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C++

1. Triple X Game Design Doc

Triple X Game Design Doc (GDD)

- Simple number puzzle game
- Hacking into a computer lock
- Need to find a valid combination of codes
- Starts pretty easy, becomes much harder
- Wrap in your own story.

Why Triple-X Game?

- Learn basics of C++ “syntax”
- Learn about variables and constants
- Create your own function with an argument
- Use `#include` ready for Unreal
- Learn the `if` and `while` structures

Why Learn C++ Programming?

- All roads lead to C++ in game development
- You'll be learning a superpower
- It's both high-level, and low-level
- Join a unique tribe of power users
- It's fun and challenging

What’s Your Story

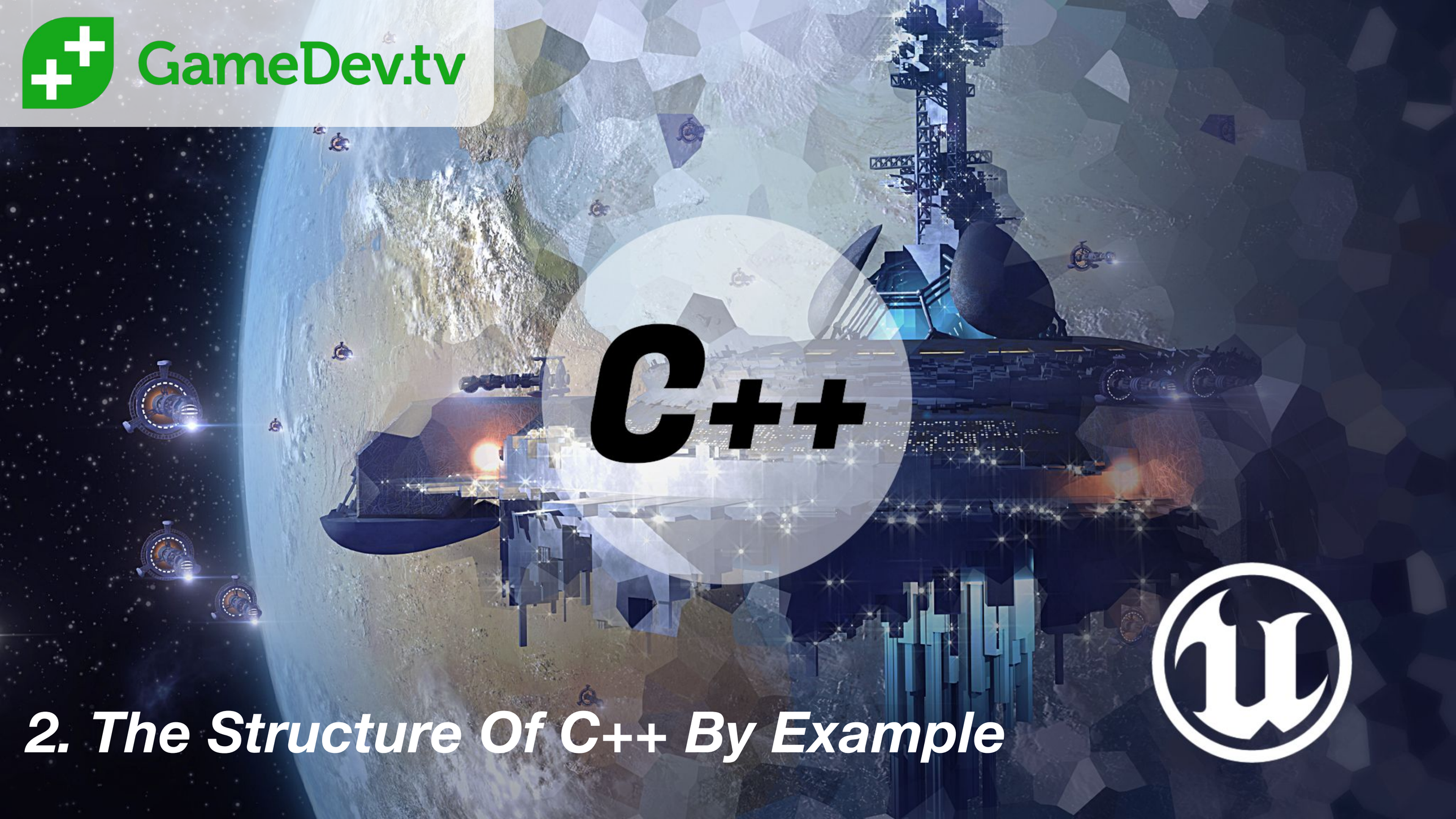
- Try and think of a unique story
- If you’re stuck, ask a kid!
- Enjoy sharing

the structure of c++ by example

- `#include` statements at top, before used
- `PlayGameAtDifficulty()` before used
- Everything inside a function indented
- `while` and `if` statements extra indented
- Colours differentiate types of text.

Explain Our `main()` Function

- Explain our main() function best you can
- Don’t worry how much / little you know
- The purpose is twofold
- Firstly: to be brave, it counts for a lot
- Secondly: to record your starting point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2. The Structure Of C++ By Example

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

Why int main()?

- Every C++ program requires int main()
- It is the entry point of a c++ program
- Without it, your program will not build!

White Space

- Compiler ignores white space!
- Don’t be reckless with your code!
- Make the effort to make it beautiful!

Your first program!

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

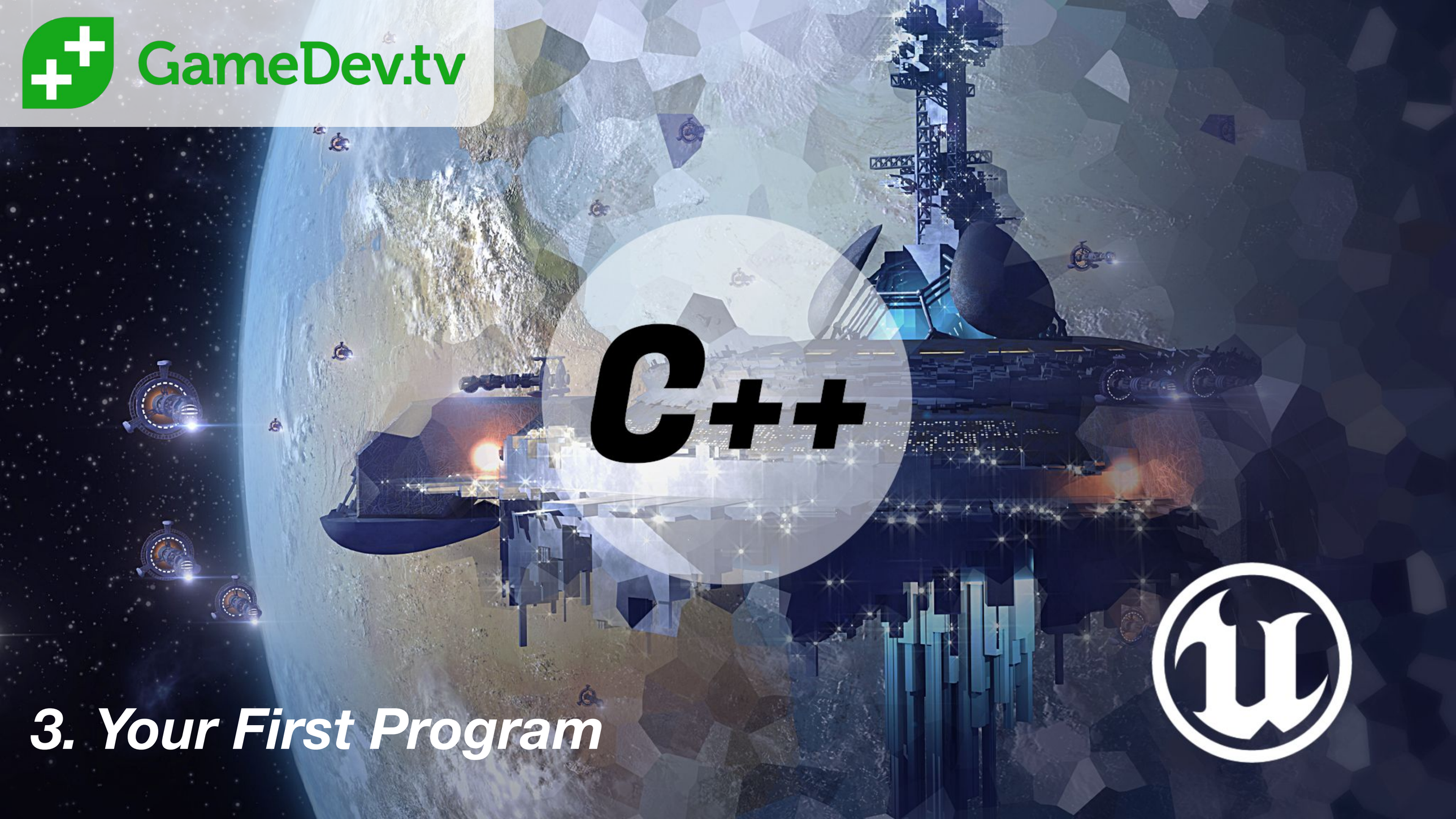
- It runs and then exits immediately!

White Space

- Write your program onto one line
- Try compiling
- Does it compile?

int main() & White Space

- int main() required in every c++ program
- Without int main() a c++ program will not run!
- We return 0 to signal program has run successfully
- Compiler ignores white space
- Code style improves readibility!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3. Your First Program

Preprocessor Directive

(Don’t be afraid!)

- Instruction to the compiler
- Used to include a library before compiling
- We want it to be at the start of our file
- # represents preprocessor directive in our code

#include <iostream>

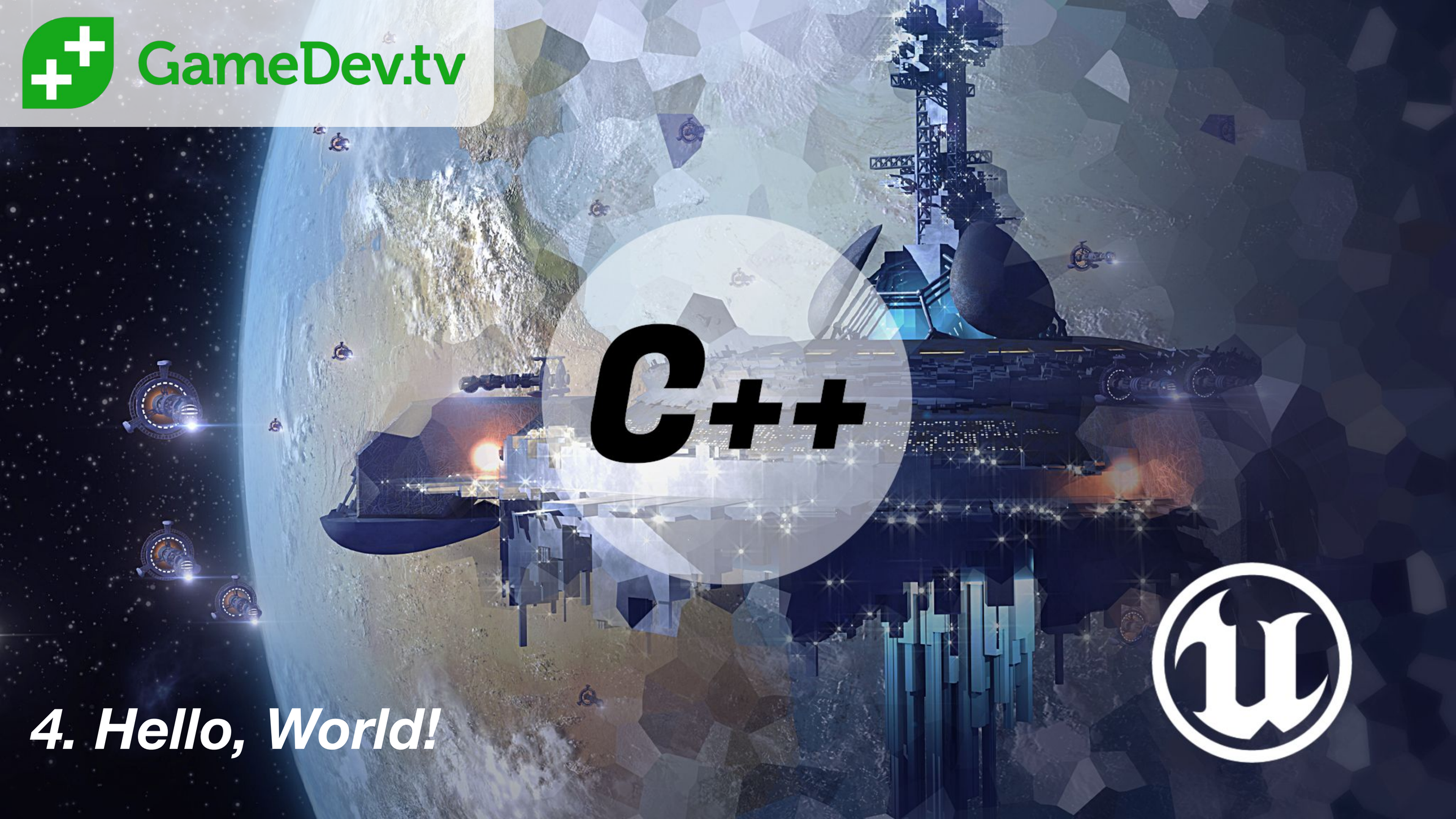
Preprocessor Directive

Header File

- Instructing the compiler to copy the contents of the iostream header file into our code before the rest of our code is compiled

Include the header file!

- Add: #include <iostream> to the first line of your file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4. Hello, World!

```
std :: cout << "Hello, World!";
```

Namespace

Scope Operator

Cout defined in std namespace

String

John Doe

John Roe

We can tell the difference in the name!

namespace::myfunction

namespace2::myfunction

Same name!

Namespace avoids the conflict of code being the same name!

TripleX Intro

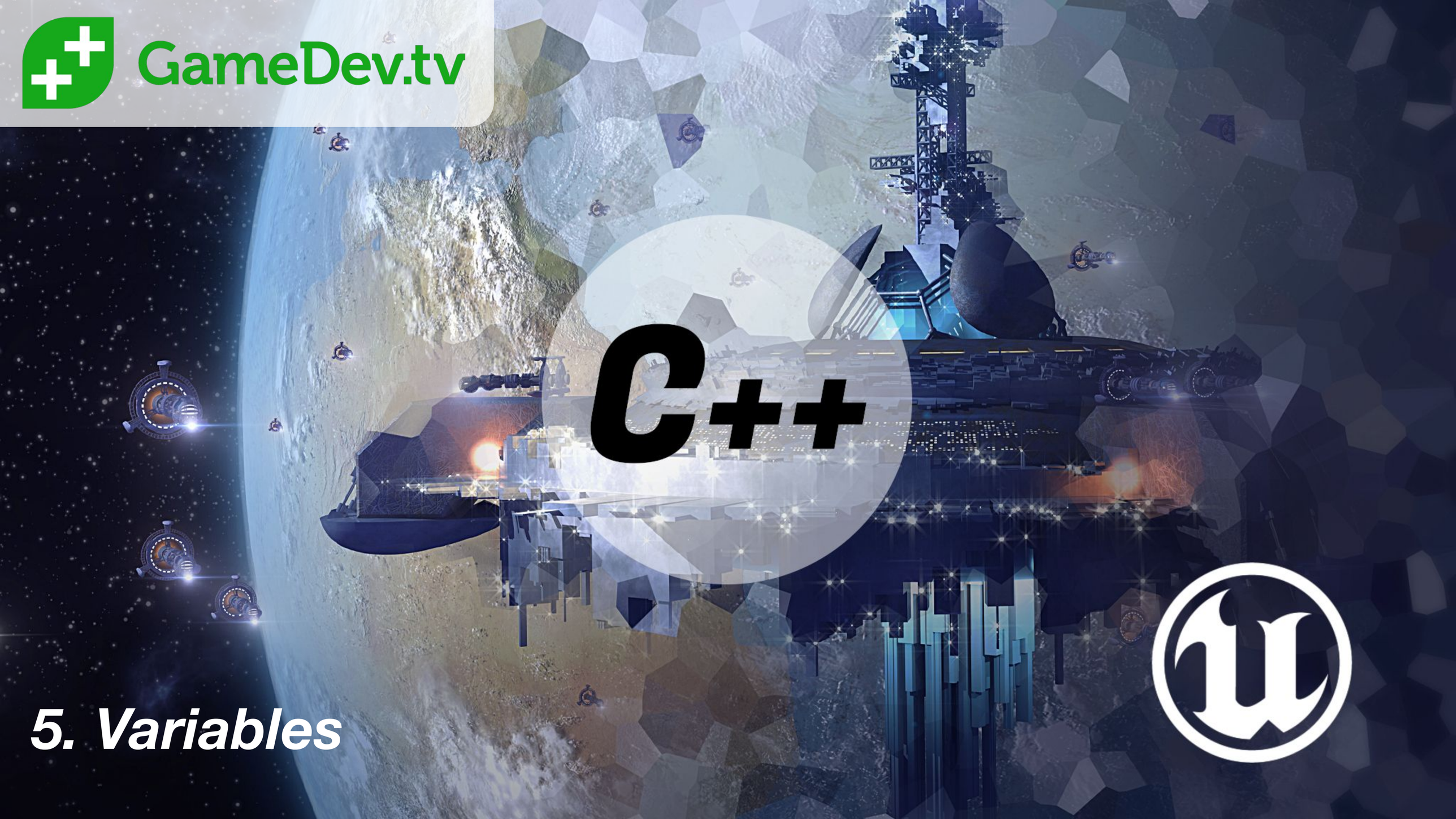
```
std::cout << "You are a secret agent breaking into a secure server room";

std::cout << "You need to enter the correct codes to continue...";
```

- Create your own intro messages for your game across two lines of code
- Save, Compile & Run program!

Hello World!

- # represents a preprocessor directive
- <iostream> is a header file
- cout is defined in std namespace
- “Strings are wrapped in quotation marks”
- std::cout << std::endl; for new line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5. Variables

Variables

- Used to store data
- To use variables in c++ you first must declare them in your code
- By declaring a variable you are reserving space in the computer's memory for it

Variable Declaration

```
int a = 0;
```

Data Type

Variable Name

By giving a value to a variable when it is declared, you are initializing it!

Variable Declaration

```
int a = 0;
```

← Initialized

```
int a;
```

← Uninitialized

Print your the value of your variable

- Print your variable onto a new line

TripleX Codes

```
You're a secret agent breaking into LEVEL 2 server room
Your SuperHacker 2000 tells you the following information...

+ There are three numbers in the code
+ The codes multiply to give 18
+ The codes add-up to 8

Enter the three code numbers followed by x
```

Declare two more variables!

- Declare an integer named b.
  - Initialize it
- Declare an integer named c.
  - Initialize it

Arithmetic Operators

Addition Operator = +

Subtraction Operator = -

Multiplication Operator = *

Division Operator = /

Multiply your variables!

- Declare the product of a, b & c
- Print your product variable on a new line

Variables

- You declare variables in code
- A variable with a given value is initialized
- Declaring a variable = Reserved space in memory
- You can add/multiply with arithmetic operators
- Print to the terminal like: std::cout << a;

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6. const & Assigning Values

Variables

- Variables can be changed at runtime
- After a variable has been declared, we can assign a new value to it at any point in our code
- *“A value that is subject to change”*

Assigning values to variables

- We never want to assign values to variables before the variable has been declared
- The compiler will not allow it.
- The compiler will not be aware that the variable exists

Try this...

- Prefix all your variable declarations with: const

```
const int a = 4;
```

- Be brave and post your thoughts in the community!
  - How do you think this affects our code?

Assigning values to variables

- We cannot assign a value to a variable before the variable has been declared
- The compiler will not be aware that the variable exists if you try assigning to it before it’s declaration
- The compiler will not allow this!

const

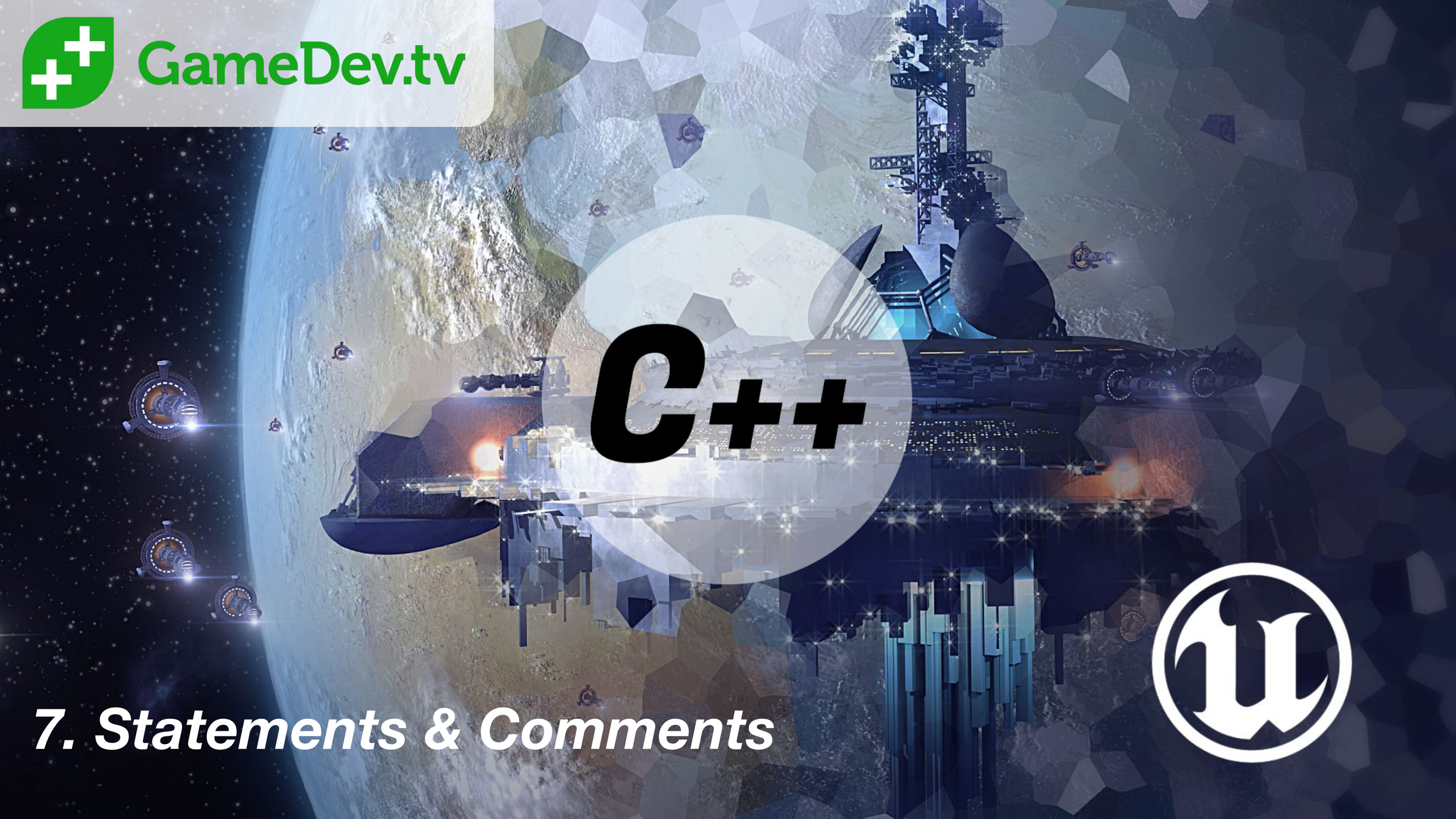
(Short for constant)

- With the const keyword, we signal our intentions to ourselves and to anybody who reads our code:
- “We never want this variable to change it’s value after it’s declaration!”
- Compiler = best friend! It protects our code!

const & assigning values

(Short for constant)

- Assignment Operator =
- We can assign values to variables like: a = 4;
- Cannot assign before a variable has been declared!
- const keyword to mark your variables as constant
- The compiler will protect const variables!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7. Statements & Comments

Expression Statements

```
std::cout << “Hello, World!”;

myvariable = 5;
```

An expression followed by a semicolon is an expression statement!

Explain these! Post in the community forum!

TripleX.cpp

```
#include <iostream>

int main()
{
    std::cout << "You are a secret agent breaking into a secure server room...";
    std::cout << std::endl;
    std::cout << "Enter the correct code to continue...";

    const int a = 4;
    const int b = 3;
    const int c = 2;

    const int sum = a + b + c;
    const int product = a * b * c;


    std::cout << std::endl;
    std::cout << sum << std::endl;
    std::cout << product << std::endl;

    return 0;
}
```

Preprocessor Directive

Main Function

Expression Statements

Declaration Statements

Expression Statements

Return Statement

Comments

- Commenting code can be used to make your code more easily understood by yourself or others!

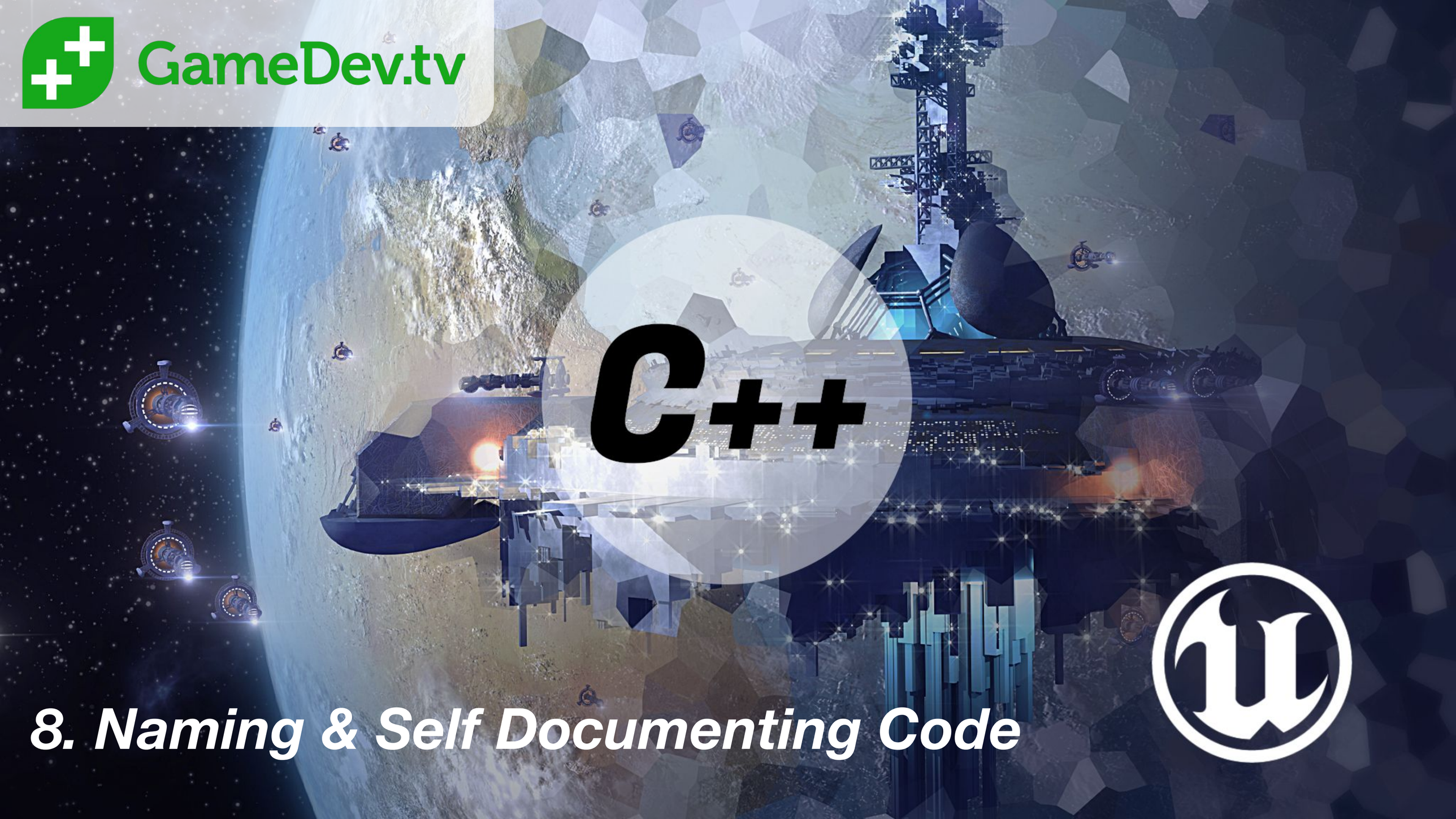
```
// This is a single line comment!
```

Comment your code!

- // We use a double forward slash to comment
- Add a comment to the start of your main function
- What do the first few lines of your main function do in the vision of your game?
- Comment wisely!

Statements & Comments

- Expression statements:
  - Expressions that end with a semicolon
- Declaration statements:
  - Statements where we declare ‘something’
- Comment like: // This is a single line comment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8. Naming & Self Documenting Code

Your turn!

- Print a message about the product
  - “The codes multiply to give: ”

- Take a screenshot of your terminal to showcase your TripleX game in the community!

Variable Naming

- Important to give your variables good names!
- Must begin with a letter or an underscore
  - Cannot start with a number!
- You must not use a reserved keyword

Keywords

- Reserved keywords are to be used by the C++ language only
- Over 90 keywords

Examples:

auto	bool	break	case
const	int	friend	return

Self Documenting Code

- Makes our code easier to read and understand
- If we give a variable a good name, we don’t have to use a comment to explain what it does!

Unreal Coding Standard

- Unreal Engine 4 uses an UpperCamelCase naming convention

myVariable **MyVariable**

The start of each word is capitalized!

https://docs.unrealengine.com/en-us/Programming/Development/CodingStandard

Rename your variables!

- Rename your a, b & c variables:
  - CodeA, CodeB, CodeC
- Rename sum and product:
  - CodeSum, CodeProduct
  - Make sure they are initialized correctly!
- Follow Unreal Engine 4’s naming convention

Naming & Self Documenting Code

- Self document code with good naming!
- Must begin with a letter or an underscore
- You must not use a reserved keyword
- Unreal’s naming convention UpperCamelCase
- Right click and “change all occurances” in VS code to rename and replace variable everywhere in file

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9. Getting User Input

```
std::cout << "Hello, World!";
```

Character Output

Insertion Operator

```
std::cin >> PlayerGuess;
```

Character Input

Extraction Operator

Extract from input stream and assign to variable: PlayerGuess

Store the players guess!

- Make use of std::cin
- Store the PlayersGuess
- Print a message and the value of PlayerGuess
  - Example: “You entered: 512”

TripleX as a Player

- As a player you have to guess a 3 number code
- 234 will be treated as “two hundred and thirty four”
- What if the code was multi digit?
  - Example: 8 12 24

Answers
CodeA
CodeB
CodeC

Guesses
GuessA
GuessB
GuessC

2 3 4

```
std::cin >> GuessA;      std::cin >> GuessB;      std::cin >> GuessC;
```

Your program will only ask for more input when cin is called IF the input stream is empty!

What’s relevant?

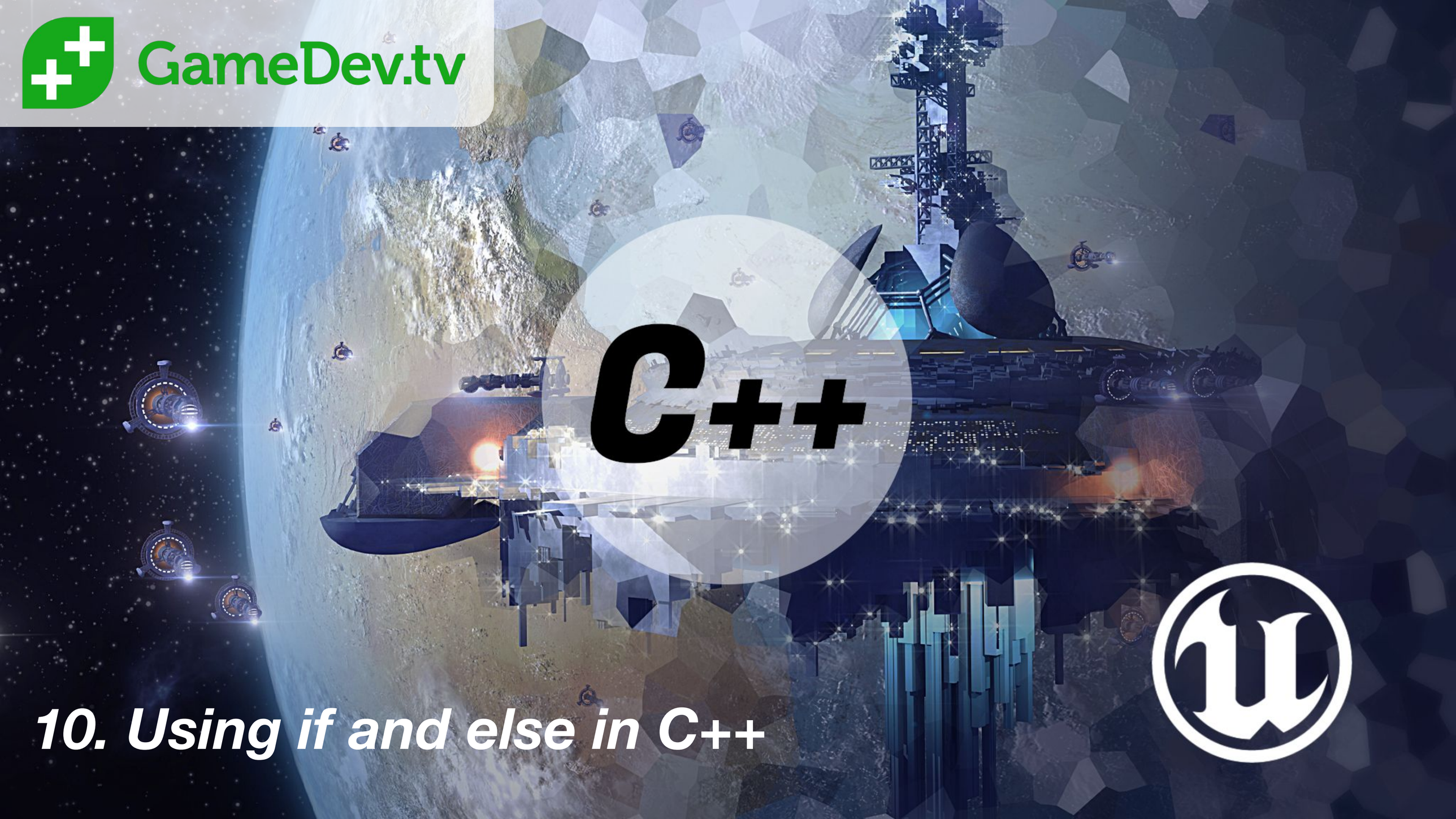
- We want the players to enter numbers only
- They can enter numbers on seperate lines
- Or the same line separated by spaces
- We need to add a fix later! Incase anything other than a number gets entered & for replayability

Declare Guess Sum & Products

- Declare GuessSum
  - Initialize it by adding GuessA, GuessB & GuessC
- Declare GuessProduct
  - Initialize it by multiplying GuessA, GuessB & Guess C

Getting User Input

- cout = Character Output
  - *Insertion Operator* = **<<**
- cin = Character Input
  - *Extraction Operator* = **>>**
- Characters like ‘x’ get converted to 0 with integers
- Chars like ‘x’ will halt <u>cin</u> from working until reset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10. Using if and else in C++

if statements

```
if (condition)
{

}
```

if statements

```
if (condition)
{
  std::cout << “you win!”;
}
```

if statements

```
if (true)
{
    std::cout << “you win!”;
}
```

if statements

```
if (false)
{
    std::cout << “you win!”;
}
```

Implement your if statement

- Implement an if statement
- Enter true as the condition
- Add a code block that prints a win message
- Play TripleX and see what happens if you win
- Play again and see what happens if you lose

if statements

```
if (condition)
{
  std::cout << “you win!”;
}
```

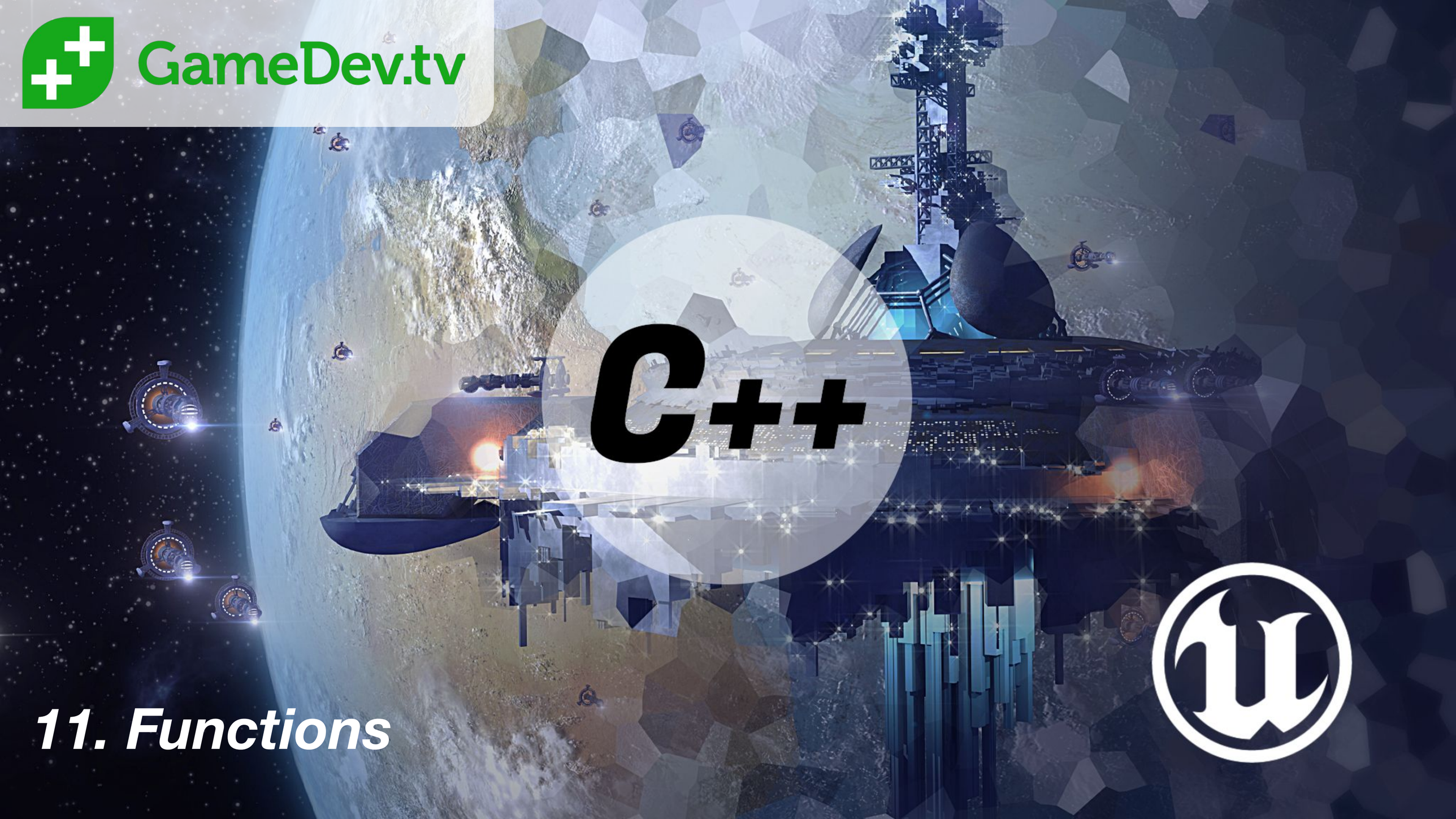
```
if (GuessSum == CodeSum && GuessProduct == CodeProduct)
{
   std::cout << “You win!”;
}

else
{
   std::cout << “You lose!”;
}
```

You win...you lose...

- Print a win message if the player enters the correct code
- Print a lose game message if the player enters an incorrect code
- Share your work so far in the community!

Using if and else in C++

- == Equality operator
- && Logical “*and*” operator
- if (condition)
  - Executes the code block below if condition is met
- else
  - Executes code block below if condition is not met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11. Functions

```
std::cout << “Hello, World!” << std::endl;
```

Not the only way to end the line!

Escape sequences

- Used to represent different characters within a string
- Escape sequences modify the format of a string

He said: “Hello, World!”

```
std::cout << “He said: ”Hello, World!”;
```

```
std::cout << “He said: \“Hello, World!\““”;
```

Double quote escape sequence

```
std::cout << “Hello, World!” << std::endl;

std::cout << “Hello, World!\n”;
```

New line
(Line feed)
Escape sequence

Make use of: \n

- Modify your strings to use \n escape sequence
  - Remove std::endl where necessary

Function

- A function is a group of statements that together, performs a task and is given a name
- Every C++ program must have at least one function
  - **main**()

```
int main()
{
  std::cout << “Hello, World!”;
  return 0;
}
```

Let’s create a function!

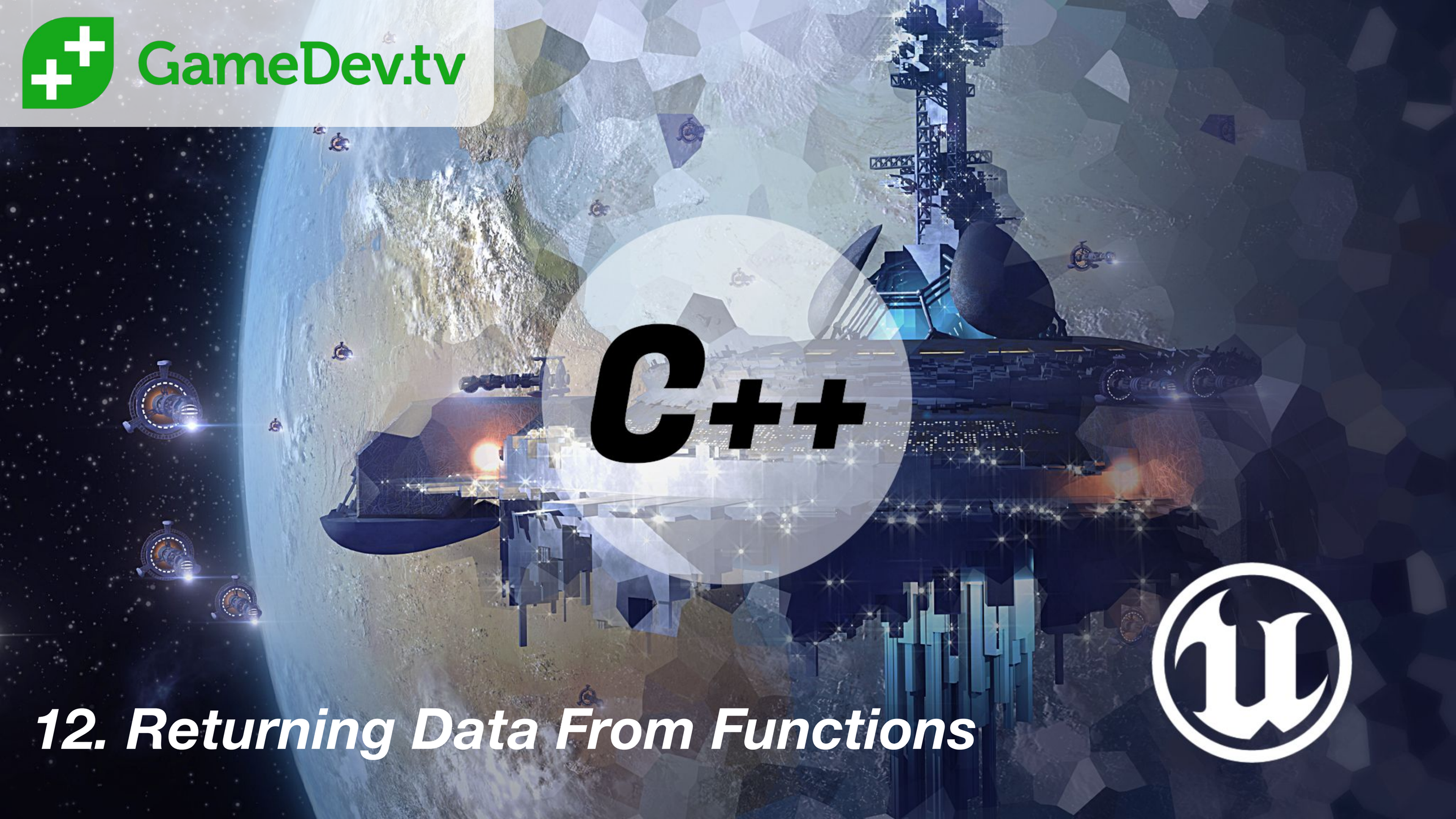
- Our function will return no value
- The name of our function is going to be PlayGame
- The function will contain no parameters
- The function body will contain the code for playing our game

Your first function!

- Return type: void
- Name the function PrintIntroduction
- PrintIntroduction() at the start of PlayGame()
- Create some cool ASCII art to share in the community!

Functions

- \n new line escape sequence in strings
- A function is a group of statements that is named and performs a task
- You must specify the return type of a function
- void to return no data
- Must be implemented before it is executed!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12. Returning Data From Functions

while loop

```
while (condition)
{
    PlayGame();
}
```

Code block executes repeatedly until the condition is not met

while you're here...

- Pause the lesson and implement a while loop into your main function
- Hard code the condition as true
- Add a code block for the while loop to execute PlayGame()

Fix the issue!

- After PlayGame() in your while loop, add these lines:
- std::cin.clear(); // Clears any errors
- std::cin.ignore(); // Discards the buffer
- Want to discuss in detail? Post in the community and chat with your fellow students!

Has the player completed the level?

- Currently PlayGame returns no data
  - It’s data type is void
- We want to return if the player has completed the current level
- To do this, we are going to work with Booleans

Boolean

- A boolean is a value that is true or false

bool PlayGame()

- Change the data type for PlayGame from void to bool
- Compile your code and see what happens...

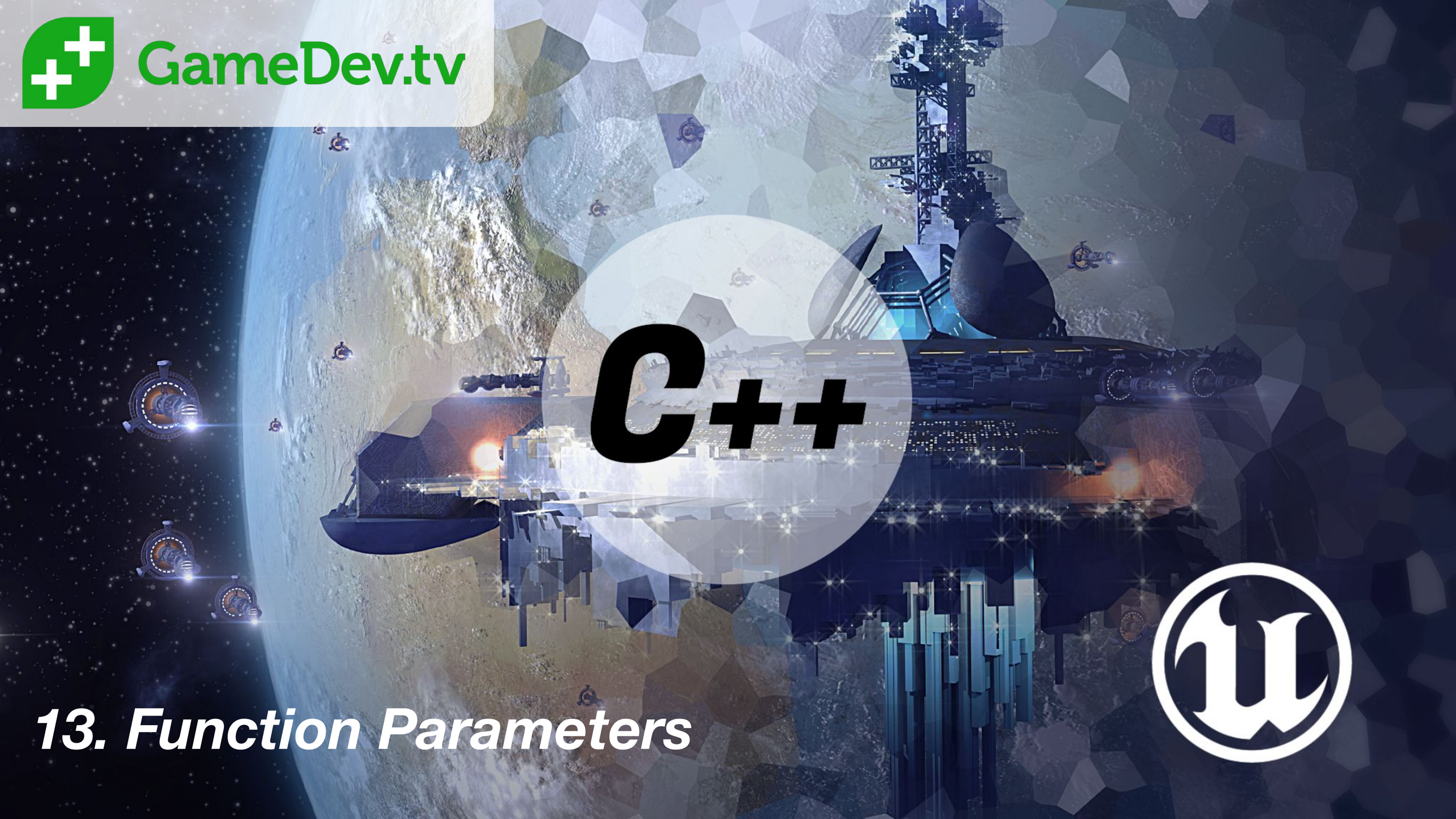
Initializing bLevelComplete

- bLevelComplete = PlayGame();

Initialize bLevelComplete with the result of PlayGame

Returning Data From Functions

- while loop to execute a code block repeatedly
- CTRL + C to exit program
- Functions that are not of type void must contain a return statement for all exit paths of the function
- bool = true or false value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13. Function Parameters

++LevelDifficulty

LevelDifficulty + 1

4 + 1 = 5

Variable Scope

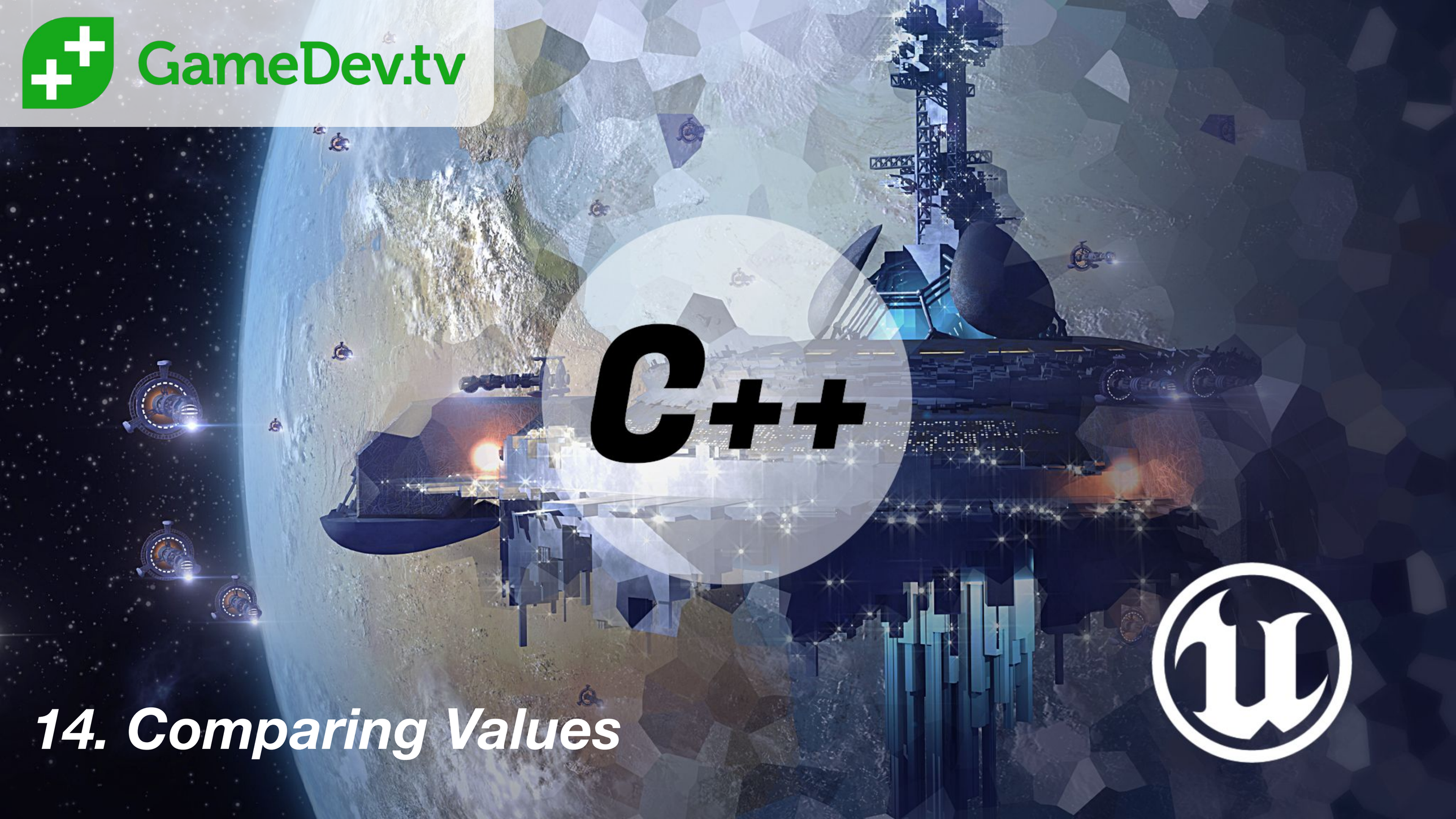
- A variable declared inside a code block has scope
- It is local to where it is declared
- Cannot be accessed or used outside of its ‘scope’

Create a parameter for PlayGame()

- Pause here and create a parameter for PlayGame()
- The data type should be int
- The parameter should be named Difficulty

Function Parameters

- Increment variables like: ++MyVariable;
- Think about where you declare your variables
  - Because of the variables scope!
- Function parameters allow us to pass values into it
- Passing values is known as passing an argument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14. Comparing Values

Declare a new variable!

- Declare a variable for storing the maximum difficulty/level
  - MaxLevel or MaxDifficulty
- Make it a constant by declaring with the keyword const
- Initialize it with the amount of levels you want in your game
- In scope within our main function
  - Declare it above the while loop

while loop condition

- LevelDifficulty should never become larger than MaxDifficulty
- Our while loop condition should check to see if the value of the LevelDifficulty is lower or equal to MaxDifficulty

Comparison operators

Equal to	==
Not equal to	!=
Greater than	>
Less than	<
Greater than or equal to	>=
Less than or equal to	<=

Update your strings to reflect the game!

- When our PlayGame function returns true or false
- Update the strings so they reflect:
  - Moving to the next level if correct code is entered
  - Retrying the level if the player enters the wrong code
- Before we return 0; in main function:
  - Print a string to the terminal that congratulates the player on completeing the game

Working with random numbers

- We are going to initialize our variables with the function that is named: **rand()**
  - This function returns a random number

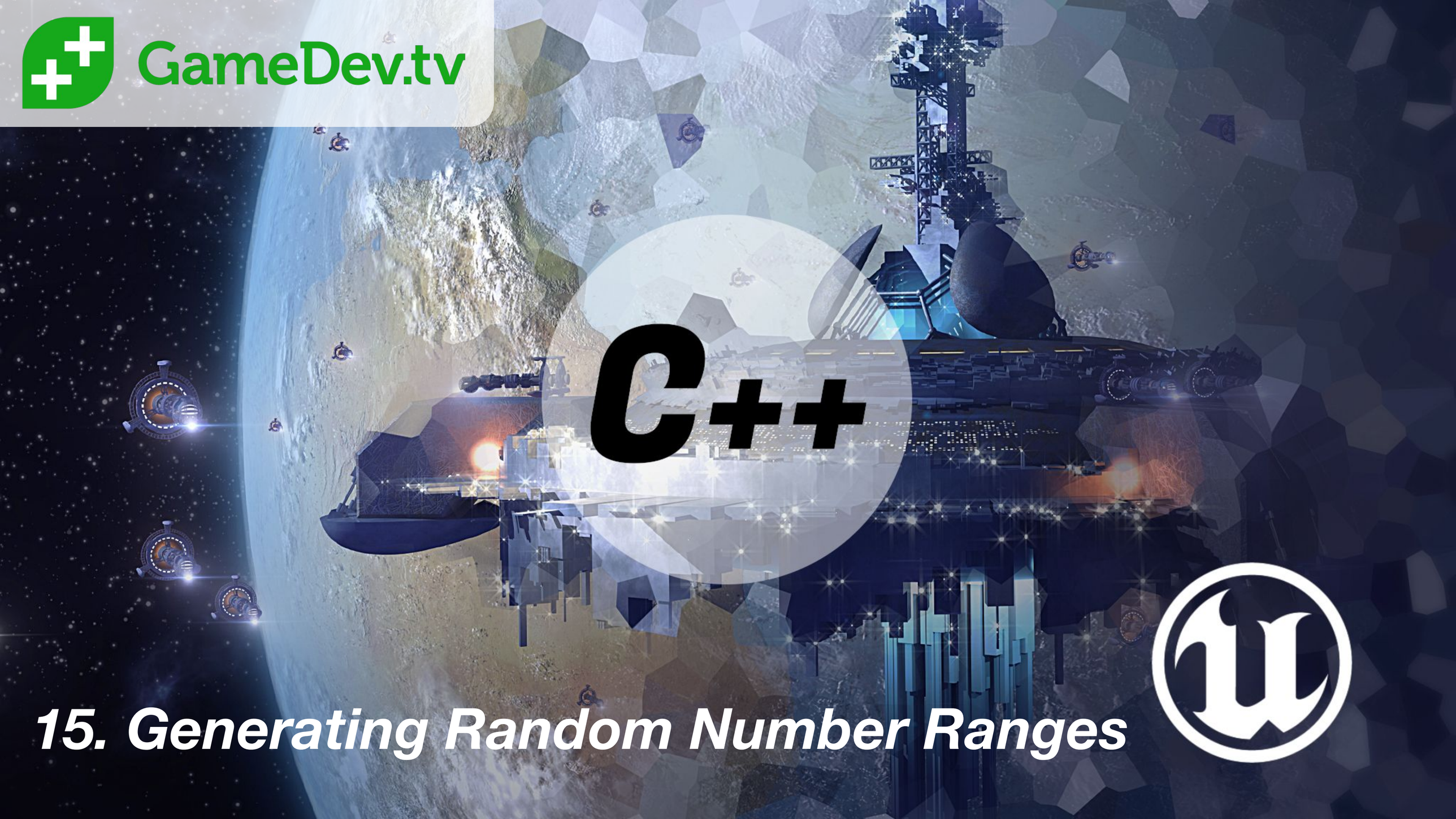
rand()

- **rand()** returns a value in the range 0 and a value that is guaranteed to be atleast **32,767!**
- We need to have more control over the range!
- We need **rand()** to take our LevelDifficulty variable into account

Comparison Operators

- Compare values with:
- Can be used for conditions
- Like in: while and if
- Make sure spacing is consistent!
- **rand()** returns a value in the range 0 and **32,767!**

Equal to	==
Not equal to	!=
Greater than	>
Less than	<
Greater than or equal to	>=
Less than or equal to	<=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15. Generating Random Number Ranges

Modulus Operator

- %
- Performs a division but returns the remainder!
- **9 / 4 = 2 r 1**
- **9 % 4 = 1**
- We can use this to map **rand()** to our own range

There’s a pattern!

- <value> % <modulus>
- Maps the <value> between a range of numbers!
- The range is between 0 and <modulus> - 1

Modulo Operation

- **2524 % 10**
  - 2524 mapped to a range between 0 - 9
  - Not 0 - 10! The range is 0 to the modulus - 1
- **The result is the same as the remainder we would get from dividing 2524 by 10!**

Modulo Operation

- **2524 % 10 = 4**
  - 2524 mapped to a range between 0 - 9
  - Not 0 - 10! The range is 0 to the modulus - 1
- **The result is the same as the remainder we would get from dividing 2524 by 10!**

Mapping rand() to a range

- rand() % <modulus>
  - Maps the random number in the range of 0 and the modulus value (subtracted by 1)

Challenge

Challenge

- Limit the range of rand() to initialize variables: CodeA, CodeB & CodeC!

Challenge

- Limit the range of rand() to initialize variables: CodeA, CodeB & CodeC!

- Play the game!

Modulus Value	rand() % <Modulus> (Range)
1	0 - 0

Difficulty	rand() % Difficulty (Range)
1	0 - 0

Difficulty	rand() % Difficulty (Range)
1	0 - 0
2	0 - 1
3	0 - 2
4	0 - 3
5	0 - 4

Difficulty	rand() % Difficulty (Range)	rand() % Difficulty + 1 (Range)
1	0	1 - 1
2	0 - 1	1 - 2
3	0 - 2	1 - 3
4	0 - 3	1 - 4
5	0 - 4	1 - 5

Challenge

- Initialize your code variables with: rand() % Difficulty
- Add 1 to Difficulty to offset the range

- Play the game!

Difficulty	rand() % Difficulty + Difficulty (Range)
1	1
2	2 - 3
3	3 - 5
4	4 - 7
5	5 - 9

Not random yet!

- Our game isn’t random yet!
- Each time we play it, it produces the same result!
- We have one more step...

Seeding rand()

- We need to initialize rand() with a different seed
  - This will produce more random results
- The best way to do this is based on your computer's time
- #include <ctime>
- At the start of main add this line:
  - srand(time(NULL));
  - Creates new random sequence based on the time of day

How far can you get?

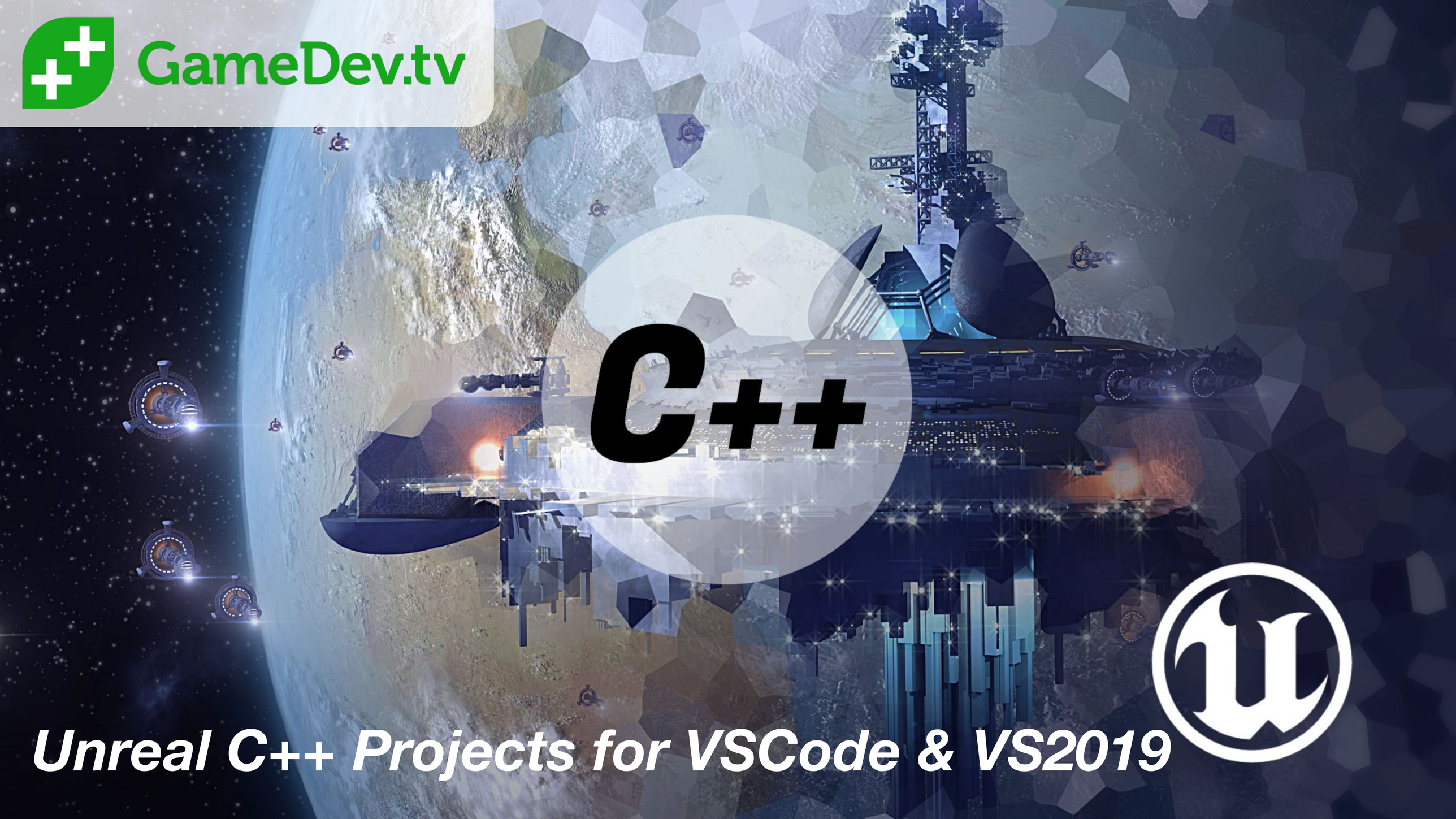
- Play your game!
- What level can you get to?
- What level do you find really hard?
- Share in the community!

Section 2 Ending

- Well done for completing section 2!
- You’ve built your first game in C++!
- Play an active part in the community!
  - Help out other students
  - Share your work

Generating Random Number Ranges

- Modulus Operator: %
- Performs a division but returns remainder
- We can use % to control the range of rand()
- + 1 to offset the range
- Well done for completing section 2!
- Play an active part in the community!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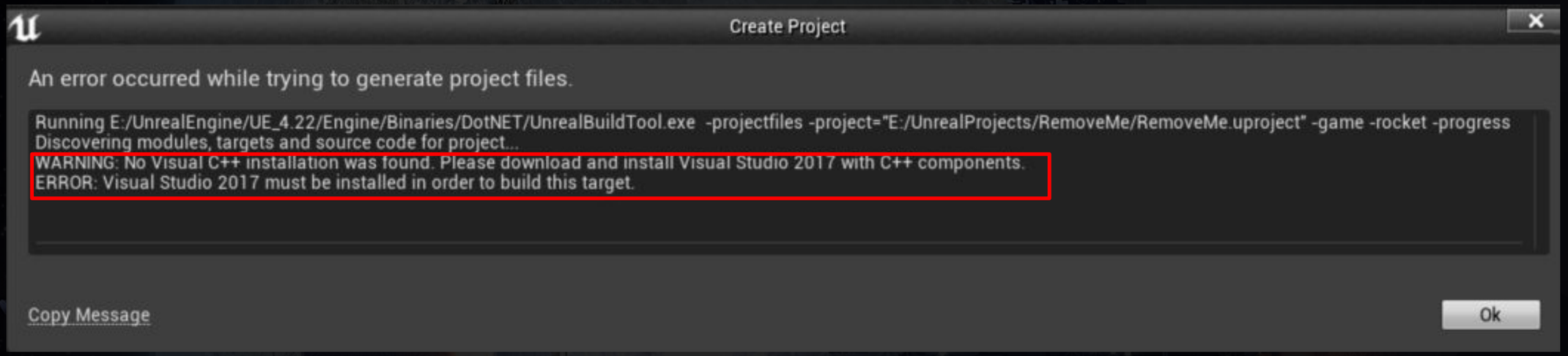
Unreal C++ Projects for VSCode & VS2019

Creating Unreal C++ Projects

- Unreal Engine 4 expects:
  - Visual Studio 2017 installed if running Windows
  - Xcode installed if running macOS
- By default, Unreal will not allow you to create C++ projects without having these installed



- What if we are running VS Code or Visual Studio 2019?

Fix for VS Code & Visual Studio 2019

- Launch the Unreal Engine 4 editor
- Create a Blueprint Project
- Change the source control editor from Unreal's *Editor Preferences*

Blueprint projects

- Blueprint projects can still be C++ projects!
- You just have to add a C++ class to your project

C++ Projects for VSCode & VS2019

- To use VSCode or VS2019:
- Create a Blueprint Project
- Change the source control editor from Unreal's *Editor Preferences*
- Blueprint projects can still be C++ projects!
- You just have to add a C++ class to your project