Data Types

- Variables are classified according to their data type.
- The data type determines the kind of information that may be stored in the variable.
- A data type is a set of values.
- Generally two main (types of) data types:
  - Numeric
  - Character
Data Types

- **int, short, long**
  - whole numbers
- **float, double**
  - real numbers
- **bool**
  - logical values: true, false
- **char**
  - single character
- **string**
  - any text

Integer Data Types

- **int, short, long**
- May be signed (default) or unsigned (signed is a modifier)
- Typical sizes and ranges (may vary depending on the system)

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>short</td>
<td>2 bytes</td>
<td>-32,768 to 32,767</td>
</tr>
<tr>
<td>unsigned short</td>
<td>2 bytes</td>
<td>0 to 65,535</td>
</tr>
<tr>
<td>int</td>
<td>4 bytes</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
<tr>
<td>unsigned int</td>
<td>4 bytes</td>
<td>0 to 4,294,967,295</td>
</tr>
<tr>
<td>long</td>
<td>4 bytes</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
<tr>
<td>unsigned long</td>
<td>4 bytes</td>
<td>0 to 4,294,967,295</td>
</tr>
</tbody>
</table>

- Literals (int by default):  0  5  100  -3  2147000001  -2434555
- Example variable definitions:
  ```java
  short dayOfWeek;
  unsigned long distance;
  int xCoordinate;
  ```
Floating-Point Data Types

- **float**, **double**, **long double**
- Typical sizes and ranges (may vary depending on the system):
  
  **float** 4 bytes  +/- 3.4e +/- 38 (~7 digits)
  **double** 8 bytes  +/- 1.7e +/- 308 (~15 digits)
  **long double** 8 bytes  +/- 1.7e +/- 308 (~15 digits)

- Literals (default type is double):
  
  31.415E5  // equivalent to 3141500.0
  -31.415e5  // equivalent to -3141500.0
  3.1e-4  // equivalent to 0.00031
  31000.0
  31000  // NO, this is an int literal
  31000.0f  // converts to float
  31000f  // error, must be a floating-point literal

[31.415E5](//equivalent to 3141500.0)
[31000.0](//NO, this is an int literal)
[31000f](//error, must be a floating-point literal)

Floating-Point Data Types

+3.4e38 is equal to 34000...000 (with 37 zeros)
-3.4e38 is equal to -34000...000 (with 37 zeros)
+3.4e-38 is equal to .000...034 (with 37 zeros)
-3.4e-38 is equal to -.000...034 (with 37 zeros)

maximum vs minimum, biggest vs smallest (absolute value)

"~7 digits"

to number of digits in the mantissa:

-1.234567e-25 is equal to .000...01234567 (with 24 zeros)

This number: 0.1234567890123456789 will get rounded to: 0.1234568 which is the same as: 0.1234568e0

If it is stored as a double, it will get rounded to:
0.123456789012346 because it can store about 15 digits in the mantissa.
The bool Data Type

- **bool**
- **Literals:** true  false

```cpp
bool boolValue;

boolValue = true;
cout << boolValue << endl;
boolValue = false;
cout << boolValue << endl;
```

Output:
1 0

- **bool is a numeric type:**
  - true is 1 and false is 0
The char Data Type

- char
- Literals: 'A' '3' '!' '\n' 'n'

```cpp
char letter;
letter = 'A';
cout << letter << endl;
letter = '!';
cout << letter << endl;
```

Output:
A
!

The char Data Type

- char is really a numeric type also!
- Note: 65 is the ASCII code for 'A'

```cpp
char letter;
letter = 65;
cout << letter << endl;
letter = 66;
cout << letter << endl;
```

Output:
A
B
The string Data Type

- We will not declare variables that contain strings yet.
- A string is a sequence of characters.
- Literals: “Hello again” “Over\nThere” “Y”
- A string is stored sequentially in memory, with the null character (‘\0’) at the end.
- The null character is not displayed.