Lesson :

Variables, Data Types and the first C++ program

List of Concepts Involved

- C++ Variables
- C++ Identifiers
- C++ Data Types
- C++ Output
- How does the C++ program work?
- C++ user input

A computer program/code consists of various components viz. variables, data types, identifiers, keywords, etc which helps us to build a successful program. Let us learn each one of them in detail and then move to our first program.

Topic 1: C++ Variables

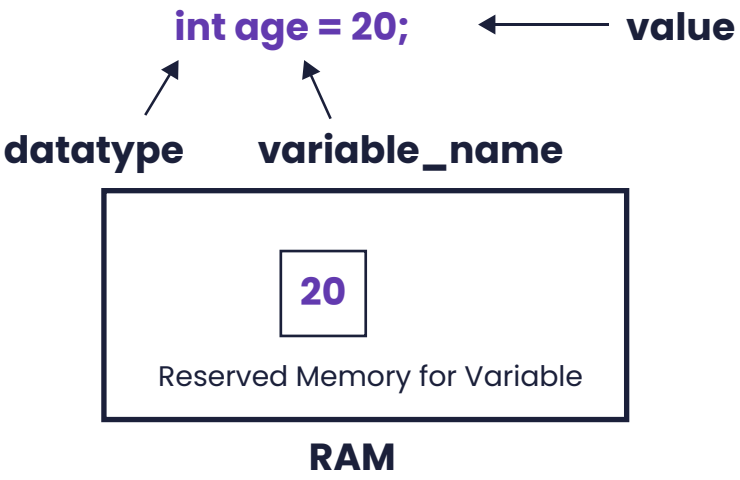
- A variable is the title of a reserved region allocated in memory. In other words, it may be referred to as the name of a memory location.
- Each variable should be given a unique name to indicate the storage area.
- A variable is a container that holds the value while the C++ program is executed.
- A variable is assigned with a data type(we will learn about it after this).

Syntax for Declaring a Variable:

Type variable_name [= value];

The variable_name is the name of a variable. We can initialize the variable by specifying an equal sign and a value (Initialization i.e. assigning an initial value, is optional).

Creating Variables Example:



In the example above, the variable can only hold integer values, as indicated by the int data type.
Here, we assigned a value to the variable during the declaration process. However, as stated before, it is optional. Variables can be declared and assigned separately. Example,

```
int rate;
rate = 40;
```

Change Values of Variables

Interestingly, a variable's value can also be changed in the programme. As an example,

```
int rate = 50;
cout<<rate; // 50
rate = 60;
cout<<rate; // 60
```

Initially, the value of rate was 50 but it has changed to 60 after the last updation, rate=60.

Naming Conventions for variables in C++

Like us, all C++ components are identified with their names.There are a few points to remember while naming the variable. They are as follows -

- Variable names should not begin with a number. For Example
  ```
  int 2var;   // 2var is an invalid variable.
  ```
- Whitespaces are not permitted in variable names. For example,
  ```
  int cricket score;  // invalid variables.
  ```
  There is a gap/whitespace between cricket and score.
- A C++ keyword (reserved word) cannot be used as a variable name. For example, int float; is an invalid expression as float is pre-defined as a keyword(we will learn about them) in C++.
- As per the latest coding practices, for variable names with more than one word the first word has all lowercase letters and first letter of subsequent words capitalised. For example, cricketScore, codePracticeProgram etc. This type of format is called camel case
- While creating variables, it's preferable to give them meaningful names like- ‘age’, ‘earning’, ‘value’ etc. for instance, makes much more sense than variable names like a, e, and v.
- We use all lowercase letters when creating one-word variable name. It's preferable(and in practice) to use physics rather than PHYSICS or pHYSICS.

Topic 2: C++ Identifiers

C++ identifier is a name given to a package, class, interface, method, or variable. All identifiers must have different names.

In C++, there are a few points to remember while dealing with identifiers :

- **Rule 1 -** All identifiers should begin with a letter (A to Z or a to z), $ and and must be unique.
- **Rule 2 -** After the first character/letter, identifiers can have any combination of characters.
- **Rule 3 -** A keyword cannot be used as an identifier.
- **Rule 4 -** The identifiers are case sensitive.
- **Rule 5 –** Whitespaces are not permitted.

Examples of legal identifiers: rank, $name, _rate, __2_mark.

Examples of illegal identifiers: 102pqr, -name.

These variables, identifiers etc. consume memory units. Before proceeding ahead, let us have a look at the memory unit concept too. Here, we will only focus on the relevant concept of memory.

Basic Memory units:

It refers to the amount of memory or storage used to measure data.

Basic memory units are:

1. Bit

A bit (binary digit 0 or 1) is the smallest unit of data that a computer can process and store.
Symbols 0 and 1 are known as bits. Here, 0 indicates the passive state of signal and 1 indicates the active state of signal.
At a time, a bit can store only one value i.e 0 or 1. To have a greater range of value, we combine multiple bits.

2. Byte

A byte is a unit of memory/ data that is equal to 8 bits.
You may think of a byte as one letter. For example, the letter 'f' is one byte or eight bits.

The bigger units are :

3. Kilobyte

A Kilobyte is a unit of memory data equal to 1024 bytes.

4. Megabyte

A Megabyte is a unit of memory data equal to 1024 kilobytes.

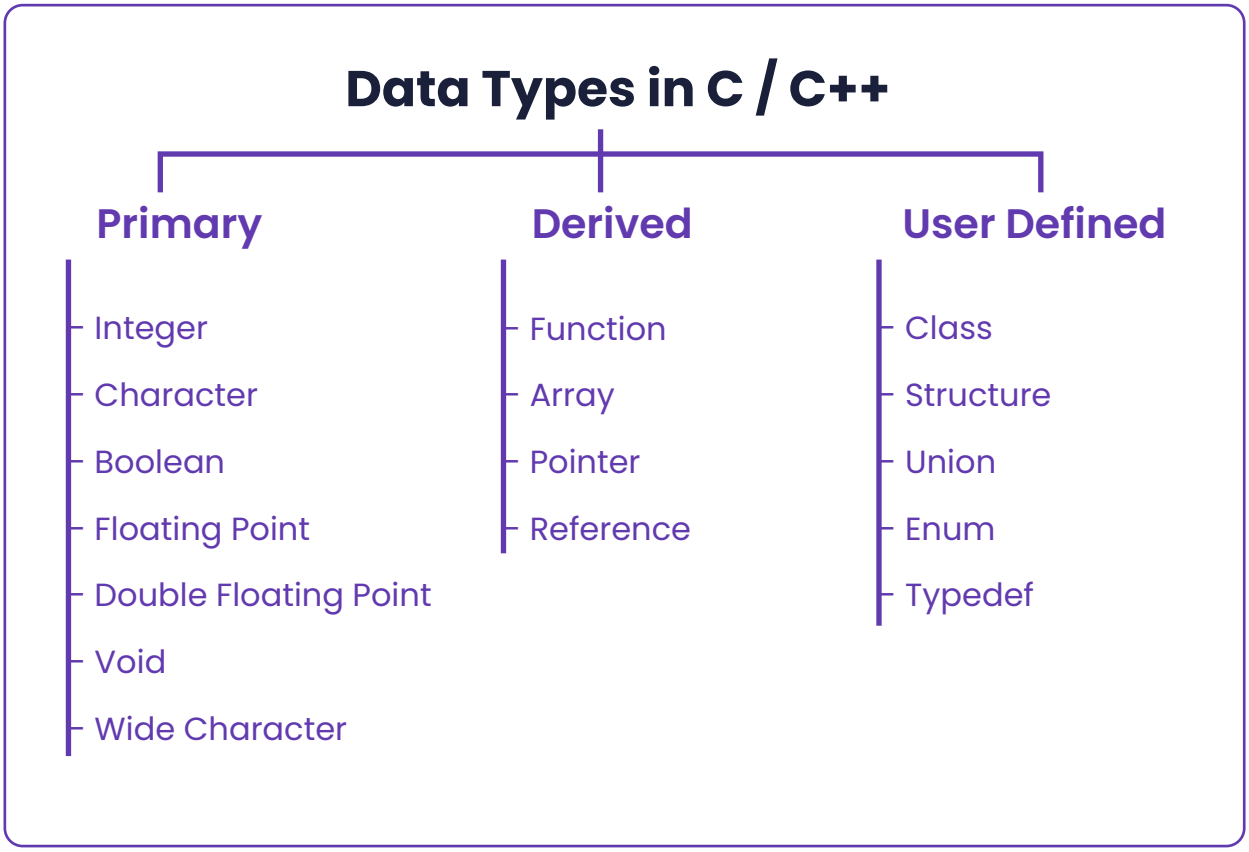
5. Gigabyte
A Gigabyte is a unit of memory data equal to 1024 Megabytes.

Lets us now move to the most important concept - data type

Topic 3: C++ Data Types

Data types specify the different sizes and values that can be stored in the variable. Based on the data type of a variable, the operating system allocates memory and decides what can be stored in the reserved memory. Therefore, by assigning different data types to variables, we can store integers, decimals, or characters in these variables.

Data types in C++ are categorized in three groups: **Built-in (Primary), User-defined** and **Derived.**



Here we will discuss primary data types only.

1. C++ int
- The int keyword is used to indicate integers.
- Its size is usually 4 bytes. Meaning, values can be stored from -2147483648 to 2147483647.
- For example: int rate=40;

2. C++ char
- This data type is used to store a single character.
- Size of char is 1 byte.
- Characters in C++ are enclosed inside single quotes ' '.
- For example: char symbol='a'

3. C++ bool
- A boolean data type is declared with the bool keyword.
- The bool data type has one of two possible values: true or false.
- For example bool flag=false;

4. C++ float
- Float is used to store floating point numbers (decimals and exponentials).
- The size of the float is 4 bytes.
- In general, 7 decimal digits precision.
- For example: float rate=40.50;

5. C++ double
- Double is used to store floating-point numbers (decimals and exponentials).
- The size of the double is 8 bytes. Hence, double has two times the precision of float.
- In general, 15 decimal digits precision.
- For example: double rate=40.6543444;

6. C++ void
- The void keyword means "nothing" or "no value".
- Void will be used in functions and pointers.
- Variables of the void type can't be declared.

7. C++ wchar_t
- Wide character wchar_t is similar to the char data type, except its size is 2 bytes instead of 1.

Note: **C++ String Data Types**
- This data type is used to store a sequence of characters (text).
- This is not a built-in data type.
- String values must be surrounded by double quotes:
- For example string name= "Ramesh";

Now that we have learnt all the relevant concepts, let us go ahead and write our very first program!

Topic 4: C++ Output/Display Program

```
// C++ program to display “Hello World in C++”:
#include <iostream>
using namespace std;
int main()
{
    // prints hello world in C++
    cout << "Hello World in C++";
}
```

Output: Hello World in C++

How Does this Programme Work?

- // C++ program to display “Hello World in C++”: This is a comment line. A comment is used for displaying additional information about the program. It does not contain any programming logic. When a comment is encountered by the compiler, that line or part of code is skipped by the compiler. Any line beginning with ‘//’ without quotes OR in between /*…*/ in C++ is a comment.

- In C++, all lines that start with a pound or hashtag(#) sign are called directives and are processed by a preprocessor which is a program invoked by the compiler. The #include directive tells the C++ preprocessor to include contents of the file specified in input stream to the compiler and then continue with the rest of the original file. #include<iostream> tells the preprocessor to include the iostream header file(file that has some already pre-written code which we are importing to avoid reinventing the wheel) in the program and iostream is the header file which contains all the basic functions of the program like input/output etc.

- Using namespace std is used to define which input/output form is going to be used. (Explained in the forth-coming lectures).

- int main():This line is used to declare a function having the name “main” whose return type is integer. Every C++ program’s execution begins with the main() function, no matter where the function is located in the program. So,it’s necessary for every C++ program to have a main() function.

- cout<<“Hello World in C++”;: This line instructs the compiler to display the message “Hello World in C++” on the screen.

Note 1: In C++ every statement should be terminated with semicolon (;) for execution.

Note 2: In C++, we can use endl or \n to insert new lines in the output data stream.

Additional information:

Like cout we also use printf() function that comes from the C language. C++ printf prototype defined under <cstdio> header file is:
int printf(const char * format, ...)
When you use the printf() function, it prints the string pointed out by the format to the standard output stdout. The format can also contain some specifiers that start with a % and replace values of variables with the printf() function.

Example:

```
#include <iostream>

using namespace std;

int main()

{

    // prints hello world in C++

    printf("Hello World in C++");

}
```

Output: Hello World in C++

Example:

```
cout<<"Physics"<<"Wallah";
```

Output: PhysicsWallah

```
cout<<"Physics"<<endl<<"Wallah";
```

Output: Physics
Wallah

Topic 5: Taking input from the user

We have already learnt that cout is used to output (print) values. Now let us explore the abilities of C++ which will allow us to get input from users. This can be done using cin.
cin is a predefined object that reads data from the user with the extraction operator (>>) (like scanf is used in case of C language).
In the following example, the user can input a number, which is stored in the variable x. Then we will print the value of x:

Example:

```
int num;
cout << "Enter any number "; // Type a number and press enter
cin >> num; // Get user input from the keyboard
cout << "Entered number is: " << num; // Display the input value
```

Example: The user is asked to enter two integers and their sum is displayed

```
#include <iostream>
using namespace std;
int main() {
  int n1, n2, sum;
  cout << "Enter two numbers: ";
  cin >> n1 >> n2;
  // sum of two numbers is stored in variable sum
  sum = n1 + n2;
 // prints sum
  cout << sum <<endl;
  return 0;
}
```

Run these examples on your system and check for outputs.

Congratulations! You are officially a programmer now !

Lets now test our understanding so far :

MCQs

Q1. What will be the output of the following code?

```
#include <iostream>
using namespace std;
int main(){
    cout << "physics" << "wallah";
}
```

a) physics wallah
b) physicswallah

Ans: b) physicswallah

Explanation:
The text will be printed exactly like we place the text inside double quotes. So first we are printing "physics". After printing, our cursor will be right next to the 's' of "physics". So "wallah" will be printed right next to the "physics" without any spaces between them.

Q2. Which of the following data types can store the longest decimal number?

a) boolean
b) double
c) float
d) long

Ans: b) double

Explanation:
Out of all given options, only float and double can hold decimal numbers and double is the longest data type to store floating-point values.

Q3. Which of the following cannot be stored in character data type?

a) Special symbols
b) Letter
c) String
d) Digit

Ans: c) String

Explanation:
String is a collection of characters and is stored in a variable of String data type.

Q4. Number of digits upto which precision value of float data type is valid?

a) Upto 7 digit
b) Upto 8 digit
c) Upto 9 digit
d) Upto 6 digit

Ans: a) Upto 7 digit

Upcoming Class Teasers

- C++ Operators