Example	Same As
=	x = 5	x = 5
+=	x += 3	x = x + 3
-=	x -= 3	x = x - 3
*=	x *= 3	x = x * 3
/=	x /= 3	x = x / 3
%=	x %= 3	x = x % 3
&=	x &= 3	x = x & 3
|=	x |= 3	x = x | 3
^=	x ^= 3	x = x ^ 3
>>=	x >>= 3	x = x >> 3
<<=	x <<= 3	x = x << 3

INTRODUCTION TO C PROGRAMMING

Comparison Operators

- Comparison operators are used to compare two values (or variables). This is important in programming, because it helps us to find answers and make decisions.
- The return value of a comparison is either 1 or 0, which means **true** (1) or **false** (0). These values are known as **Boolean values**, and you will learn more about them in the Booleans and If..Else chapter.
- In the following example, we use the **greater than** operator (>) to find out if 5 is greater than 3:

```
int x = 5;
int y = 3;
printf("%d", x > y); // returns 1 (true) because 5 is greater than 3
```

INTRODUCTION TO C PROGRAMMING

Comparison Operators

- A list of all comparison operators:

Operator	Name	Example
==	Equal to	x == y
!=	Not equal	x != y
>	Greater than	x > y
<	Less than	x < y
>=	Greater than or equal to	x >= y
<=	Less than or equal to	x <= y

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Logical Operators

- You can also test for true or false values with logical operators.
- Logical operators are used to determine the logic between variables or values:

Operator	Name	Description	Example
&&	Logical and	Returns true if both statements are true	x < 5 && x < 10
||	Logical or	Returns true if one of the statements is true	x < 5 || x < 4
!	Logical not	Reverse the result, returns false if the result is true	!(x < 5 && x < 10)

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Size of Operator

- The memory size (in bytes) of a data type or a variable can be found with the sizeof operator:

```c
int myInt;
float myFloat;
double myDouble;
char myChar;

printf("%lu\n", sizeof(myInt));
printf("%lu\n", sizeof(myFloat));
printf("%lu\n", sizeof(myDouble));
printf("%lu\n", sizeof(myChar));
```

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C Booleans

- Very often, in programming, you will need a data type that can only have one of two values, like:
    - YES / NO
    - ON / OFF
    - TRUE / FALSE
- For this, C has a bool data type, which is known as **booleans**.
- Booleans represent values that are either true or false.

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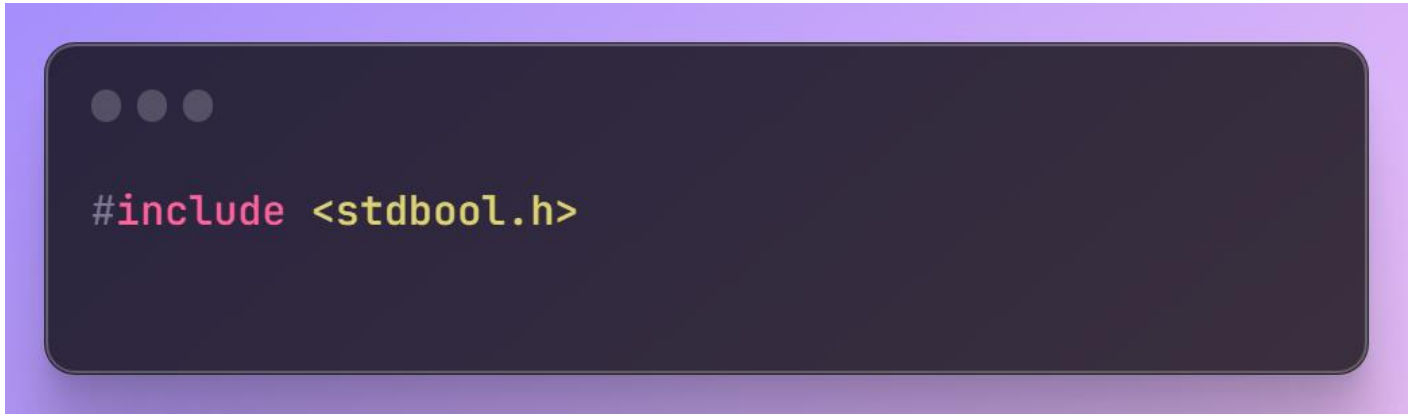
Boolean Variables

- In C, the bool type is not a built-in data type, like int or char.
- It was introduced in C99, and you must **import** the following header file to use it:



- A boolean variable is declared with the bool keyword and can only take the values true or false:

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Boolean Variables

- Before trying to print the boolean variables, you should know that boolean values are returned as integers:

  - 1 (or any other number that is not 0) represents true
  - 0 represents false

- Therefore, you must use the %d format specifier to print a boolean value:

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Boolean Variables

Example

```
// Create boolean variables
bool isProgrammingFun = true;
bool isFishTasty = false;

// Return boolean values
printf("%d", isProgrammingFun);   // Returns 1 (true)
printf("%d", isFishTasty);        // Returns 0 (false)
```

- However, it is more common to return a boolean value by **comparing** values and variables.

INTRODUCTION TO C PROGRAMMING

Comparing Values and Variables

- Comparing values are useful in programming, because it helps us to find answers and make decisions.
- For example, you can use a comparison operator, such as the **greater than** (>) operator, to compare two values:

Example

```
printf("%d", 10 > 9);  // Returns 1 (true) because 10 is greater than 9
```

INTRODUCTION TO C PROGRAMMING

Comparing Values and Variables

- You can also compare two variables:

Example

```
int x = 10;
int y = 9;
printf("%d", x > y);
```

INTRODUCTION TO C PROGRAMMING

Comparing Values and Variables

- In the example below, we use the **equal to** (==) operator to compare different values:

Example

```
printf("%d", 10 == 10); // Returns 1 (true), because 10 is equal to 10
printf("%d", 10 == 15); // Returns 0 (false), because 10 is not equal to 15
printf("%d", 5 == 55);  // Returns 0 (false) because 5 is not equal to 55
```

- You are not limited to only compare numbers. You can also compare boolean variables, or even special structures, like arrays (which you will learn more about in a later chapter):

INTRODUCTION TO C PROGRAMMING

Comparing Values and Variables

Example

```
bool isHamburgerTasty = true;
bool isPizzaTasty = true;

// Find out if both hamburger and pizza is tasty
printf("%d", isHamburgerTasty == isPizzaTasty);
```

INTRODUCTION TO C PROGRAMMING

Real Life Example

- Let's think of a "real life example" where we need to find out if a person is old enough to vote.
- In the example below, we use the >= comparison operator to find out if the age (25) is **greater than** OR **equal to** the voting age limit, which is set to 18:

Example

```
int myAge = 25;
int votingAge = 18;

printf("%d", myAge >= votingAge); // Returns 1 (true), meaning 25 year olds are allowed to
vote!
```

INTRODUCTION TO C PROGRAMMING

Real Life Example

- Cool, right? An even better approach (since we are on a roll now), would be to wrap the code above in an if...else statement, so we can perform different actions depending on the result:

Example

```
int myAge = 25;
int votingAge = 18;

if (myAge >= votingAge) {
  printf("Old enough to vote!");
} else {
  printf("Not old enough to vote.");
}
```

INTRODUCTION TO C PROGRAMMING

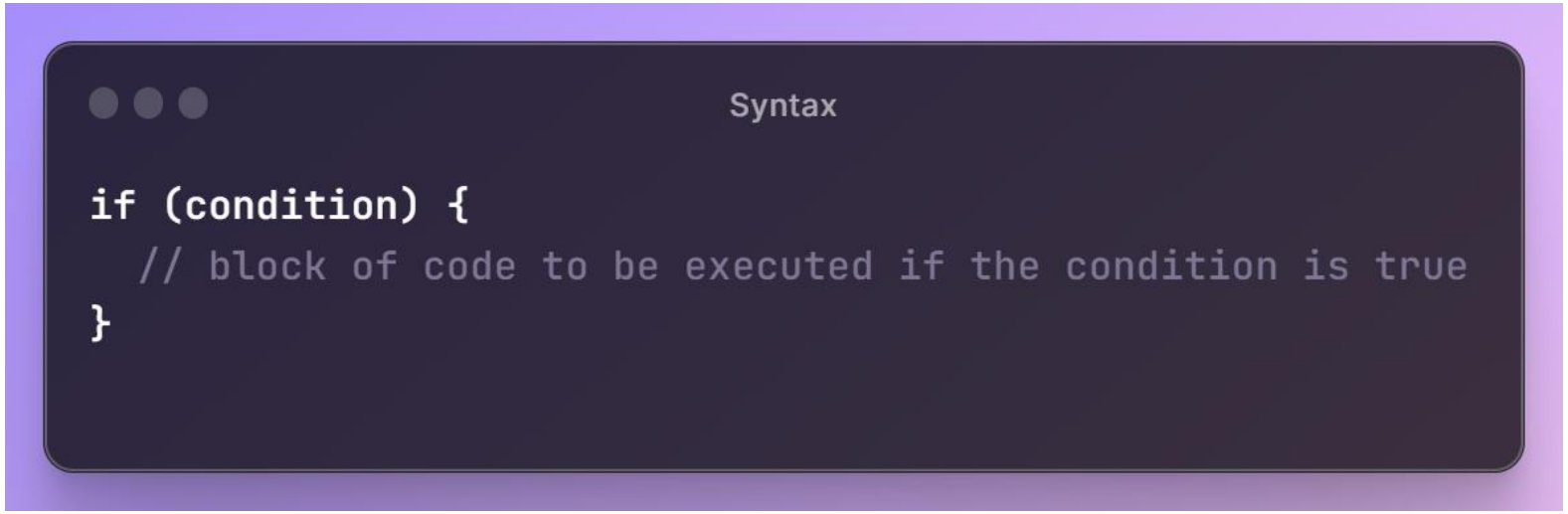
C If …Else

- You have already learned that C supports the usual logical **conditions** from mathematics:
    - Less than: a < b
    - Less than or equal to: a <= b
    - Greater than: a > b
    - Greater than or equal to: a >= b
    - Equal to a == b
    - Not Equal to: a != b
- You can use these conditions to perform different actions for different decisions.
- C has the following conditional statements:
- Use if to specify a block of code to be executed, if a specified condition is true.
- Use else to specify a block of code to be executed, if the same condition is false.
- Use else if to specify a new condition to test, if the first condition is false.
- Use switch to specify many alternative blocks of code to be executed.

INTRODUCTION TO C PROGRAMMING

The If Statement

- Use the if statement to specify a block of code to be executed if a condition is true.



- Note that if is in lowercase letters. Uppercase letters (If or IF) will generate an error.

INTRODUCTION TO C PROGRAMMING

The If Statement

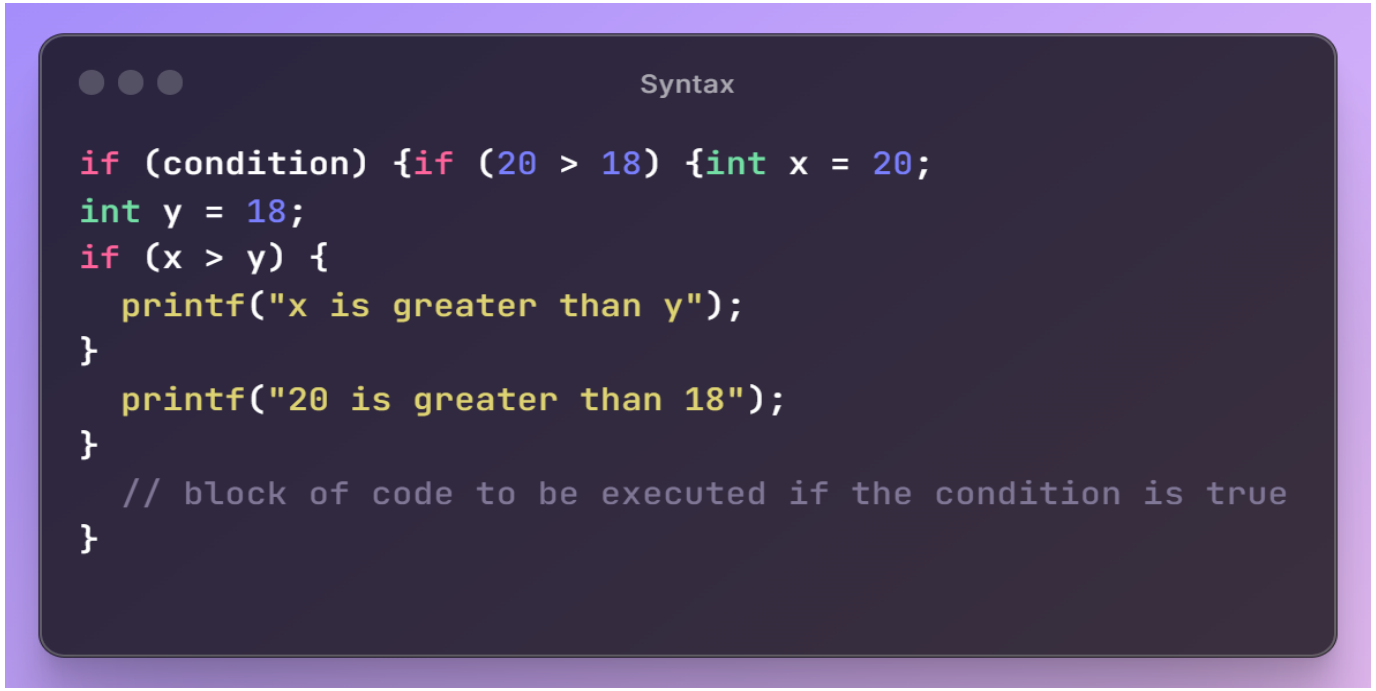
- In the example below, we test two values to find out if 20 is greater than 18. If the condition is true, print some text:

Syntax

```
if (condition) {if (20 > 18) {
  printf("20 is greater than 18");
}
  // block of code to be executed if the condition is true
}
```

INTRODUCTION TO C PROGRAMMING

The If Statement



- In the example above we use two variables, **x** and **y**, to test whether x is greater than y (using the > operator). As x is 20, and y is 18, and we know that 20 is greater than 18, we print to the screen that "x is greater than y".

INTRODUCTION TO C PROGRAMMING

The Else Statement

- Use the else statement to specify a block of code to be executed if the condition is false.

Syntax

```
if (condition) {
  // block of code to be executed if the condition is true
} else {
  // block of code to be executed if the condition is false
}
```

Syntax

```
int time = 20;
if (time < 18) {
  printf("Good day.");
} else {
  printf("Good evening.");
}
// Outputs "Good evening."
```

- In the example above, time (20) is greater than 18, so the condition is false. Because of this, we move on to the else condition and print to the screen "Good evening". If the time was less than 18, the program would print "Good day".

INTRODUCTION TO C PROGRAMMING

The Else If Statement

- Use the else if statement to specify a new condition if the first condition is false.

Syntax

```
if (condition1) {
  // block of code to be executed if condition1 is true
} else if (condition2) {
  // block of code to be executed if the condition1 is false and condition2 is true
} else {
  // block of code to be executed if the condition1 is false and condition2 is false
}
```

INTRODUCTION TO C PROGRAMMING

The Else If Statement

- In the example above, time (22) is greater than 10, so the **first condition** is false. The next condition, in the else if statement, is also false, so we move on to the else condition since **condition1** and **condition2** is both false - and print to the screen "Good evening".

- However, if the time was 14, our program would print "Good day."

Syntax

```
int time = 22;
if (time < 10) {
  printf("Good morning.");
} else if (time < 20) {
  printf("Good day.");
} else {
  printf("Good evening.");
}
// Outputs "Good evening."
```

INTRODUCTION TO C PROGRAMMING

The Else If Statement

- This example shows how you can use if..else to find out if a number is positive or negative and find out if a number is even or odd:

Syntax

```c
int myNum = 10; // Is this a positive or negative number?

if (myNum > 0) {
  printf("The value is a positive number.");
} else if (myNum < 0) {
  printf("The value is a negative number.");
} else {
  printf("The value is 0.");
}
```

Syntax

```c
int myNum = 5;  // Is this an even or odd number?

if (myNum % 2 == 0) {
  printf("%d is even.\n", myNum);
} else {
  printf("%d is odd.\n", myNum);
}
```

INTRODUCTION TO C PROGRAMMING

Short Hand If…Else (Ternary Operator)

- There is also a short-hand if else, which is known as the **ternary operator** because it consists of three operands. It can be used to replace multiple lines of code with a single line. It is often used to replace simple if else statements:

INTRODUCTION TO C PROGRAMMING

Short Hand If…Else (Ternary Operator)

Instead of writing:

Syntax

```
int time = 20;
if (time < 18) {
  printf("Good day.");
} else {
  printf("Good evening.");
}
```

You can simply write:

Syntax

```
int time = 20;
(time < 18) ? printf("Good day.") : printf("Good evening.");
```

It is completely up to you if you want to use the traditional if...else statement or the ternary operator.

INTRODUCTION TO C PROGRAMMING

Switch Statement

- Instead of writing **many** if..else statements, you can use the switch statement.
- The switch statement selects one of many code blocks to be executed:

Syntax

```
switch(expression) {
  case x:
    // code block
    break;
  case y:
    // code block
    break;
  default:
    // code block
}
```

INTRODUCTION TO C PROGRAMMING

Switch Statement

- This is how it works:
  - The switch expression is evaluated once.
  - The value of the expression is compared with the values of each case.
  - If there is a match, the associated block of code is executed.
  - The break statement breaks out of the switch block and stops the execution.
  - The default statement is optional, and specifies some code to run if there is no case match.

INTRODUCTION TO C PROGRAMMING

Switch Statement

- The example below uses the weekday number to calculate the weekday name:

Syntax

```
int day = 4;

switch (day) {
  case 1:
    printf("Monday");
    break;
  case 2:
    printf("Tuesday");
    break;
  case 3:
    printf("Wednesday");
    break;
  case 4:
    printf("Thursday");
    break;
  case 5:
    printf("Friday");
    break;
  case 6:
    printf("Saturday");
    break;
  case 7:
    printf("Sunday");
    break;
}

// Outputs "Thursday" (day 4)
```

INTRODUCTION TO C PROGRAMMING

The Break Keyword

- When C reaches a break keyword, it breaks out of the switch block.
- This will stop the execution of more code and case testing inside the block.
- When a match is found, and the job is done, it's time for a break. There is no need for more testing.
- A break can save a lot of execution time because it "ignores" the execution of all the rest of the code in the switch block.

INTRODUCTION TO C PROGRAMMING

The Default Keyword

- The default keyword specifies some code to run if there is no case match:

Note: The default keyword must be used as the last statement in the switch, and it does not need a break.

Syntax

```
int day = 4;

switch (day) {
  case 6:
    printf("Today is Saturday");
    break;
  case 7:
    printf("Today is Sunday");
    break;
  default:
    printf("Looking forward to the Weekend");
}

// Outputs "Looking forward to the Weekend"
```

INTRODUCTION TO C PROGRAMMING

Loops

- Loops can execute a block of code as long as a specified condition is reached.
- Loops are handy because they save time, reduce errors, and they make code more readable.

INTRODUCTION TO C PROGRAMMING

While Loop

- The while loop loops through a block of code as long as a specified condition is true:

Syntax

```
while (condition) {
  // code block to be executed
}
```

Syntax

```
int i = 0;

while (i < 5) {
  printf("%d\n", i);
  i++;
}
```

Note: Do not forget to increase the variable used in the condition (i++), otherwise the loop will never end!

INTRODUCTION TO C PROGRAMMING

The Do/While Loop

- The do/while loop is a variant of the while loop. This loop will execute the code block once, before checking if the condition is true, then it will repeat the loop as long as the condition is true.

Syntax

```
do {
  // code block to be executed
}
while (condition);
```

INTRODUCTION TO C PROGRAMMING

The Do/While Loop

- The example below uses a do/while loop. The loop will always be executed at least once, even if the condition is false, because the code block is executed before the condition is tested:

- Do not forget to increase the variable used in the condition, otherwise the loop will never end!

INTRODUCTION TO C PROGRAMMING

Real-Life Examples

- To demonstrate a practical example of the **while loop**, we can create a simple "countdown" program:

Syntax

```c
int countdown = 3;

while (countdown > 0) {
  printf("%d\n", countdown);
  countdown--;
}

printf("Happy New Year!!\n");
```

INTRODUCTION TO C PROGRAMMING

Real-Life Example

- To demonstrate a practical example of the **while loop** combined with an **if else statement**, let's say we play a game of Yatzy!

Syntax

```
int dice = 1;

while (dice <= 6) {
  if (dice < 6) {
    printf("No Yatzy\n");
  } else {
    printf("Yatzy!\n");
  }
  dice = dice + 1;
}
```

- If the loop passes the values ranging from 1 to 5, it prints "No Yatzy". Whenever it passes the value 6, it prints "Yatzy!".

INTRODUCTION TO C PROGRAMMING

For Loops

- When you know exactly how many times you want to loop through a block of code, use the for loop instead of a while loop:

- **Statement 1** is executed (one time) before the execution of the code block.
- **Statement 2** defines the condition for executing the code block.
- **Statement 3** is executed (every time) after the code block has been executed.

INTRODUCTION TO C PROGRAMMING

For Loops

- The example below will print the numbers 0 to 4:

Syntax

```
int i;

for (i = 0; i < 5; i++) {
  printf("%d\n", i);
}
```

Example explained:

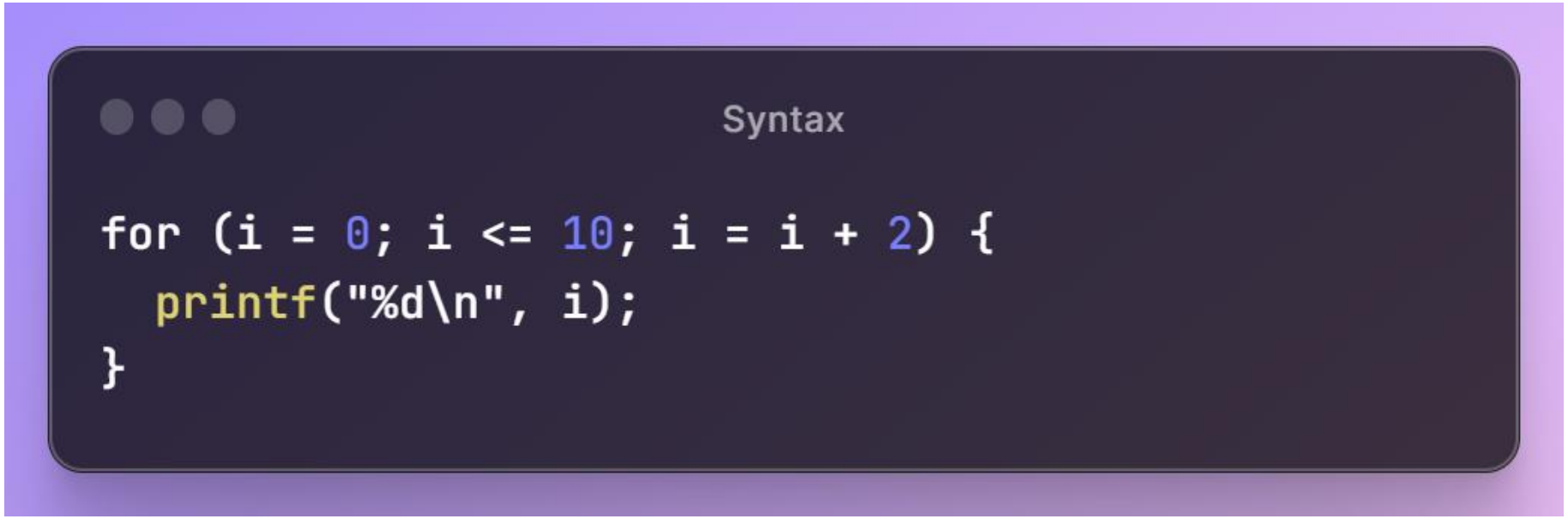
- Statement 1 sets a variable before the Loop starts (int i = 0).
- Statement 2 defines the condition for the loop to run (i must be less than 5). If the condition is true, the loop will start over again, if it is false, the loop will end.
- Statement 3 increases a value (i++) each time the code block in the loop has been executed.

INTRODUCTION TO C PROGRAMMING

Loops

Another Example

- This example will only print even values between 0 and 10:



INTRODUCTION TO C PROGRAMMING

Loops

Nested Loops

- It is also possible to place a loop inside another loop. This is called a **nested loop**.
- The "inner loop" will be executed one time for each iteration of the "outer loop":

Syntax

```
int i, j;

// Outer loop
for (i = 1; i <= 2; ++i) {
  printf("Outer: %d\n", i);  // Executes 2 times

  // Inner loop
  for (j = 1; j <= 3; ++j) {
    printf(" Inner: %d\n", j);  // Executes 6 times (2 * 3)
  }
}
```

INTRODUCTION TO C PROGRAMMING

Loops

Real-Life Example

- To demonstrate a practical example of the **for loop**, let's create a program that prints the multiplication table for a specified number:

Syntax

```
int number = 2;
int i;

// Print the multiplication table for the number 2
for (i = 1; i <= 10; i++) {
  printf("%d x %d = %d\n", number, i, number * i);
}

return 0;
```

INTRODUCTION TO C PROGRAMMING

C Break

- You have already seen the break statement used in an earlier chapter of this tutorial. It was used to "jump out" of a switch statement.

- The break statement can also be used to jump out of a **loop**.

- This example jumps out of the **for loop** when i is equal to 4:

syntax

```
int i;

for (i = 0; i < 10; i++) {
  if (i == 4) {
    break;
  }
  printf("%d\n", i);
}
```

INTRODUCTION TO C PROGRAMMING

C Continue

- The continue statement breaks one iteration (in the loop), if a specified condition occurs, and continues with the next iteration in the loop.

- This example skips the value of 4:

syntax

```
int i;

for (i = 0; i < 10; i++) {
  if (i == 4) {
    continue;
  }
  printf("%d\n", i);
}
```

INTRODUCTION TO C PROGRAMMING

C Break/Continue:

- You can also use break and continue in while loops:

Break Example :

syntax

```c
int i = 0;

while (i < 10) {
  if (i == 4) {
    break;
  }
  printf("%d\n", i);
  i++;
}
```

Continue Example :

Example

```c
int i = 0;

while (i < 10) {
  if (i == 4) {
    i++;
    continue;
  }
  printf("%d\n", i);
  i++;
}
```

INTRODUCTION TO C PROGRAMMING

C Arrays

- Arrays are used to store multiple values in a single variable, instead of declaring separate variables for each value.
- To create an array, define the data type (like int) and specify the name of the array followed by **square brackets []**.
- To insert values to it, use a comma-separated list, inside curly braces:

syntax

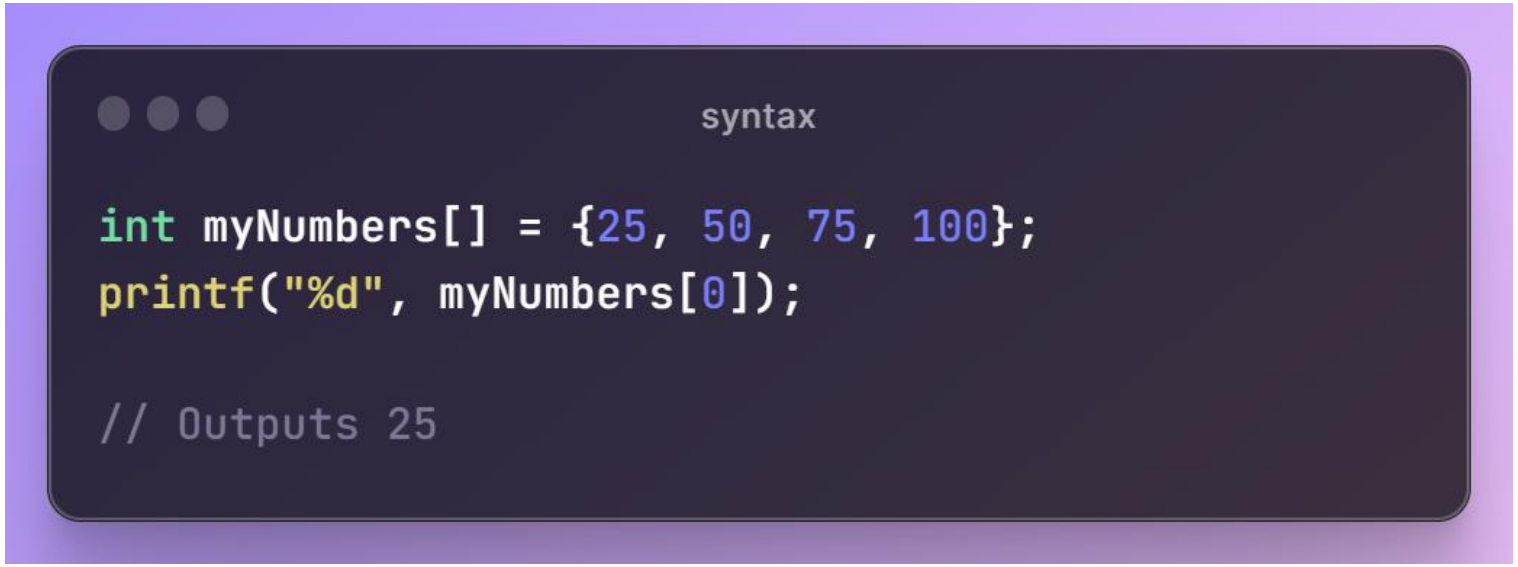
```
int myNumbers[] = {25, 50, 75, 100};
```

- We have now created a variable that holds an array of four integers.

INTRODUCTION TO C PROGRAMMING

Access the Elements of an Array

- To access an array element, refer to its **index number**.
- Array indexes start with **0**: [0] is the first element. [1] is the second element, etc.
- This statement accesses the value of the **first element [0]** in myNumbers:



INTRODUCTION TO C PROGRAMMING

Change an Array Element

- To change the value of a specific element, refer to the index number:

syntax

```
myNumbers[0] = 33;
```

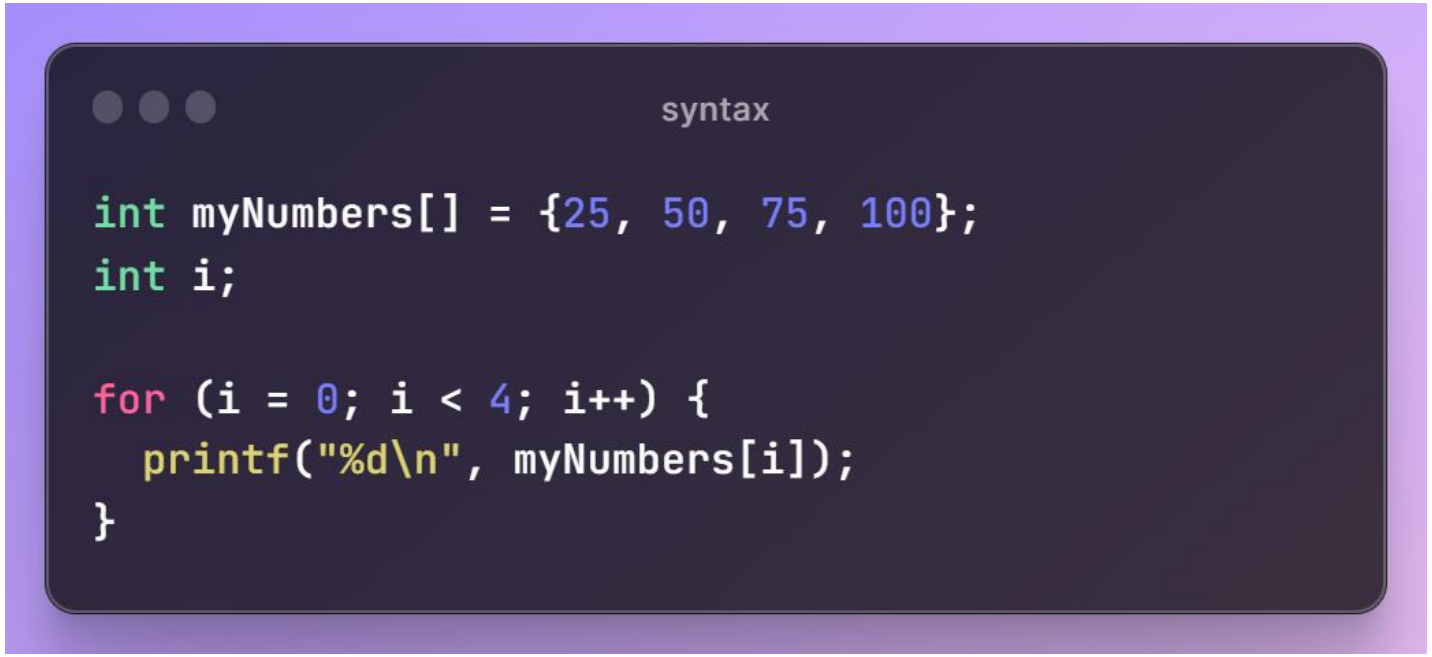
syntax

```
int myNumbers[] = {25, 50, 75, 100};
myNumbers[0] = 33;

printf("%d", myNumbers[0]);

// Now outputs 33 instead of 25
```

INTRODUCTION TO C PROGRAMMING

Loop Through an Array

- You can loop through the array elements with the for loop.
- The following example outputs all elements in the myNumbers array:



INTRODUCTION TO C PROGRAMMING

Set Array Size

- Another common way to create arrays, is to specify the size of the array, and add elements later:

- Using this method, **you should know the number of array elements in advance,** in order for the program to store enough memory.

- You are not able to change the size of the array after creation.

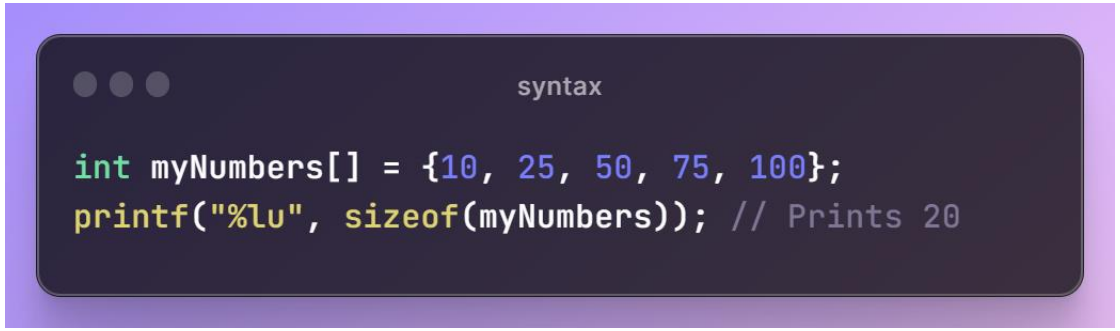
syntax

```
// Declare an array of four integers:
int myNumbers[4];

// Add elements
myNumbers[0] = 25;
myNumbers[1] = 50;
myNumbers[2] = 75;
myNumbers[3] = 100;
```

INTRODUCTION TO C PROGRAMMING

Get Array Size or Length

- To get the size of an array, you can use the sizeof operator:



- Why did the result show 20 instead of 5, when the array contains 5 elements?

- It is because the sizeof operator returns the size of a type in **bytes**.

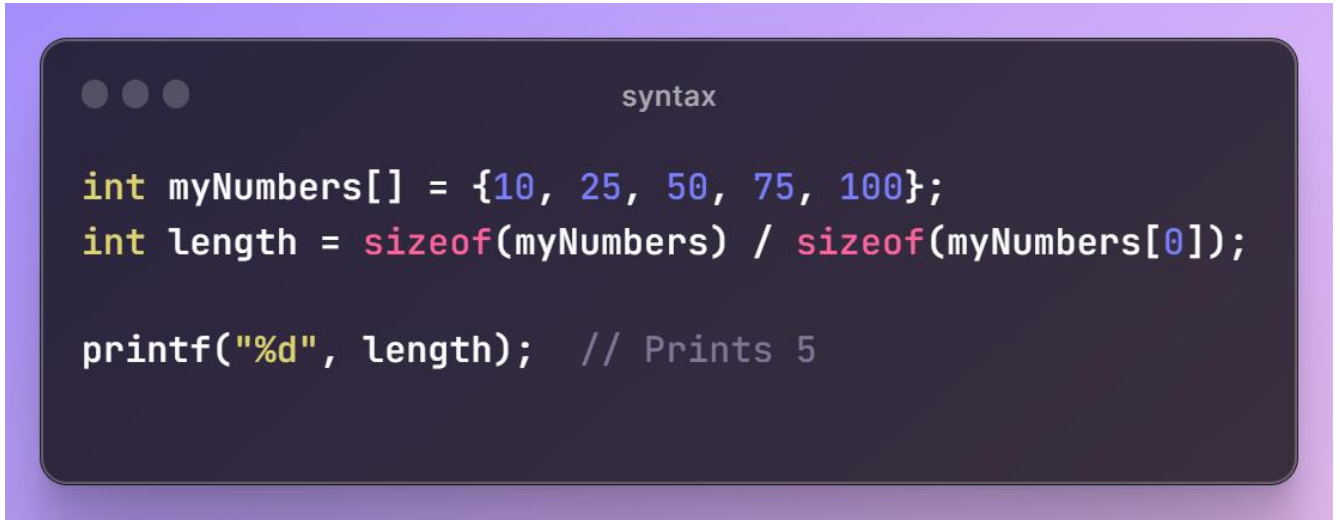
- You learned from the Data Types chapter that an int type is usually 4 bytes, so from the example above, 4 x 5 (*4 bytes x 5 elements*) = **20 bytes**.

INTRODUCTION TO C PROGRAMMING

Get Array Size or Length

- Knowing the memory size of an array is great when you are working with larger programs that require good memory management.

- But when you just want to find out how many elements an array has, you can use the following formula (which divides the size of the array by the size of one array element):



INTRODUCTION TO C PROGRAMMING

Making Better Loops

- In the array loops section above, we wrote the size of the array in the loop condition (i < 4). This is not ideal, since it will only work for arrays of a specified size.

- However, by using the sizeof formula from the example above, we can now make loops that work for arrays of any size, which is more sustainable.

Instead of Writing :

```
syntax

int myNumbers[] = {25, 50, 75, 100};
int i;

for (i = 0; i < 4; i++) {
  printf("%d\n", myNumbers[i]);
}
```

It is Better to write :

```
syntax

int myNumbers[] = {25, 50, 75, 100};
int length = sizeof(myNumbers) / sizeof(myNumbers[0]);
int i;

for (i = 0; i < length; i++) {
  printf("%d\n", myNumbers[i]);
}
```

INTRODUCTION TO C PROGRAMMING

Making Better Loops

Instead of Writing :

```
syntax

int myNumbers[] = {25, 50, 75, 100};
int i;

for (i = 0; i < 4; i++) {
  printf("%d\n", myNumbers[i]);
}
```

It is Better to write :

```
syntax

int myNumbers[] = {25, 50, 75, 100};
int length = sizeof(myNumbers) / sizeof(myNumbers[0]);
int i;

for (i = 0; i < length; i++) {
  printf("%d\n", myNumbers[i]);
}
```

INTRODUCTION TO C PROGRAMMING

Real-life Example

- To demonstrate a practical example of using arrays, let's create a program that calculates the average of different ages:

syntax

```c
// An array storing different ages
int ages[] = {20, 22, 18, 35, 48, 26, 87, 70};

float avg, sum = 0;
int i;

// Get the length of the array
int length = sizeof(ages) / sizeof(ages[0]);

// Loop through the elements of the array
for (int i = 0; i < length; i++) {
  sum += ages[i];
}

// Calculate the average by dividing the sum by the length
avg = sum / length;

// Print the average
printf("The average age is: %.2f", avg);
```

INTRODUCTION TO C PROGRAMMING

C MultiDimensional Arrays

- In the previous chapter, you learned about arrays, which is also known as **single dimension arrays**. These are great, and something you will use a lot while programming in C. However, if you want to store data as a tabular form, like a table with rows and columns, you need to get familiar with **multidimensional arrays**.

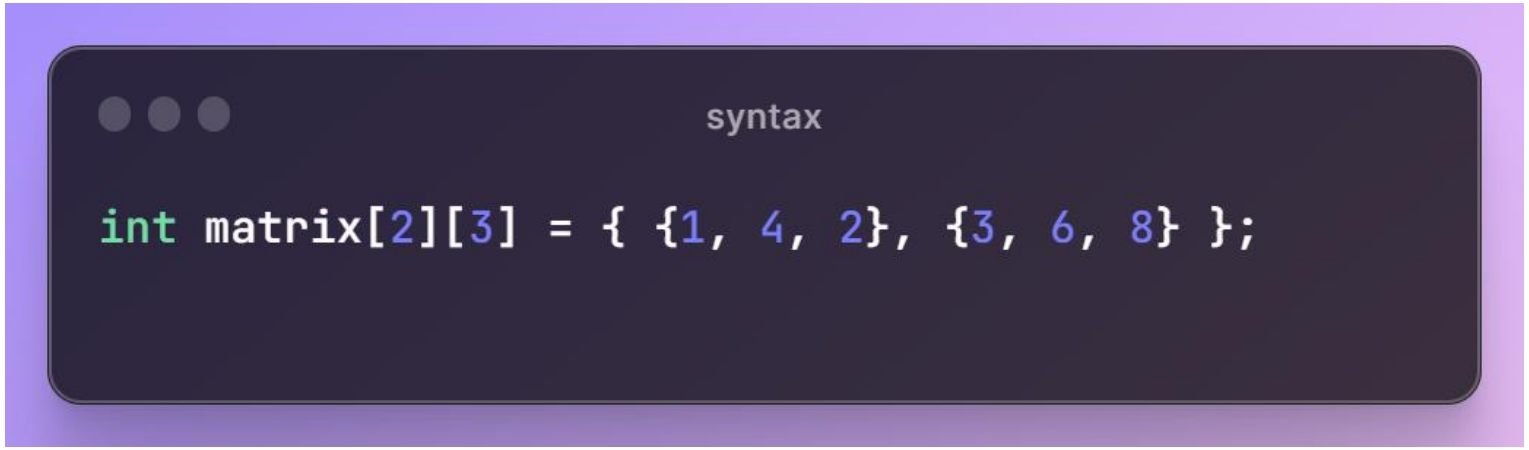
- A multidimensional array is basically an array of arrays.

- Arrays can have any number of dimensions. In this chapter, we will introduce the most common; two-dimensional arrays (2D).

INTRODUCTION TO C PROGRAMMING

C Two-Dimensional Arrays

- A 2D array is also known as a matrix (a table of rows and columns).
- To create a 2D array of integers, take a look at the following example:



INTRODUCTION TO C PROGRAMMING

C Two-Dimensional Arrays

- The first dimension represents the number of rows **[2]**, while the second dimension represents the number of columns **[3]**. The values are placed in row-order, and can be visualized like this:

	COLUMN 0	COLUMN 1	COLUMN 2
ROW 0	1	4	2
ROW 1	3	6	8

INTRODUCTION TO C PROGRAMMING

Access the Elements of a 2D Array

- To access an element of a two-dimensional array, you must specify the index number of both the row and column.

- This statement accesses the value of the element in the **first row (0)** and **third column (2)** of the **matrix** array.

Remember that: Array indexes start with 0
[0] is the first element.
[1] is the second element, etc.

syntax

```
int matrix[2][3] = { {1, 4, 2}, {3, 6, 8} };

printf("%d", matrix[0][2]);  // Outputs 2
```

INTRODUCTION TO C PROGRAMMING

Change Elements in a 2D Array

- To change the value of an element, refer to the index number of the element in each of the dimensions:

- The following example will change the value of the element in the **first row (0)** and **first column (0)**:

syntax

```
int matrix[2][3] = { {1, 4, 2}, {3, 6, 8} };
matrix[0][0] = 9;

printf("%d", matrix[0][0]);  // Now outputs 9 instead of 1
```

INTRODUCTION TO C PROGRAMMING

Loop Through a 2D Array

- To loop through a multi-dimensional array, you need one loop for each of the array's dimensions.
- The following example outputs all elements in the **matrix** array:

syntax

```
int matrix[2][3] = { {1, 4, 2}, {3, 6, 8} };

int i, j;
for (i = 0; i < 2; i++) {
  for (j = 0; j < 3; j++) {
    printf("%d\n", matrix[i][j]);
  }
}
```

INTRODUCTION TO C PROGRAMMING

C Strings

- Strings are used for storing text/characters.
- For example, "Hello World" is a string of characters.
- Unlike many other programming languages, C does not have a **String type** to easily create string variables. Instead, you must use the char type and create an array of characters to make a string in C:
- Note that you have to use double quotes ("").

INTRODUCTION TO C PROGRAMMING

C Strings

- To output the string, you can use the printf() function together with the format specifier %s to tell C that we are now working with strings:

INTRODUCTION TO C PROGRAMMING

Access Strings

- Since strings are actually arrays in C, you can access a string by referring to its index number inside square brackets [].

- This example prints the **first character (0)** in **greetings**:

Note that we have to use the %c format specifier to print a **single character**.

INTRODUCTION TO C PROGRAMMING

Modify Strings

- To change the value of a specific character in a string, refer to the index number, and use **single quotes**:

INTRODUCTION TO C PROGRAMMING

Loop Through a Strings

- You can also loop through the characters of a string, using a for loop:

syntax

```
char carName[] = "Volvo";
int i;

for (i = 0; i < 5; ++i) {
  printf("%c\n", carName[i]);
}
```

INTRODUCTION TO C PROGRAMMING

Loop Through a Strings

- And like we specified in the arrays chapter, you can also use the *size of formula* (instead of manually write the size of the array in the loop condition (i < 5)) to make the loop more sustainable:

syntax

```
char carName[] = "Volvo";
int length = sizeof(carName) / sizeof(carName[0]);
int i;

for (i = 0; i < length; ++i) {
  printf("%c\n", carName[i]);
}
```

INTRODUCTION TO C PROGRAMMING

Another Way of creating Strings

- In the examples above, we used a "string literal" to create a string variable. This is the easiest way to create a string in C.
- You should also note that you can create a string with a set of characters. This example will produce the same result as the example in the beginning of this page:

syntax

```
char greetings[] = {'H', 'e', 'l', 'l', 'o', ' ', 'W', 'o', 'r', 'l', 'd', '!', '\0'};
printf("%s", greetings);
```

Why do we include the \0 character at the end? This is known as the "null terminating character", and must be included when creating strings using this method. It tells C that this is the end of the string.

INTRODUCTION TO C PROGRAMMING

Differences

- The difference between the two ways of creating strings, is that the first method is easier to write, and you do not have to include the \0 character, as C will do it for you.
- You should note that the size of both arrays is the same: They both have **13 characters** (space also counts as a character by the way), including the \0 character:

```syntax
char greetings[] = {'H', 'e', 'l', 'l', 'o', ' ', 'W', 'o', 'r', 'l', 'd', '!', '\0'};
char greetings2[] = "Hello World!";

printf("%lu\n", sizeof(greetings));   // Outputs 13
printf("%lu\n", sizeof(greetings2));  // Outputs 13
```

INTRODUCTION TO C PROGRAMMING

Real-life Example

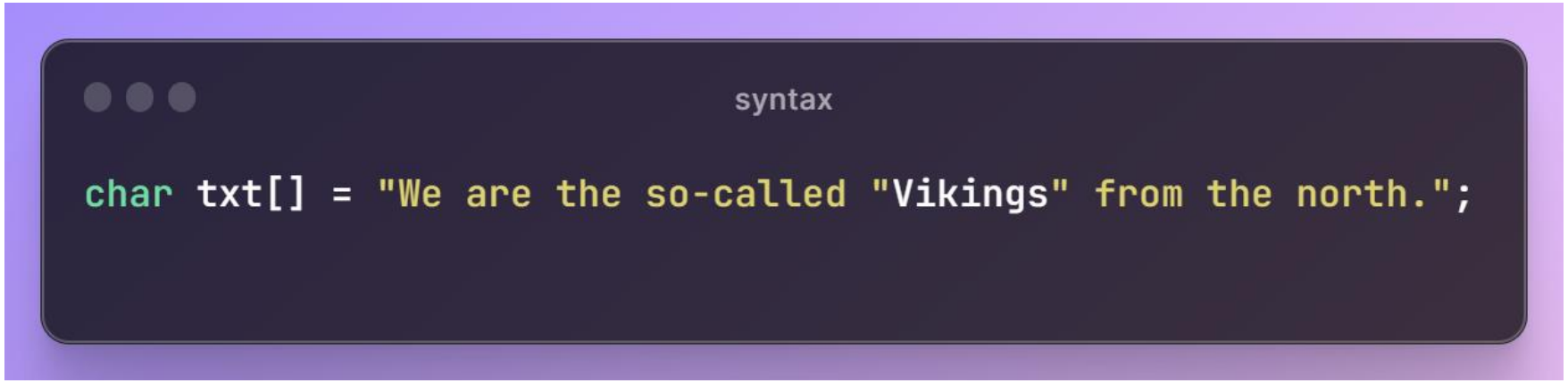
- Use strings to create a simple welcome message:

INTRODUCTION TO C PROGRAMMING

C Special Characters

Strings - Special Characters

- Because strings must be written within quotes, C will misunderstand this string, and generate an error:



- The solution to avoid this problem, is to use the **backslash escape character**.

INTRODUCTION TO C PROGRAMMING

C Special Characters

- The backslash (\) escape character turns special characters into string characters:

Escape character	Result	Description
\'	'	Single quote
\"	"	Double quote
\\	\	Backslash

- The sequence \" inserts a double quote in a string:

syntax

```
char txt[] = "We are the so-called \"Vikings\" from the north.";
```

INTRODUCTION TO C PROGRAMMING

C Special Characters

- The sequence \' inserts a single quote in a string:

```
syntax
char txt[] = "It\'s alright.";
```

- The sequence \\ inserts a single backslash in a string:

```
syntax
char txt[] = "It\'s alright.";
```

INTRODUCTION TO C PROGRAMMING

C Special Characters

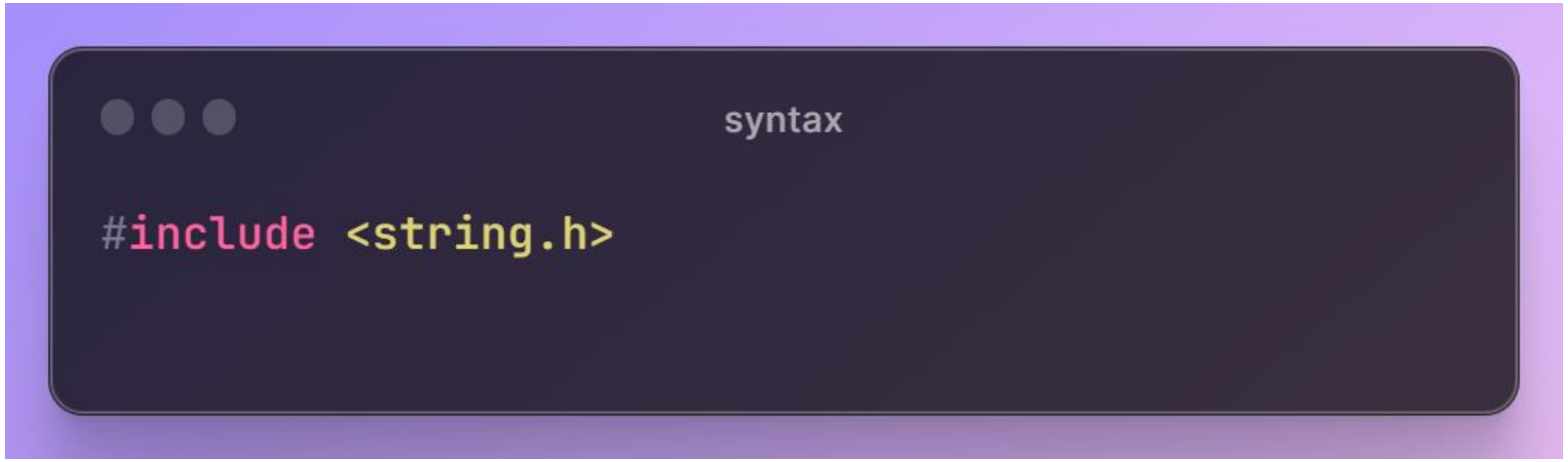
- Other popular escape characters in C are:

Escape Character	Result
\n	New Line
\t	Tab
\0	Null

INTRODUCTION TO C PROGRAMMING

C String Functions

- C also has many useful string functions, which can be used to perform certain operations on strings.
- To use them, you must include the <string.h> header file in your program:



INTRODUCTION TO C PROGRAMMING

C String Functions

String Length:

- For example, to get the length of a string, you can use the strlen() function:

INTRODUCTION TO C PROGRAMMING

C String Functions

- In the Strings chapter, we used sizeof to get the size of a string/array. Note that sizeof and strlen behaves differently, as sizeof also includes the \0 character when counting:

```
syntax

char alphabet[] = "ABCDEFGHIJKLMNOPQRSTUVWXYZ";
printf("%d", strlen(alphabet));   // 26
printf("%d", sizeof(alphabet));   // 27
```

- It is also important that you know that sizeof will always return the memory size (in bytes), and not the actual string length:

```
syntax

char alphabet[50] = "ABCDEFGHIJKLMNOPQRSTUVWXYZ";
printf("%d", strlen(alphabet));   // 26
printf("%d", sizeof(alphabet));   // 50
```

INTRODUCTION TO C PROGRAMMING

C String Functions

Concatenate Strings

- To concatenate (combine) two strings, you can use the strcat() function:

syntax

```
char str1[20] = "Hello ";
char str2[] = "World!";

// Concatenate str2 to str1 (result is stored in str1)
strcat(str1, str2);

// Print str1
printf("%s", str1);
```

- Note that the size of str1 should be large enough to store the result of the two strings combined (20 in our example).

INTRODUCTION TO C PROGRAMMING

C String Functions

Copy Strings

- To copy the value of one string to another, you can use the strcpy() function:

syntax

```
char str1[20] = "Hello World!";
char str2[20];

// Copy str1 to str2
strcpy(str2, str1);

// Print str2
printf("%s", str2);
```

Note that the size of str2 should be large enough to store the copied string (20 in our example).

INTRODUCTION TO C PROGRAMMING

C String Functions

Compare Strings:

- To compare two strings, you can use the strcmp() function.
- It returns 0 if the two strings are equal, otherwise a value that is not 0:

syntax

```
char str1[] = "Hello";
char str2[] = "Hello";
char str3[] = "Hi";

// Compare str1 and str2, and print the result
printf("%d\n", strcmp(str1, str2));  // Returns 0 (the strings are equal)

// Compare str1 and str3, and print the result
printf("%d\n", strcmp(str1, str3));  // Returns -4 (the strings are not equal)
```

INTRODUCTION TO C PROGRAMMING

C User Input

- You have already learned that printf() is used to **output values** in C.
- To get **user input**, you can use the scanf() function:

syntax

```
// Create an integer variable that will store the number we get from the user
int myNum;

// Ask the user to type a number
printf("Type a number: \n");

// Get and save the number the user types
scanf("%d", &myNum);

// Output the number the user typed
printf("Your number is: %d", myNum);
```

- The scanf() function takes two arguments: the format specifier of the variable (%d in the example above) and the reference operator (&myNum), which stores the memory address of the variable.

INTRODUCTION TO C PROGRAMMING

Multiple Input

- The scanf() function also allow multiple inputs (an integer and a character in the following example):

syntax

```
// Create an int and a char variable
int myNum;
char myChar;

// Ask the user to type a number AND a character
printf("Type a number AND a character and press enter: \n");

// Get and save the number AND character the user types
scanf("%d %c", &myNum, &myChar);

// Print the number
printf("Your number is: %d\n", myNum);

// Print the character
printf("Your character is: %c\n", myChar);
```

INTRODUCTION TO C PROGRAMMING

C User Input

- **Take String Input**
- You can also get a string entered by the user:

syntax

```
// Create a string
char firstName[30];

// Ask the user to input some text
printf("Enter your first name: \n");

// Get and save the text
scanf("%s", firstName);

// Output the text
printf("Hello %s", firstName);
```

INTRODUCTION TO C PROGRAMMING

C User Input

Note: When working with strings in scanf(), you must specify the size of the string/array (we used a very high number, 30 in our example, but atleast then we are certain it will store enough characters for the first name), and you don't have to use the reference operator (&).

- However, the scanf() function has some limitations: it considers space (whitespace, tabs, etc) as a terminating character, which means that it can only display a single word (even if you type many words). For example:

syntax

```
char fullName[30];

printf("Type your full name: \n");
scanf("%s", &fullName);

printf("Hello %s", fullName);

// Type your full name: John Doe
// Hello John
```

INTRODUCTION TO C PROGRAMMING

C User Input

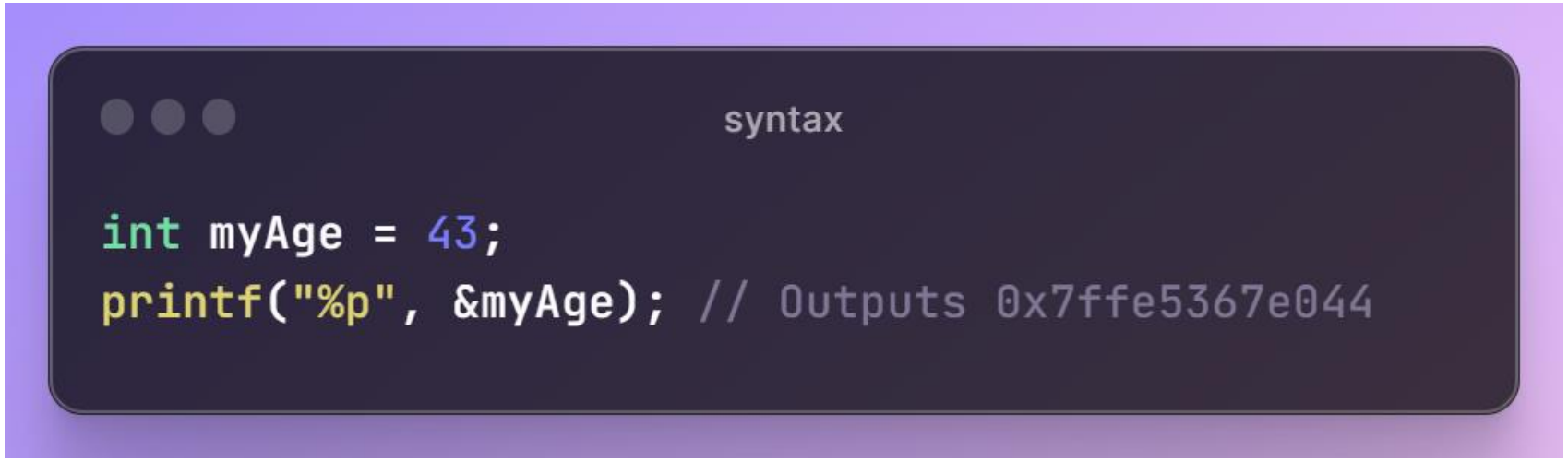
- From the example above, you would expect the program to print "John Doe", but it only prints "John".
- That's why, when working with strings, we often use the fgets() function to **read a line of text**. Note that you must include the following arguments: the name of the string variable, sizeof(*string_name*), and stdin:

- Use the scanf() function to get a single word as input, and use fgets() for multiple words.

INTRODUCTION TO C PROGRAMMING

C Memory Address

- When a variable is created in C, a memory address is assigned to the variable.
- The memory address is the location of where the variable is stored on the computer.
- When we assign a value to the variable, it is stored in this memory address.
- To access it, use the reference operator (&), and the result represents where the variable is stored:



INTRODUCTION TO C PROGRAMMING

C Memory Address

Note: The memory address is in hexadecimal form (0x..). You will probably not get the same result in your program, as this depends on where the variable is stored on your computer.

- You should also note that &myAge is often called a "pointer". A pointer basically stores the memory address of a variable as its value. To print pointer values, we use the %p format specifier.

- You will learn much more about pointers in the next chapter.

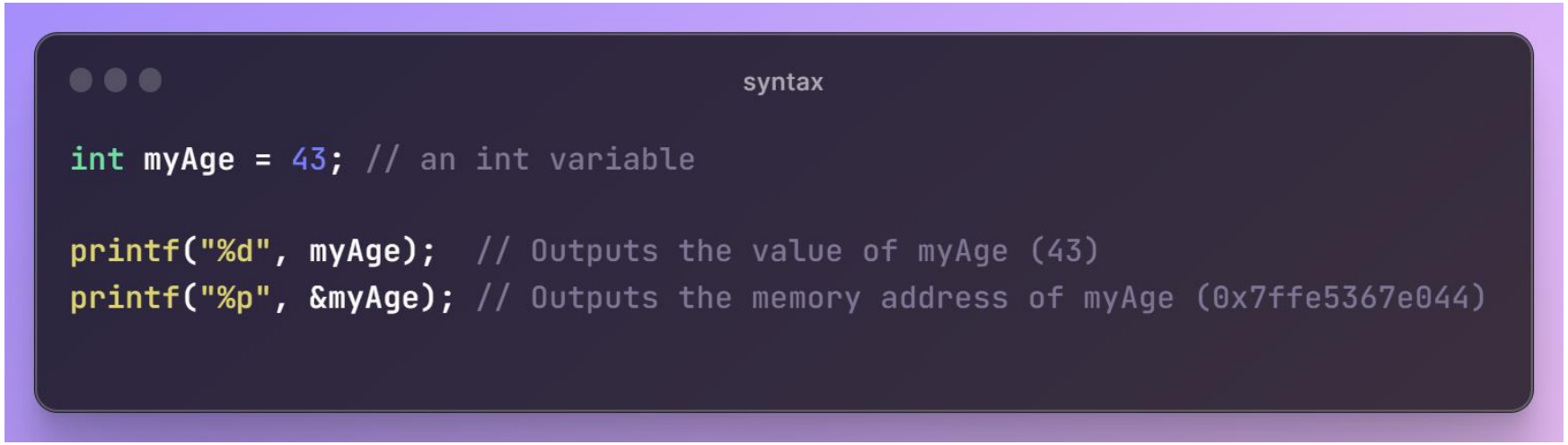
Why is it useful to know the memory address?

- **Pointers** are important in C, because they allow us to manipulate the data in the computer's memory - **this can reduce the code and improve the performance**.

INTRODUCTION TO C PROGRAMMING

Creating Pointers

- You learned from the previous chapter, that we can get the **memory address** of a variable with the reference operator &:



- A **pointer** is a variable that **stores** the **memory address** of another variable as its value.

INTRODUCTION TO C PROGRAMMING

C Pointers

- A **pointer variable points** to a **data type** (like int) of the same type, and is created with the * operator.
- The address of the variable you are working with is assigned to the pointer:

syntax

```
int myAge = 43;     // An int variable
int* ptr = &myAge;  // A pointer variable, with the name ptr, that stores the address of myAge

// Output the value of myAge (43)
printf("%d\n", myAge);

// Output the memory address of myAge (0x7ffe5367e044)
printf("%p\n", &myAge);

// Output the memory address of myAge with the pointer (0x7ffe5367e044)
printf("%p\n", ptr);
```

C Pointers

Example explained

- Create a pointer variable with the name ptr, that **points to** an int variable (myAge). Note that the type of the pointer has to match the type of the variable you're working with (int in our example).
- Use the & operator to store the memory address of the myAge variable, and assign it to the pointer.
- Now, ptr holds the value of myAge's memory address.

INTRODUCTION TO C PROGRAMMING

Dereference

- In the example above, we used the pointer variable to get the memory address of a variable (used together with the & **reference** operator).
- You can also get the value of the variable the pointer points to, by using the * operator (the **dereference** operator):

syntax

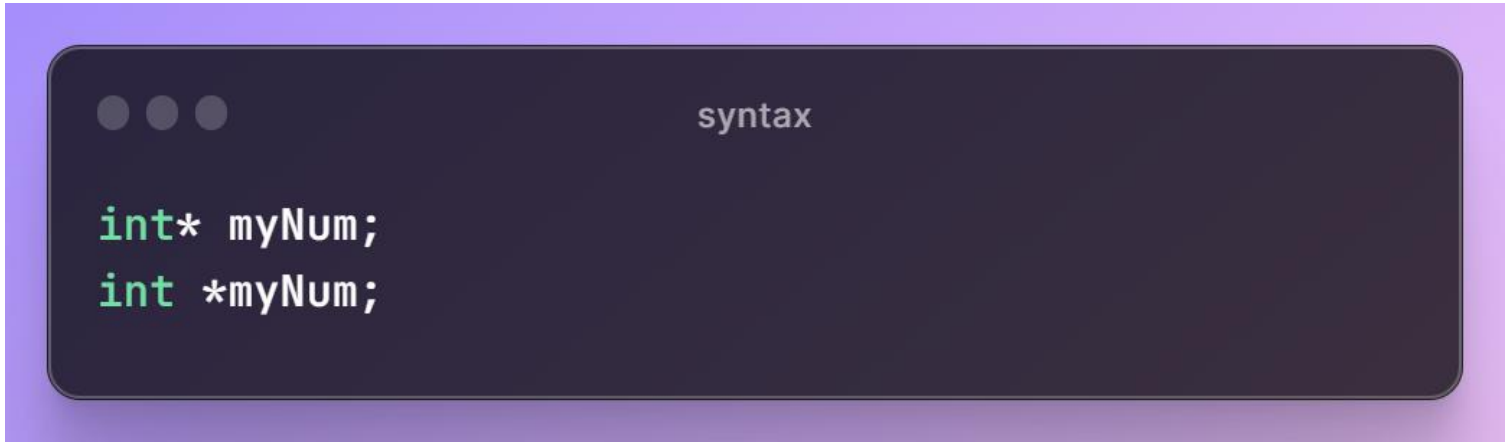
```
int myAge = 43;      // Variable declaration
int* ptr = &myAge;   // Pointer declaration

// Reference: Output the memory address of myAge with the pointer (0x7ffe5367e044)
printf("%p\n", ptr);

// Dereference: Output the value of myAge with the pointer (43)
printf("%d\n", *ptr);
```

INTRODUCTION TO C PROGRAMMING

C Pointers

- Note that the * sign can be confusing here, as it does two different things in our code:
- When used in declaration (int* ptr), it creates a **pointer variable**.
- When not used in declaration, it act as a **dereference operator**.

Good To Know: There are two ways to declare pointer variables in C:



INTRODUCTION TO C PROGRAMMING

C Pointers

Notes on Pointers

- Pointers are one of the things that make C stand out from other programming languages, like Python and Java.

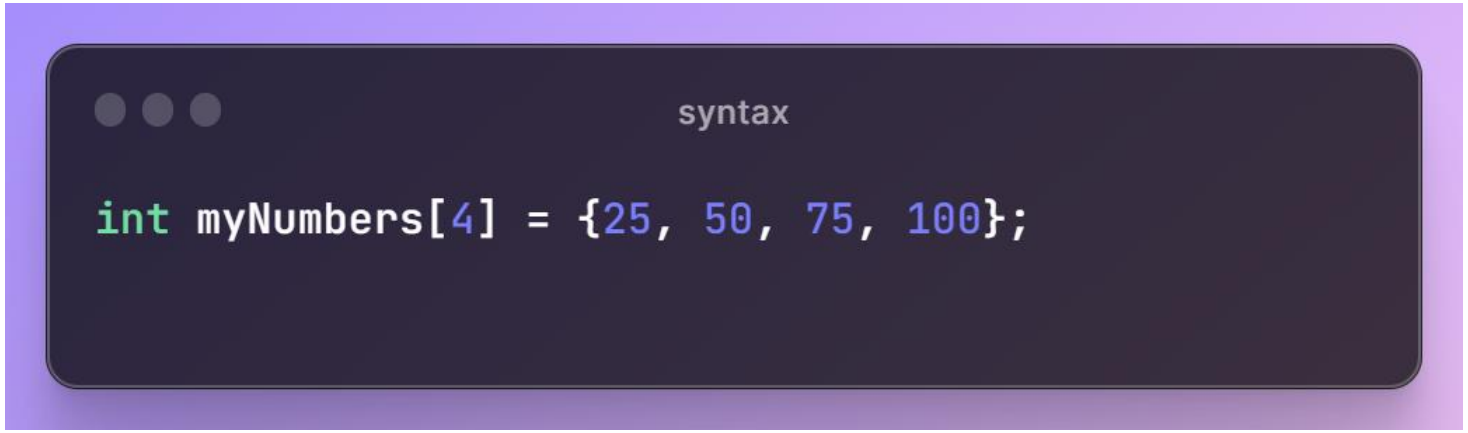
- They are important in C, because they allow us to manipulate the data in the computer's memory. This can reduce the code and improve the performance. If you are familiar with data structures like lists, trees and graphs, you should know that pointers are especially useful for implementing those. And sometimes you even have to use pointers, for example when working with files.

- **But be careful**; pointers must be handled with care, since it is possible to damage data stored in other memory addresses.

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- You can also use pointers to access arrays.
- Consider the following array of integers:



INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- You learned from the arrays chapter that you can loop through the array elements with a for loop:

syntax

```
int myNumbers[4] = {25, 50, 75, 100};
int i;

for (i = 0; i < 4; i++) {
  printf("%d\n", myNumbers[i]);
}
Result:

25
50
75
100
```

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- Instead of printing the value of each array element, let's print the memory address of each array element:

syntax

```
int myNumbers[4] = {25, 50, 75, 100};
int i;

for (i = 0; i < 4; i++) {
  printf("%p\n", &myNumbers[i]);
}
Result:

0x7ffe70f9d8f0
0x7ffe70f9d8f4
0x7ffe70f9d8f8
0x7ffe70f9d8fc
```

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- Note that the last number of each of the elements' memory address is different, with an addition of 4.
- It is because the size of an int type is typically 4 bytes, remember:

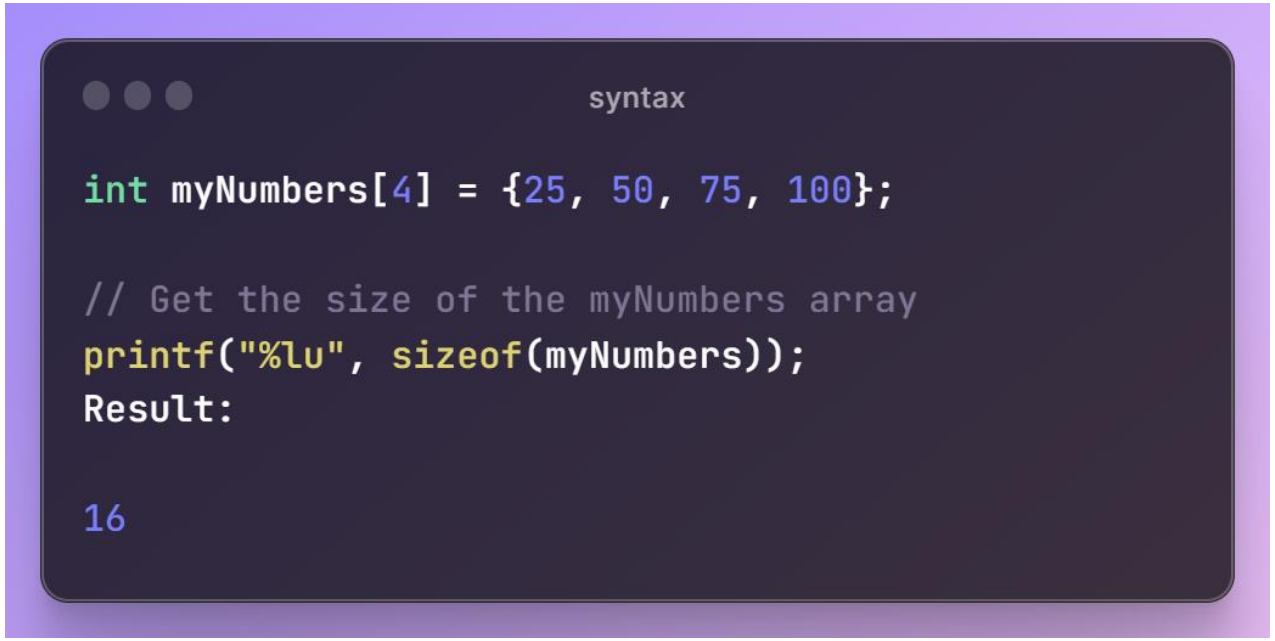
syntax

```
// Create an int variable
int myInt;

// Get the memory size of an int
printf("%lu", sizeof(myInt));
Result:

4
```

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- So from the "memory address example" above, you can see that the compiler reserves 4 bytes of memory for each array element, which means that the entire array takes up 16 bytes (4 * 4) of memory storage:



INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

How Are Pointers Related to Arrays

Ok, so what's the relationship between pointers and arrays? Well, in C, the **name of an array**, is actually a **pointer** to the **first element** of the array.
Confused? Let's try to understand this better, and use our "memory address example" above again.
The **memory address** of the **first element** is the same as the **name of the array**:

Syntax

```
int myNumbers[4] = {25, 50, 75, 100};

// Get the memory address of the myNumbers array
printf("%p\n", myNumbers);

// Get the memory address of the first array element
printf("%p\n", &myNumbers[0]);
Result:

0x7ffe70f9d8f0
0x7ffe70f9d8f0
```

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- This basically means that we can work with arrays through pointers!

- How? Since myNumbers is a pointer to the first element in myNumbers, you can use the * operator to access it:

Syntax

```
int myNumbers[4] = {25, 50, 75, 100};

// Get the value of the first element in myNumbers
printf("%d", *myNumbers);
Result:

25
```

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

- To access the rest of the elements in myNumbers, you can increment the pointer/array (+1, +2, etc):

Syntax

```
int myNumbers[4] = {25, 50, 75, 100};

// Get the value of the second element in myNumbers
printf("%d\n", *(myNumbers + 1));

// Get the value of the third element in myNumbers
printf("%d", *(myNumbers + 2));

// and so on..
Result:

50
75
```

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

Or loop through it:

Syntax

```
int myNumbers[4] = {25, 50, 75, 100};
int *ptr = myNumbers;
int i;

for (i = 0; i < 4; i++) {
  printf("%d\n", *(ptr + i));
}
Result:

25
50
75
100
```

C Pointers & Arrays

- It is also possible to change the value of array elements with pointers:
- This way of working with arrays might seem a bit excessive. Especially with simple arrays like in the examples above. However, for large arrays, it can be much more efficient to access and manipulate arrays with pointers.
- It is also considered faster and easier to access two-dimensional arrays with pointers.
- And since strings are actually arrays, you can also use pointers to access strings.
- For now, it's great that you know how this works. But like we specified in the previous chapter; **pointers must be handled with care**, since it is possible to overwrite other data stored in memory.

INTRODUCTION TO C PROGRAMMING

C Pointers & Arrays

Syntax

```
int myNumbers[4] = {25, 50, 75, 100};

// Change the value of the first element to 13
*myNumbers = 13;

// Change the value of the second element to 17
*(myNumbers +1) = 17;

// Get the value of the first element
printf("%d\n", *myNumbers);

// Get the value of the second element
printf("%d\n", *(myNumbers + 1));
Result:

13
17
```

INTRODUCTION TO C PROGRAMMING

C Functions

- A function is a block of code which only runs when it is called.
- You can pass data, known as parameters, into a function.
- Functions are used to perform certain actions, and they are important for reusing code: Define the code once, and use it many times.

INTRODUCTION TO C PROGRAMMING

Predefined Functions

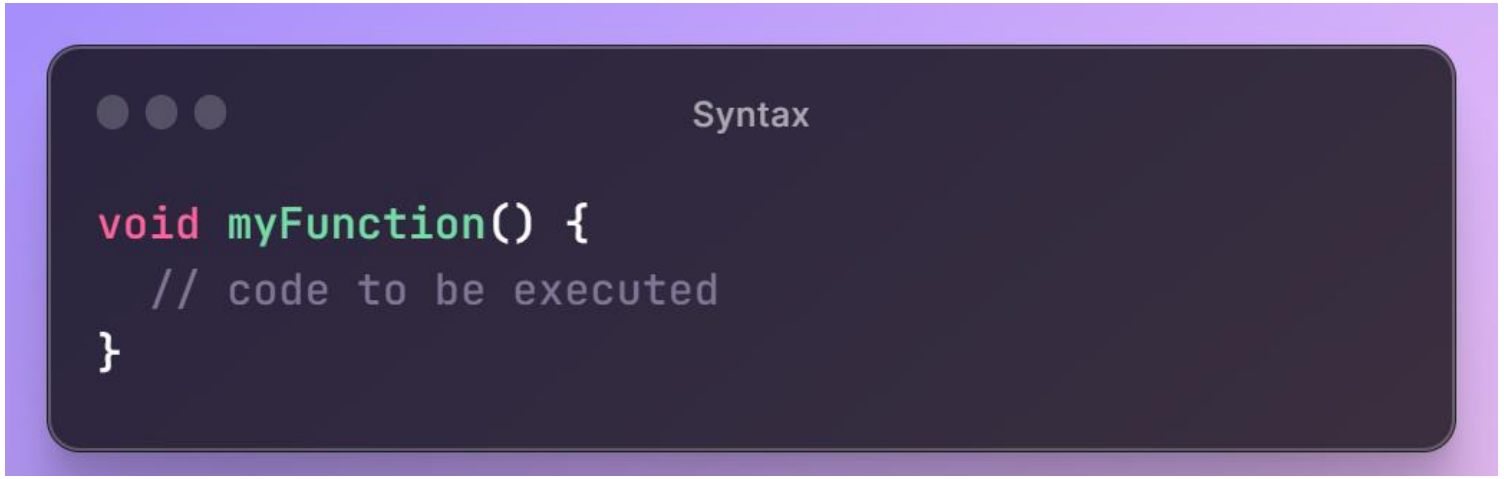
- So it turns out you already know what a function is. You have been using it the whole time while studying this tutorial!

- For example, main() is a function, which is used to execute code, and printf() is a function; used to output/print text to the screen:

INTRODUCTION TO C PROGRAMMING

Create a Function

- To create (often referred to as *declare*) your own function, specify the name of the function, followed by parentheses () and curly brackets {}:



Example Explained

- myFunction() is the name of the function
- void means that the function does not have a return value. You will learn more about return values later in the next chapter
- Inside the function (the body), add code that defines what the function should do.

INTRODUCTION TO C PROGRAMMING

Call a Function

- Declared functions are not executed immediately. They are "saved for later use", and will be executed when they are called.

Syntax

```
Inside main, call myFunction():

// Create a function
void myFunction() {
  printf("I just got executed!");
}

int main() {
  myFunction(); // call the function
  return 0;
}

// Outputs "I just got executed!"
```

INTRODUCTION TO C PROGRAMMING

Call a Function

- To call a function, write the function's name followed by two parentheses () and a semicolon ;
- In the following example, myFunction() is used to print a text (the action), when it is called:

* A function can be called multiple times:

Syntax

```
void myFunction() {
  printf("I just got executed!");
}

int main() {
  myFunction();
  myFunction();
  myFunction();
  return 0;
}

// I just got executed!
// I just got executed!
// I just got executed!
```

INTRODUCTION TO C PROGRAMMING

Parameters and Arguments

- Information can be passed to functions as a parameter. Parameters act as variables inside the function.

- Parameters are specified after the function name, inside the parentheses. You can add as many parameters as you want, just separate them with a comma:

Syntax

```
returnType functionName(parameter1, parameter2, parameter3) {
  // code to be executed
}
```

INTRODUCTION TO C PROGRAMMING

C Function Parameters

- The following function that takes a string of characters with **name** as parameter. When the function is called, we pass along a name, which is used inside the function to print "Hello" and the name of each person.

When a **parameter** is passed to the function, it is called an **argument**. So, from the example above: name is a **parameter**, while Liam, Jenny and Anja are **arguments**.

Syntax

```
void myFunction(char name[]) {
  printf("Hello %s\n", name);
}

int main() {
  myFunction("Liam");
  myFunction("Jenny");
  myFunction("Anja");
  return 0;
}

// Hello Liam
// Hello Jenny
// Hello Anja
```

INTRODUCTION TO C PROGRAMMING

Multiple Parameters

- Inside the function, you can add as many parameters as you want:

- Note that when you are working with multiple parameters, the function call must have the same number of arguments as there are parameters, and the arguments must be passed in the same order.

Syntax

```
void myFunction(char name[], int age) {
  printf("Hello %s. You are %d years old.\n", name, age);
}

int main() {
  myFunction("Liam", 3);
  myFunction("Jenny", 14);
  myFunction("Anja", 30);
  return 0;
}

// Hello Liam. You are 3 years old.
// Hello Jenny. You are 14 years old.
// Hello Anja. You are 30 years old.
```

INTRODUCTION TO C PROGRAMMING

Pass Arrays as Function Parameters

- You can also pass arrays to a function:

Syntax

```
void myFunction(int myNumbers[5]) {
  for (int i = 0; i < 5; i++) {
    printf("%d\n", myNumbers[i]);
  }
}

int main() {
  int myNumbers[5] = {10, 20, 30, 40, 50};
  myFunction(myNumbers);
  return 0;
}
```

Pass Arrays as Function Parameters

Example Explained

- The function (myFunction) takes an array as its parameter (int myNumbers[5]), and loops through the array elements with the for loop.
- When the function is called inside main(), we pass along the myNumbers array, which outputs the array elements.
- **Note** that when you call the function, you only need to use the name of the array when passing it as an argument myFunction(myNumbers). However, the full declaration of the array is needed in the function parameter (int myNumbers[5]).

INTRODUCTION TO C PROGRAMMING

Return Values

- The void keyword, used in the previous examples, indicates that the function should not return a value. If you want the function to return a value, you can use a data type (such as int or float, etc.) instead of void, and use the return keyword inside the function:

Syntax

```
int myFunction(int x) {
  return 5 + x;
}

int main() {
  printf("Result is: %d", myFunction(3));
  return 0;
}

// Outputs 8 (5 + 3)
```

INTRODUCTION TO C PROGRAMMING

Return Values

- This example returns the sum of a function with **two parameters**:

Syntax

```
int myFunction(int x, int y) {
  return x + y;
}

int main() {
  printf("Result is: %d", myFunction(5, 3));
  return 0;
}

// Outputs 8 (5 + 3)
```

- You can also store the result in a variable:

Syntax

```
int myFunction(int x, int y) {
  return x + y;
}

int main() {
  int result = myFunction(5, 3);
  printf("Result is = %d", result);
  return 0;
}
// Outputs 8 (5 + 3)
```

INTRODUCTION TO C PROGRAMMING

Real-Life Example

- To demonstrate a practical example of using functions, let's create a program that converts a value from fahrenheit to celsius:

Syntax

```c
// Function to convert Fahrenheit to Celsius
float toCelsius(float fahrenheit) {
  return (5.0 / 9.0) * (fahrenheit - 32.0);
}

int main() {
  // Set a fahrenheit value
  float f_value = 98.8;

  // Call the function with the fahrenheit value
  float result = toCelsius(f_value);

  // Print the fahrenheit value
  printf("Fahrenheit: %.2f\n", f_value);

  // Print the result
  printf("Convert Fahrenheit to Celsius: %.2f\n", result);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

C Function Declaration and Definition

- You just learned from the previous chapters that you can create and call a function in the following way:

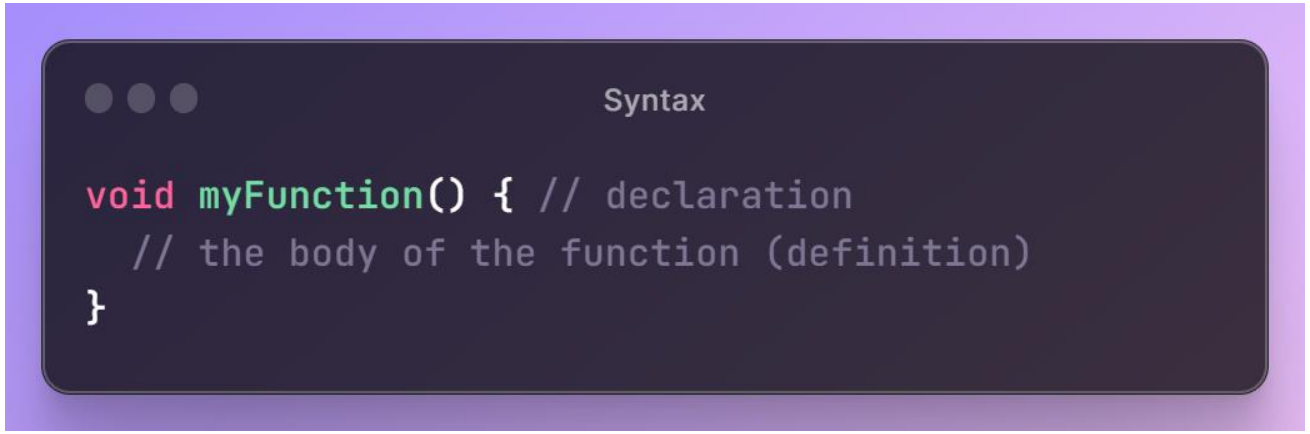
Syntax

```
// Create a function
void myFunction() {
  printf("I just got executed!");
}

int main() {
  myFunction(); // call the function
  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

C Function Declaration and Definition

- A function consist of two parts:
  - **Declaration:** the function's name, return type, and parameters (if any)
  - **Definition:** the body of the function (code to be executed)



INTRODUCTION TO C PROGRAMMING

C Function Declaration and Definition

- For code optimization, it is recommended to separate the declaration and the definition of the function.

- You will often see C programs that have function declaration above main(), and function definition below main(). This will make the code better organized and easier to read:

Syntax

```
// Function declaration
void myFunction();

// The main method
int main() {
  myFunction();  // call the function
  return 0;
}

// Function definition
void myFunction() {
  printf("I just got executed!");
}
```

INTRODUCTION TO C PROGRAMMING

C Function Declaration and Definition

Another Example

- If we use the example from the previous chapter regarding function parameters and return values:

Syntax

```
int myFunction(int x, int y) {
  return x + y;
}

int main() {
  int result = myFunction(5, 3);
  printf("Result is = %d", result);
  return 0;
}
// Outputs 8 (5 + 3)
```

INTRODUCTION TO C PROGRAMMING

C Function Declaration and Definition

- It is considered good practice to write it like this instead:

Syntax

```c
// Function declaration
int myFunction(int, int);

// The main method
int main() {
  int result = myFunction(5, 3); // call the function
  printf("Result is = %d", result);
  return 0;
}

// Function definition
int myFunction(int x, int y) {
  return x + y;
}
```

INTRODUCTION TO C PROGRAMMING

C Recursion

- Recursion is the technique of making a function call itself. This technique provides a way to break complicated problems down into simple problems which are easier to solve.

- Recursion may be a bit difficult to understand. The best way to figure out how it works is to experiment with it.

INTRODUCTION TO C PROGRAMMING

Recursion Example

- Adding two numbers together is easy to do, but adding a range of numbers is more complicated. In the following example, recursion is used to add a range of numbers together by breaking it down into the simple task of adding two numbers:

Syntax

```
int sum(int k);

int main() {
  int result = sum(10);
  printf("%d", result);
  return 0;
}

int sum(int k) {
  if (k > 0) {
    return k + sum(k - 1);
  } else {
    return 0;
  }
}
```

Recursion Example

Example Explained

- When the sum() function is called, it adds parameter k to the sum of all numbers smaller than k and returns the result. When k becomes 0, the function just returns 0. When running, the program follows these steps:

- Since the function does not call itself when k is 0, the program stops there and returns the result.

```
10 + sum(9)
10 + ( 9 + sum(8) )
10 + ( 9 + ( 8 + sum(7) ) )
...
10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 + sum(0)
10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1 + 0
```

Recursion Example

- The developer should be very careful with recursion as it can be quite easy to slip into writing a function which never terminates, or one that uses excess amounts of memory or processor power. However, when written correctly recursion can be a very efficient and mathematically-elegant approach to programming.

INTRODUCTION TO C PROGRAMMING

C Math Functions

- There is also a list of math functions available, that allows you to perform mathematical tasks on numbers.
- To use them, you must include the math.h **header file** in your program:

Syntax

```
#include <math.h>
```

Square Root

- To find the square root of a number, use the sqrt() function:

Syntax

```
printf("%f", sqrt(16));
```

INTRODUCTION TO C PROGRAMMING

C Math Functions

Round a Number

- The ceil() function rounds a number upwards to its nearest integer, and the floor() method rounds a number downwards to its nearest integer, and returns the result:

Syntax

```
printf("%f", ceil(1.4));
printf("%f", floor(1.4));
```

Power

- The pow() function returns the value of *x* to the power of *y* (x^y):

Syntax

```
printf("%f", pow(4, 3));
```

INTRODUCTION TO C PROGRAMMING

Other Math Functions

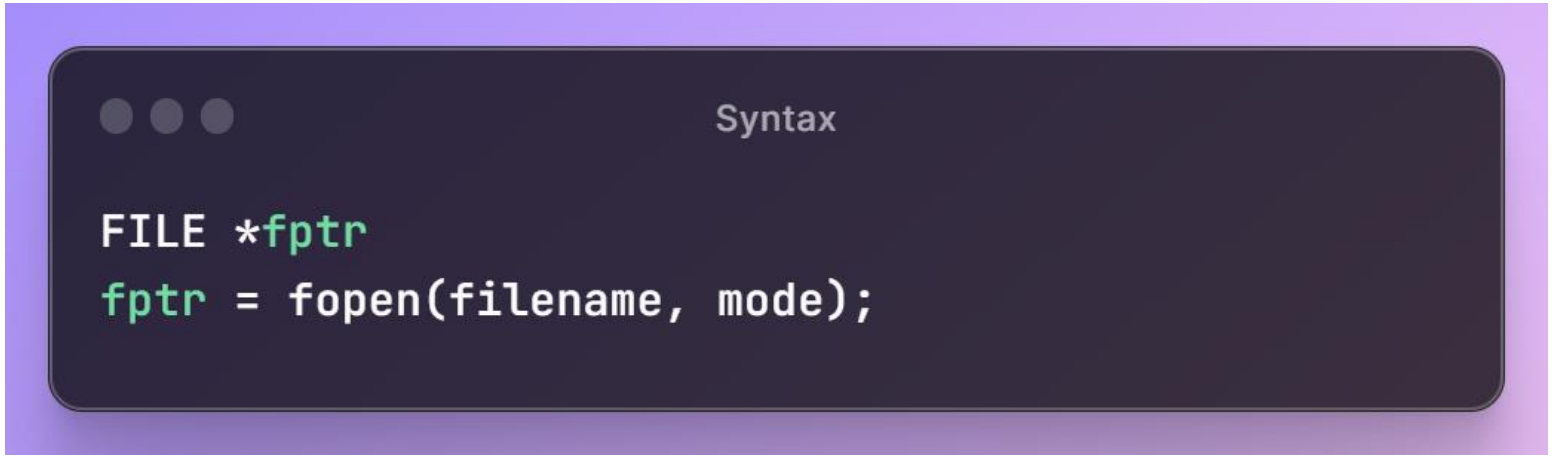
- A list of other popular math functions (from the <math.h> library) can be found in the table below:

Function	Description
abs(x)	Returns the absolute value of x
acos(x)	Returns the arccosine of x
asin(x)	Returns the arcsine of x
atan(x)	Returns the arctangent of x
cbrt(x)	Returns the cube root of x
cos(x)	Returns the cosine of x
exp(x)	Returns the value of E^x
sin(x)	Returns the sine of x (x is in radians)
tan(x)	Returns the tangent of an angle

INTRODUCTION TO C PROGRAMMING

File Handling

- In C, you can create, open, read, and write to files by declaring a pointer of type FILE, and use the fopen() function:



- FILE is basically a data type, and we need to create a pointer variable to work with it (fptr). For now, this line is not important. It's just something you need when working with files.

INTRODUCTION TO C PROGRAMMING

C Files

- To actually open a file, use the fopen() function, which takes two parameters:

Parameter	Description
filename	The name of the actual file you want to open (or create), like `filename.txt`
mode	A single character, which represents what you want to do with the file (read, write or append): `w` - Writes to a file `a` - Appends new data to a file `r` - Reads from a file

INTRODUCTION TO C PROGRAMMING

Create a Files

- To create a file, you can use the w mode inside the fopen() function.
- The w mode is used to write to a file. **However**, if the file does not exist, it will create one for you:

Note: The file is created in the same directory as your other C files, if nothing else is specified.

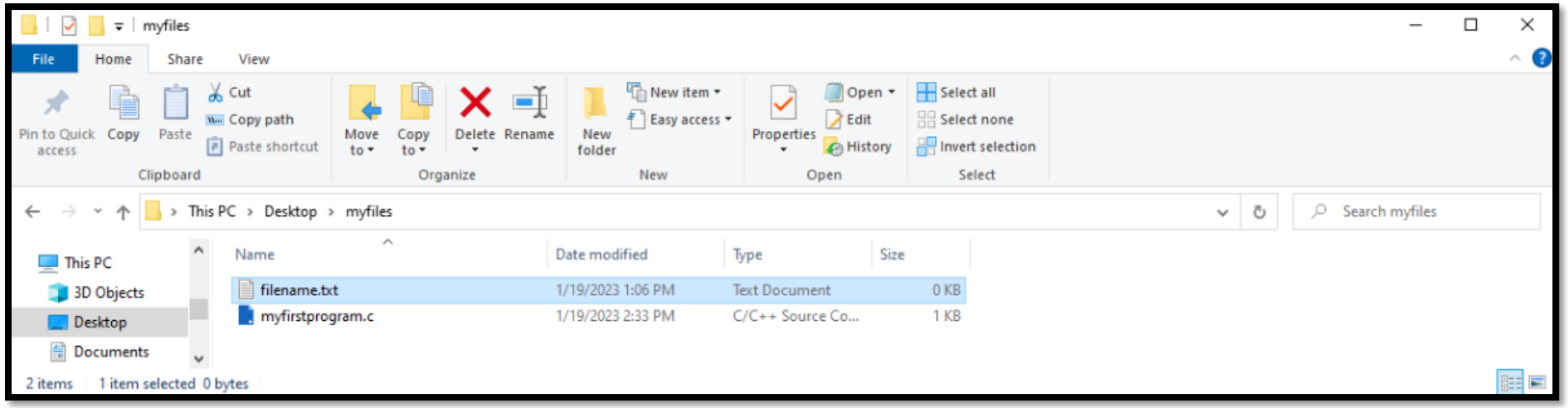
Syntax

```
FILE *fptr;

// Create a file
fptr = fopen("filename.txt", "w");

// Close the file
fclose(fptr);
```

INTRODUCTION TO C PROGRAMMING

Create a Files

- On our computer, it looks like this:



Tip: If you want to create the file in a specific folder, just provide an absolute path:

Syntax

```
fptr = fopen("C:\directoryname\filename.txt", "w");
```

INTRODUCTION TO C PROGRAMMING

C Write to Files

- Let's use the w mode from the previous chapter again, and write something to the file we just created.

- The w mode means that the file is opened for **writing**. To insert content to it, you can use the fprintf() function and add the pointer variable (fptr in our example) and some text:

Syntax

```
FILE *fptr;

// Open a file in writing mode
fptr = fopen("filename.txt", "w");

// Write some text to the file
fprintf(fptr, "Some text");

// Close the file
fclose(fptr);
```

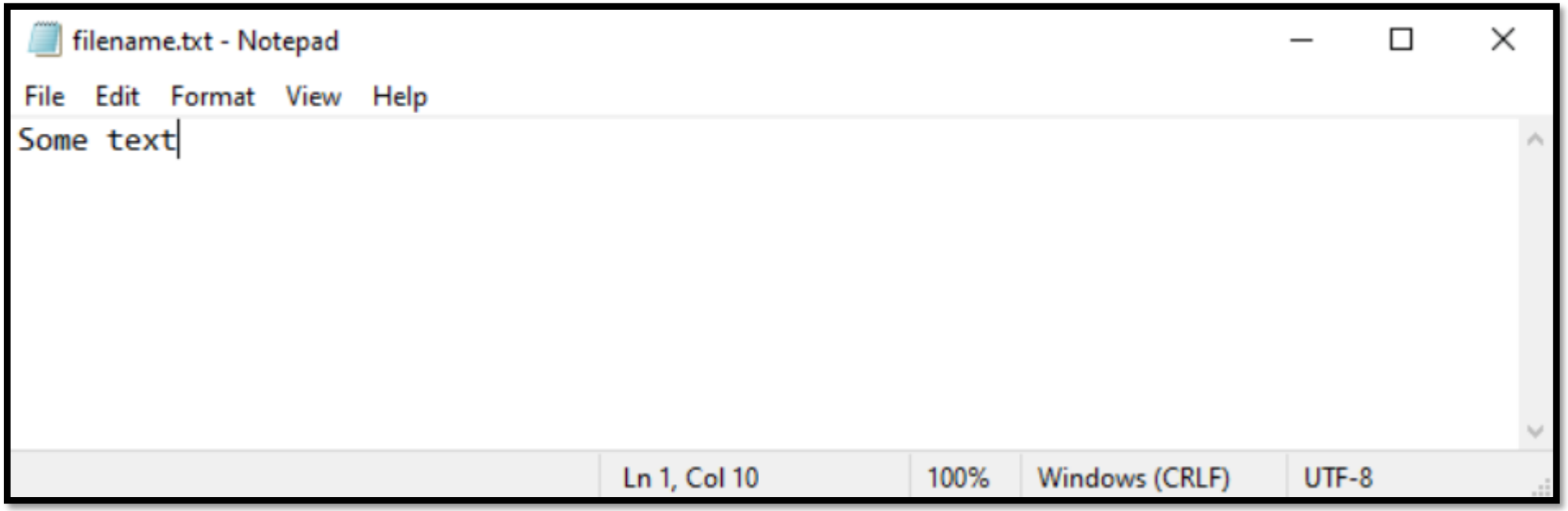
Closing the Files

- Did you notice the fclose() function in our example above?
- This will close the file when we are done with it.
- It is considered as good practice, because it makes sure that:
  - Changes are saved properly
  - Other programs can use the file (if you want)
  - Clean up unnecessary memory space

INTRODUCTION TO C PROGRAMMING

C Write to Files

- As a result, when we open the file on our computer, it looks like this:



INTRODUCTION TO C PROGRAMMING

C Write to Files

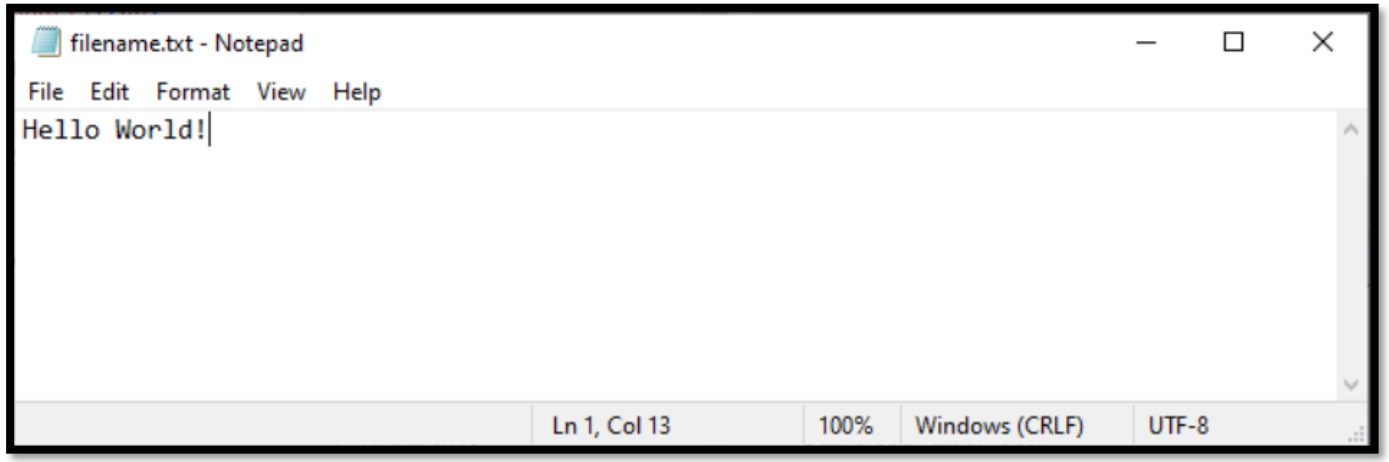
- **Note:** If you write to a file that already exists, the old content is deleted, and the new content is inserted. This is important to know, as you might accidentally erase existing content.

Syntax

```
fprintf(fptr, "Hello World!");
```

For example:

- As a result, when we open the file on our computer, it says "Hello World!" instead of "Some text":



INTRODUCTION TO C PROGRAMMING

Append Content to a Files

- If you want to add content to a file without deleting the old content, you can use the a mode.
- The a mode appends content at the end of the file:

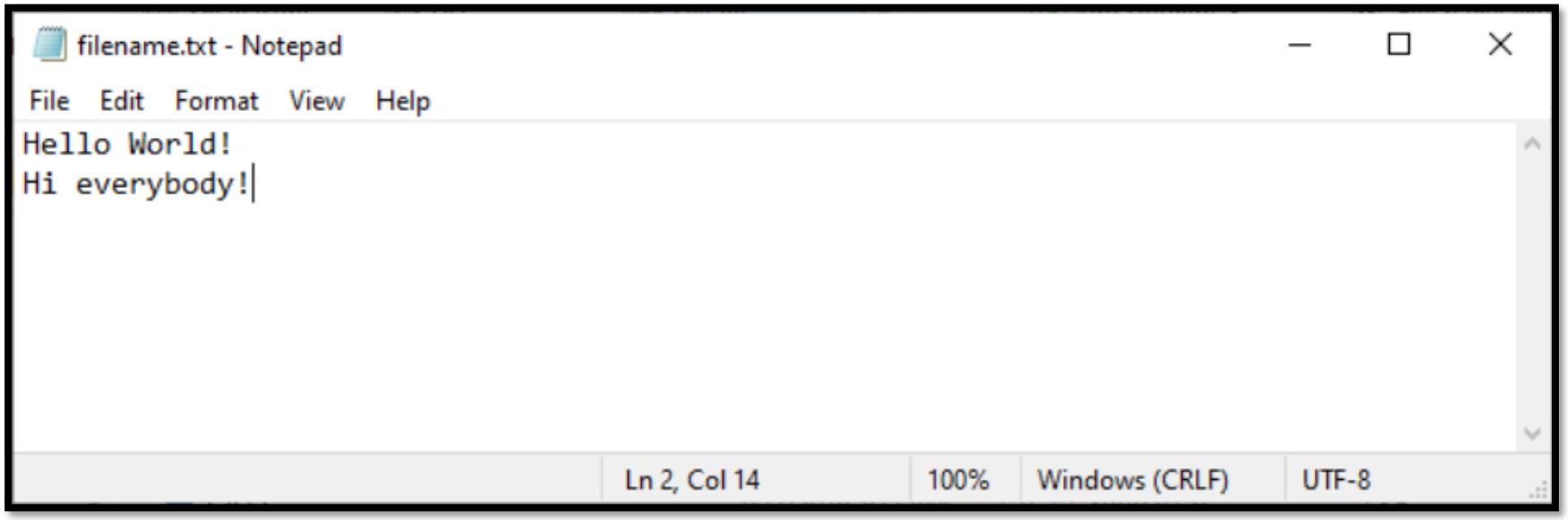
Syntax

```
FILE *fptr;

// Open a file in append mode
fptr = fopen("filename.txt", "a");

// Append some text to the file
fprintf(fptr, "\nHi everybody!");

// Close the file
fclose(fptr);
```

INTRODUCTION TO C PROGRAMMING

Append Content to a Files

- As a result, when we open the file on our computer, it looks like this:



Note: Just like with the w mode; if the file does not exist, the a mode will create a new file with the "appended" content.

INTRODUCTION TO C PROGRAMMING

C Read Files

- In the previous chapter, we wrote to a file using w and a modes inside the fopen() function.
- To **read** from a file, you can use the r mode:
- This will make the filename.txt open for reading.
- It requires a little bit of work to read a file in C. Hang in there! We will guide you step-by-step.

Syntax

```
FILE *fptr;

// Open a file in read mode
fptr = fopen("filename.txt", "r");
```

INTRODUCTION TO C PROGRAMMING

C Read Files

- Next, we need to create a string that should be big enough to store the content of the file.
- For example, let's create a string that can store up to 100 characters:

Syntax

```
FILE *fptr;

// Open a file in read mode
fptr = fopen("filename.txt", "r");

// Store the content of the file
char myString[100];
```

INTRODUCTION TO C PROGRAMMING

C Read Files

- In order to read the content of filename.txt, we can use the fgets() function.

1. The first parameter specifies where to store the file content, which will be in the myString array we just created.

2. The second parameter specifies the maximum size of data to read, which should match the size of myString (100).

3. The third parameter requires a file pointer that is used to read the file (fptr in our example).

Syntax

```
fgets(myString, 100, fptr);
```

INTRODUCTION TO C PROGRAMMING

C Read Files

- Now, we can print the string, which will output the content of the file:

Note: The fgets function only reads the first line of the file. If you remember, there were two lines of text in filename.txt.

Syntax

```
FILE *fptr;

// Open a file in read mode
fptr = fopen("filename.txt", "r");

// Store the content of the file
char myString[100];

// Read the content and store it inside myString
fgets(myString, 100, fptr);

// Print the file content
printf("%s", myString);

// Close the file
fclose(fptr);
```

INTRODUCTION TO C PROGRAMMING

C Read Files

- To read every line of the file, you can use a while loop:

Syntax

```
FILE *fptr;

// Open a file in read mode
fptr = fopen("filename.txt", "r");

// Store the content of the file
char myString[100];

// Read the content and print it
while(fgets(myString, 100, fptr)) {
  printf("%s", myString);
}

// Close the file
fclose(fptr);
Hello World!
Hi everybody!
```

INTRODUCTION TO C PROGRAMMING

Good Practice

- If you try to open a file for reading that does not exist, the fopen() function will return NULL.
- **Tip:** As a good practice, we can use an if statement to test for NULL, and print some text instead (when the file does not exist):

- If the file does not exist, the following text is printed:

```
Not able to open the file.
```

Syntax

```
FILE *fptr;

// Open a file in read mode
fptr = fopen("loremipsum.txt", "r");

// Print some text if the file does not exist
if(fptr == NULL) {
  printf("Not able to open the file.");
}

// Close the file
fclose(fptr);
```

INTRODUCTION TO C PROGRAMMING

Good Practice

- With this in mind, we can create a more sustainable code if we use our "read a file" example above again:

Syntax

If the file exist, read the content and print it. If the file does not exist, print a message:

```
FILE *fptr;

// Open a file in read mode
fptr = fopen("filename.txt", "r");

// Store the content of the file
char myString[100];

// If the file exist
if(fptr != NULL) {

  // Read the content and print it
  while(fgets(myString, 100, fptr)) {
    printf("%s", myString);
  }

// If the file does not exist
} else {
  printf("Not able to open the file.");
}

// Close the file
fclose(fptr);
Hello World!
Hi everybody!
```

INTRODUCTION TO C PROGRAMMING

C Structures (structs)

- Structures (also called structs) are a way to group several related variables into one place. Each variable in the structure is known as a **member** of the structure.

- Unlike an array, a structure can contain many different data types (int, float, char, etc.).

INTRODUCTION TO C PROGRAMMING

Create a Structures (structs)

- You can create a structure by using the struct keyword and declare each of its members inside curly braces:

Syntax

```
struct MyStructure {   // Structure declaration
  int myNum;           // Member (int variable)
  char myLetter;       // Member (char variable)
}; // End the structure with a semicolon
```

- To access the structure, you must create a variable of it.

INTRODUCTION TO C PROGRAMMING

C Structures (structs)

- Use the struct keyword inside the main() method, followed by the name of the structure and then the name of the structure variable:

Syntax

```
Create a struct variable with the name "s1":

struct myStructure {
  int myNum;
  char myLetter;
};

int main() {
  struct myStructure s1;
  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Access Structure Member

- To access members of a structure, use the dot syntax (.):

Syntax

```
// Create a structure called myStructure
struct myStructure {
  int myNum;
  char myLetter;
};

int main() {
  // Create a structure variable of myStructure called s1
  struct myStructure s1;

  // Assign values to members of s1
  s1.myNum = 13;
  s1.myLetter = 'B';

  // Print values
  printf("My number: %d\n", s1.myNum);
  printf("My letter: %c\n", s1.myLetter);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Access Structure Member

- Now you can easily create multiple structure variables with different values, using just one structure:

Syntax

```
// Create different struct variables
struct myStructure s1;
struct myStructure s2;

// Assign values to different struct variables
s1.myNum = 13;
s1.myLetter = 'B';

s2.myNum = 20;
s2.myLetter = 'C';
```

INTRODUCTION TO C PROGRAMMING

What About Strings in Structures?

- Remember that strings in C are actually an array of characters, and unfortunately, you can't assign a value to an array like this:

- An error will occur:

```
prog.c:12:15: error: assignment to expression with array type
```

Syntax

```c
struct myStructure {
  int myNum;
  char myLetter;
  char myString[30];  // String
};

int main() {
  struct myStructure s1;

  // Trying to assign a value to the string
  s1.myString = "Some text";

  // Trying to print the value
  printf("My string: %s", s1.myString);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Access Structure Member

- However, there is a solution for this! You can use the strcpy() function and assign the value to s1.myString, like this:

Result:

```
My string: Some text
```

Syntax

```c
struct myStructure {
  int myNum;
  char myLetter;
  char myString[30]; // String
};

int main() {
  struct myStructure s1;

  // Assign a value to the string using the strcpy function
  strcpy(s1.myString, "Some text");

  // Print the value
  printf("My string: %s", s1.myString);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Simpler Syntax

- You can also assign values to members of a structure variable at declaration time, in a single line.
- Just insert the values in a comma-separated list inside curly braces {}. Note that you don't have to use the strcpy() function for string values with this technique:

Note: The order of the inserted values must match the order of the variable types declared in the structure (13 for int, 'B' for char, etc).

Syntax

```
// Create a structure
struct myStructure {
  int myNum;
  char myLetter;
  char myString[30];
};

int main() {
  // Create a structure variable and assign values to it
  struct myStructure s1 = {13, 'B', "Some text"};

  // Print values
  printf("%d %c %s", s1.myNum, s1.myLetter, s1.myString);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Copy Structures

- You can also assign one structure to another.
- In the following example, the values of s1 are copied to s2:

Syntax

```
struct myStructure s1 = {13, 'B', "Some text"};
struct myStructure s2;

s2 = s1;
```

INTRODUCTION TO C PROGRAMMING

Modify Values

- If you want to change/modify a value, you can use the dot syntax (.).
- And to modify a string value, the strcpy() function is useful again:

Syntax

```
struct myStructure {
  int myNum;
  char myLetter;
  char myString[30];
};

int main() {
  // Create a structure variable and assign values to it
  struct myStructure s1 = {13, 'B', "Some text"};

  // Modify values
  s1.myNum = 30;
  s1.myLetter = 'C';
  strcpy(s1.myString, "Something else");

  // Print values
  printf("%d %c %s", s1.myNum, s1.myLetter, s1.myString);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Modify Values

- Modifying values are especially useful when you copy structure values:

Syntax

```
// Create a structure variable and assign values to it
struct myStructure s1 = {13, 'B', "Some text"};

// Create another structure variable
struct myStructure s2;

// Copy s1 values to s2
s2 = s1;

// Change s2 values
s2.myNum = 30;
s2.myLetter = 'C';
strcpy(s2.myString, "Something else");

// Print values
printf("%d %c %s\n", s1.myNum, s1.myLetter, s1.myString);
printf("%d %c %s\n", s2.myNum, s2.myLetter, s2.myString);
```

INTRODUCTION TO C PROGRAMMING

Real-life Example

- Use a structure to store different information about Cars:

Syntax

```c
struct Car {
  char brand[50];
  char model[50];
  int year;
};

int main() {
  struct Car car1 = {"BMW", "X5", 1999};
  struct Car car2 = {"Ford", "Mustang", 1969};
  struct Car car3 = {"Toyota", "Corolla", 2011};

  printf("%s %s %d\n", car1.brand, car1.model, car1.year);
  printf("%s %s %d\n", car2.brand, car2.model, car2.year);
  printf("%s %s %d\n", car3.brand, car3.model, car3.year);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

C Enumeration (enum)

- An **enum** is a special type that represents a group of constants (unchangeable values).
- To create an enum, use the enum keyword, followed by the name of the enum, and separate the enum items with a comma:

Syntax

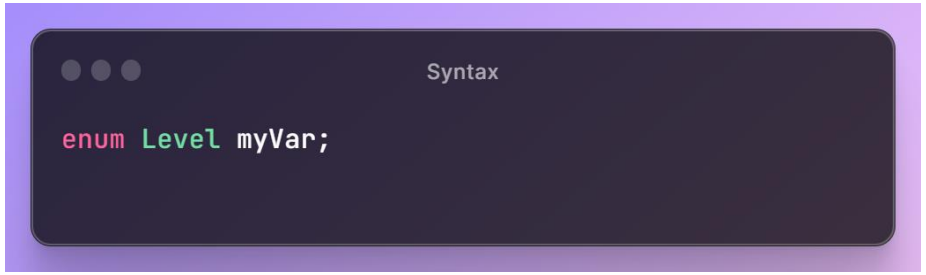
```
enum Level {
  LOW,
  MEDIUM,
  HIGH
};
```

- Note that the last item does not need a comma.
- It is not required to use uppercase, but often considered as good practice.
- Enum is short for "enumerations", which means "specifically listed".

INTRODUCTION TO C PROGRAMMING

C Enumeration (enum)

- To access the enum, you must create a variable of it.
- Inside the main() method, specify the enum keyword, followed by the name of the enum (Level) and then the name of the enum variable (myVar in this example):



- Now that you have created an enum variable (myVar), you can assign a value to it.
- The assigned value must be one of the items inside the enum (LOW, MEDIUM or HIGH):

INTRODUCTION TO C PROGRAMMING

C Enumeration (enum)

- By default, the first item (LOW) has the value 0, the second (MEDIUM) has the value 1, etc.
- If you now try to print myVar, it will output 1, which represents MEDIUM:

Syntax

```
int main() {
  // Create an enum variable and assign a value to it
  enum Level myVar = MEDIUM;

  // Print the enum variable
  printf("%d", myVar);

  return 0;
}
```

INTRODUCTION TO C PROGRAMMING

Change Value

- As you know, the first item of an enum has the value 0. The second has the value 1, and so on.
- To make more sense of the values, you can easily change them:

```
syntax
enum Level {
  LOW = 25,
  MEDIUM = 50,
  HIGH = 75
};

printf("%d", myVar); // Now outputs 50
```

- Note that if you assign a value to one specific item, the next items will update their numbers accordingly:

```
syntax
enum Level {
  LOW = 5,
  MEDIUM, // Now 6
  HIGH // Now 7
};
```

INTRODUCTION TO C PROGRAMMING

Enum in a Switch Statement

- Enums are often used in switch statements to check for corresponding values:

syntax

```
enum Level {
  LOW = 1,
  MEDIUM,
  HIGH
};

int main() {
  enum Level myVar = MEDIUM;

  switch (myVar) {
    case 1:
      printf("Low Level");
      break;
    case 2:
      printf("Medium level");
      break;
    case 3:
      printf("High level");
      break;
  }
  return 0;
}
```

Enum in a Switch Statement

Why And When To Use Enums?

- Enums are used to give names to constants, which makes the code easier to read and maintain.
- Use enums when you have values that you know aren't going to change, like month days, days, colors, deck of cards, etc.