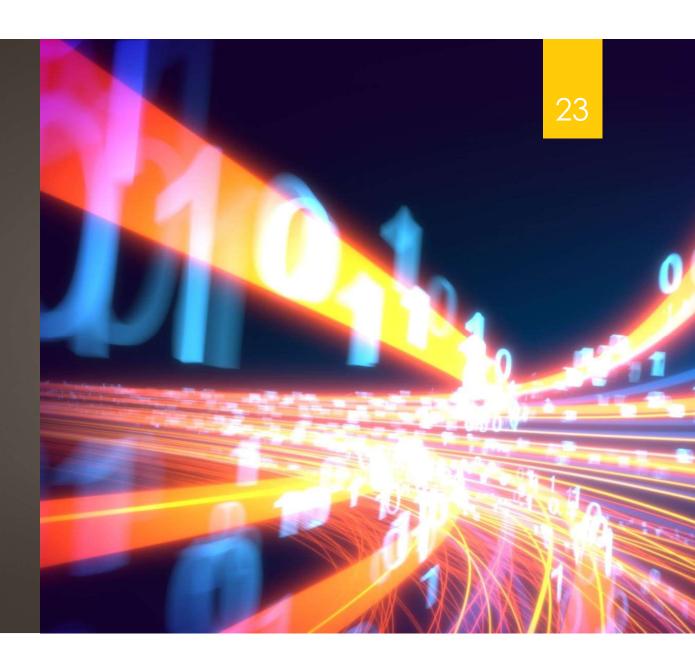
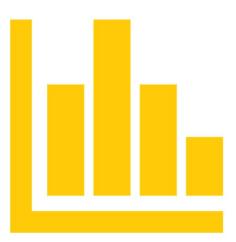
Data Types

- 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

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

```
#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 11 = 10 ;
    signed long 12 = 20 ;
    unsigned long 13 = 30 ;
    long long ll1 = 10;
    signed long long 112 = 20 ;
    unsigned long long 113 = 30;
    cout <<"The s1 size in memory = " <<sizeof (s1) <<endl;</pre>
    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;</pre>
    cout <<"The i2 size in memory = " <<sizeof (i2) <<endl;
    cout <<"The i3 size in memory = " <<sizeof (i3) <<endl;</pre>
    cout <<"The l1 size in memory = " <<sizeof (l1) <<endl;</pre>
    cout <<"The 12 size in memory = " <<sizeof (12) <<endl;</pre>
    cout <<"The 13 size in memory = " <<sizeof (13) <<endl;</pre>
    cout <<"The ll1 size in memory = " <<sizeof (ll1) <<endl;</pre>
    cout <<"The 112 size in memory = " <<sizeof (112) <<end1;</pre>
    cout <<"The 113 size in memory = " <<sizeof (113) <<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 l1 size in memory = 4
The l13 size in memory = 8
The l11 size in memory = 8
The l12 size in memory = 8
```

```
#include <iostream>
     #include <climits>
     using namespace std;
4
     int main ()
5 - {
6
         cout << "\n\n Check the upper and lower limits of integer :\n";</pre>
7
         cout << "----\n";
                                                                        " << INT_MAX << endl;
8
         cout << " The maximum limit of int data type :
                                                                        " << INT_MIN << endl;
         cout << " The minimum limit of int data type :
10
                                                                        " << UINT_MAX << endl;
         cout << " The maximum limit of unsigned int data type :
                                                                         " << LLONG_MAX << endl;
11
         cout << " The maximum limit of long long data type :
12
                                                                         " << LLONG MIN << endl;
         cout << " The minimum limit of long long data type :
13
         cout << " The maximum limit of unsigned long long data type :</pre>
                                                                        " << ULLONG MAX << endl;
                                                                        " << SHRT_MIN << endl;
14
         cout << " The minimum limit of short data type :
15
                                                                        " << SHRT_MAX << endl;
         cout << " The maximum limit of short data type :
16
17
         cout << " The maximum limit of unsigned short data type :</pre>
                                                                        " << USHRT_MAX << endl;
         cout << endl;
18
19
         return 0;
20
21
```

```
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
rocess exited after 0.08577 seconds with return value 0
ress 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

```
#include <iostream>
     #include <cfloat>
     using namespace std;
     int main ()
5 - {
 6
         float f = 9.9 ;
7
         double d = 9.9 ;
8
         long double 1d = 9.9 ;
9
         cout << "\n\n Check the upper and lower limits of countable datatypes :\n";</pre>
10
         cout << " The minimum limit of float data type :
                                                                           " << FLT MIN << endl;
                                                                           " << FLT_MAX << endl;
11
         cout << " The maximum limit of float data type :
                                                                            " << DBL_MIN << endl;
12
         cout << " The minimum limit of double data type :
13
         cout << " The maximum limit of double data type :
                                                                            " << DBL MAX << endl;
14
         cout << " The minimum limit of long double data type :
                                                                                 " << LDBL MIN << endl;
15
         cout << " The maximum limit of long double data type :
                                                                                 " << LDBL_MAX << endl;
16
17
         cout << "\n\n Check the space of memory occupied by countable datatypes :\n";</pre>
18
         cout <<"The f size in memory = " <<sizeof (f) <<endl;
19
         cout <<"The d size in memory = " <<sizeof (d) <<endl;</pre>
20
         cout <<"The ld size in memory = " <<sizeof (ld) <<endl;
21
         return 0;
22
```

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
                                              1.79769e+308
The maximum limit of double data type :
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;</pre>
```

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;
    }
}</pre>
```

Character Datatype

```
    #include <iostream>
    using namespace std;
    int main ()
    {
    char c = 65;
    cout <<c <<endl;</li>
    c = '65';
    cout << c <<endl;</li>
    c = 200;
    cout << c <<endl;</li>
    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;</pre>
```

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?