Data Types

- C++ data types fall into three categories:
  - Simple data type
  - Structured data type
  - Pointers

Simple Data Types

- There are four simple data types in C / C++.
  - Countable data types
  - Measurable data types
  - Character data types
  - String data types

Signed vs Unsigned Number

- Unsigned numbers include 0 or positive numbers
- Signed Numbers include 0, positive and negative numbers

Countable Data Types

- Integer: Whole Numbers, Can be positive or negative
  - unsigned integer
  - signed integer
  - unsigned short
  - signed short
  - unsigned long
  - signed long

Countable Data Types


```cpp
#include <iostream>
using namespace std ;
int main ()
{
    short s1 = 10 ;
    signed short s2 = 20 ;
    unsigned short s3 = 30 ;
    int i1 = 10 ;
    signed int i2 = 20 ;
    unsigned int i3 = 30 ;
    long l1 = 10 ;
    signed long l2 = 20 ;
    unsigned long l3 = 30 ;
    long long ll1 = 10 ;
    signed long long ll2 = 20 ;
    unsigned long long ll3 = 30 ;
    cout <<"The s1 size in memory = " <<sizeof (s1) <<endl;
    cout <<"The s2 size in memory = " <<sizeof (s2) <<endl;
    cout <<"The s3 size in memory = " <<sizeof (s3) <<endl;
    cout <<"The i1 size in memory = " <<sizeof (i1) <<endl;
    cout <<"The i2 size in memory = " <<sizeof (i2) <<endl;
    cout <<"The i3 size in memory = " <<sizeof (i3) <<endl;
    cout <<"The l1 size in memory = " <<sizeof (l1) <<endl;
    cout <<"The l2 size in memory = " <<sizeof (l2) <<endl;
    cout <<"The l3 size in memory = " <<sizeof (l3) <<endl;
    cout <<"The ll1 size in memory = " <<sizeof (ll1) <<endl;
    cout <<"The ll2 size in memory = " <<sizeof (ll2) <<endl;
    cout <<"The ll3 size in memory = " <<sizeof (ll3) <<endl;
    return 0 ;
}
```

```
The s1 size in memory = 2
The s2 size in memory = 2
The s3 size in memory = 2
The i1 size in memory = 4
The i2 size in memory = 4
The i3 size in memory = 4
The l1 size in memory = 4
The l2 size in memory = 4
The l3 size in memory = 4
The ll1 size in memory = 8
The ll2 size in memory = 8
The ll3 size in memory = 8
```

Countable Data Types


```cpp
#include <iostream>
#include <climits>
using namespace std ;
int main ()
{
    cout << "\n\n Check the upper and lower limits of integer :\n";
    cout << "-------------------------------------------------\n";
    cout << " The maximum limit of int data type :                 " << INT_MAX << endl;
    cout << " The minimum limit of int data type :                 " << INT_MIN << endl;
    cout << " The maximum limit of unsigned int data type :        " << UINT_MAX << endl;
    cout << " The maximum limit of long long data type :           " << LLONG_MAX << endl;
    cout << " The minimum limit of long long data type :            " << LLONG_MIN << endl;
    cout << " The maximum limit of unsigned long long data type :  " << ULLONG_MAX << endl;
    cout << " The minimum limit of short data type :               " << SHRT_MIN << endl;
    cout << " The maximum limit of short data type :               " << SHRT_MAX << endl;
    cout << " The maximum limit of unsigned short data type :      " << USHRT_MAX << endl;
    cout << endl;
    return 0 ;
}

```

Countable Data Types


```
Check the upper and lower limits of integer :
-------------------------------------------------
The maximum limit of int data type :                  2147483647
The minimum limit of int data type :                  -2147483648
The maximum limit of unsigned int data type :         4294967295
The maximum limit of long long data type :            9223372036854775807
The minimum limit of long long data type :             -9223372036854775808
The maximum limit of unsigned long long data type :   18446744073709551615
The minimum limit of short data type :                -32768
The maximum limit of short data type :                32767
The maximum limit of unsigned short data type :       65535


--------------------------------
Process exited after 0.08577 seconds with return value 0
Press any key to continue . . .
```

Important Take Away

What happens if you:

- Change the variable to `5000`?
- Change the variable to `5,000`?
- Change the variable to `050`?
- Change the variable to `"5000"` (with double quotes)?

Measurable Data Types

- Floating Point Numbers: Numbers with a Decimal, can be positive or negative
  - float
  - double
  - long double

Measurable Data Types


```cpp
#include <iostream>
#include <cfloat>
using namespace std ;
int main ()
{
    float f = 9.9 ;
    double d = 9.9 ;
    long double ld = 9.9 ;
    cout << "\n\n Check the upper and lower limits of countable datatypes :\n";
    cout << " The minimum limit of float data type :                " << FLT_MIN << endl;
    cout << " The maximum limit of float data type :                " << FLT_MAX << endl;
    cout << " The minimum limit of double data type :                " << DBL_MIN << endl;
    cout << " The maximum limit of double data type :                " << DBL_MAX << endl;
    cout << " The minimum limit of long double data type :                " << LDBL_MIN << endl;
    cout << " The maximum limit of long double data type :                " << LDBL_MAX << endl;
    cout << endl;
    cout << "\n\n Check the space of memory occupied by countable datatypes :\n";
    cout <<"The f size in memory = " <<sizeof (f) <<endl;
    cout <<"The d size in memory = " <<sizeof (d) <<endl;
    cout <<"The ld size in memory = " <<sizeof (ld) <<endl;
    return 0 ;
}
```

Measurable Data Types


```
 Check the upper and lower limits of countable datatypes :
 The minimum limit of float data type :                1.17549e-038
 The maximum limit of float data type :                3.40282e+038
 The minimum limit of double data type :                2.22507e-308
 The maximum limit of double data type :                1.79769e+308
 The minimum limit of long double data type :                3.3621e-4932
 The maximum limit of long double data type :                1.18973e+4932



 Check the space of memory occupied by countable datatypes :
The f size in memory = 4
The d size in memory = 8
The ld size in memory = 16
```

What happens if you:

- Change the variable to `50.`?
- Change the variable to `.001`?

Boolean Data Type

- Variable can take any of the following two values:
  - true (1)
  - false (0)

Example


```
bool thisIsFun = true;
cout << boolalpha << thisIsFun << endl;
```

What happens if you:

- Change the variable to `false`?
- Remove the `boolalpha` `<<` command?
- Change the variable to `True`?
- Change the variable to `False`?
- Change the variable to `TRUE`?

Character Datatype

- Store single character
- In coding we use ***char*** for character datatype
- The value must be enclosed in single quotes (‘ ’)
- Syntax: char variable_name = ‘Value’ ;
- Example: char grade = ‘A’ ;
- Character datatype will take **1 byte** of memory
- Range of character is **-128 to 127**
- Range of unsigned character is **255**
- **CHAR_MIN**
- **CHAR_MAX**
- **UCHAR_MAX**

Character Datatype

```
#include <iostream>
using namespace std ;
int main ()
{
cout << CHAR_MIN <<endl ;
cout << CHAR_MAX <<endl ;
cout <<UCHAR_MAX <<endl ;
char sub1_grade = 'A' , sub2_grade = 'B+' ;
cout << sub1_grade <<endl <<sub2_grade <<endl ;
return 0 ;
}
```

Character Datatype

```
#include <iostream>
using namespace std ;
int main ()
{
char c = 65 ;
cout <<c <<endl ;
c = '65' ;
cout << c <<endl ;
c = 200 ;
cout << c <<endl ;
return 0 ;
}
```

String Datatype

- Store sequence of characters
- In coding we use ***char*** **[]** or **string** for string datatype
- The value must be enclosed in double quotes (“ “)
- Syntax: char variable_name [size in number] = “Value” ;
- Example: char std_name = “Ahmad” ;
- string variable_name = “value” ;
- string std_name = “Mujtaba” ;
- Char [***n***] datatype will take ***n*** **number of bytes** of memory.
- String datatype will take ***n*** **number of bytes** of memory where ***n*** represents the number of characters in string.

String Datatype

- **What will be the output of following program?**

```
#include <iostream>
using namespace std ;
int main ()
{
char name [10] = "Mujtaba" ;
string name1 = "Mujtaba" ;
cout << name << "\t" << sizeof (name) <<endl;
cout << name1 << "\t" << sizeof (name1) <<endl;
return 0 ;
```

What happens if you:

- Forget one of the " quotation marks?
- Forget both " " quotation marks?
- Use single (') quotation marks?
- Use uppercase `String` instead of lowercase `string`?