

Data Types

Section 2.6 – 2.12

Today

- Last week we covered
 - `main` function
 - `cout` object
 - How data that is used by a program can be declared and stored
- Today we will
 - Investigate the various types of data that C++ can handle

Declaration Statements

- Examples of declaration statements

```
const double PI = 3.14;
const double RADIUS = 5.4;
double area;
double circ;
```
- With the above statements we are declaring four things
 - `PI` to store the value of Pi that never changes
 - `RADIUS` to store the value of radius that never changes
 - `area` to store the area of the circle
 - `circ` to store the circumference of the circle

Declaration Statements

- Variable declarations
 - Allocate space for data to be used in the program
 - The data *can* be changed

```
double area;  
double circ;
```

- Constant declaration
 - Allocate space for data that *cannot* be changed

```
const double PI = 3.14;  
const double RADIUS = 5.4;
```

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Variable Declaration

- If there is more than one variable of a single data type then you
 - State the data type
 - List the variable identifiers (names) separated by commas
 - Semicolon

```
data-type identifier1, identifier2;  
double area, circ;
```

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Identifiers (2.6)

- Programmer-defined names that represent some element of a program
- C++ limits on variable names:
 1. Identifiers must begin with a letter or an underscore
 2. Identifiers must consist of letters, numbers and underscore, nothing else
 3. Identifiers cannot be a *reserved keyword*

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Reserved Keywords

- What are keywords?
- Examples?
- A list of C++ keywords can be found on page 42 of your textbook

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Identifiers

- Identifiers are case sensitive
 - `int totalCost;`
 - `int TotalCost;`
 - `totalCost` and `TotalCost` are different variables
 - different locations in memory, different data
- Use meaningful variable names
- If you have a variable that represents the width, then call it `width` not `w`

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Identifiers

- Q.1 Which of the following declarations are invalid and why?
 - `char Letter1;`
 - `char lletter;`
 - `double inches, kms;`
 - `double inches*num;`
 - `int joe's;`
 - `Int cent_per_inch;`
 - `double two-dimensional;`
 - `char hello;`
 - `int return;`
 - `size int;`

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Data types

- C++ can store many different types of data
- A data type defines what operations can be performed on data of that type
 - how the program interprets the data stored in that chunk of memory
- We will be looking at
 - Integer numbers
 - Characters
 - Strings
 - Floating-point numbers
 - Booleans

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Integers (2.7)

- The main integer data type is `int`
 - Integer (whole) numbers, both positive and negative
- `ints` are finite (why?)
 - a limited range of values that is *implementation* dependent
- An `int` without a sign (+ or -) is assumed to be positive
- 2,353 is not an `int`, 2353 is an `int`
- What operations can be performed on integers?

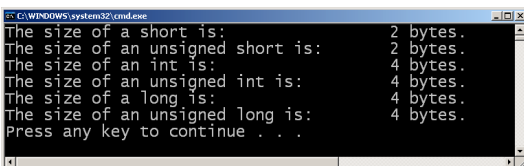
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Integer Data Types

- There are six integer data types, each with a different range and a different size
 - what does `unsigned` mean?



```
C:\WINDOWS\system32\cmd.exe
The size of a short is: 2 bytes.
The size of an unsigned short is: 2 bytes.
The size of an int is: 4 bytes.
The size of an unsigned int is: 4 bytes.
The size of a long is: 4 bytes.
The size of an unsigned long is: 4 bytes.
Press any key to continue . . .
```

- Range of data types is listed on page 44
- see program 2-17 on page 58 for the above output

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Variable Ranges

Type	Size	Values
short int	2 bytes	-32,768 to 32,767
int	4 bytes	-2,147,483,648 to 2,147,483,647
unsigned int	4 bytes	0 to 4,294,967,295
long int	4 bytes	-2,147,483,648 to 2,147,483,647

- What is the range of an **unsigned short**?
- What data type should you use for a person's age?
- What data type should you use for the temperature on the moon?
- What data type should you use for the size of a music file (mp3)? **Why?**

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char (2.8)

- The **char** data type is used to store single characters (letters, digits, special characters)
 - 1 byte of data
- Characters are stored as integers
 - however, `'1'` is not equal to integer value 1
- The most common method for encoding characters is ASCII
- Character constants are enclosed in single quotes
- Examples of character constants are: `'A'`, `'a'`, `'*'` , `'2'`, `'$'`

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ASCII Character Set

- page 1097

Decimal Value	Character
32	<space>
33	!
65	A
66	B
67	C
97	a
98	b
99	c

- <http://asciitable.com>

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Example

```
// page 48, program 2-11
#include <iostream>

using namespace std;

int main()
{
    char letter;

    letter = 65;
    cout << letter << endl;
    letter = 66;
    cout << letter << endl;
    return 0;
}
```

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Program 4.2

```
// page 49, program 2-12
#include <iostream>

using namespace std;

int main()
{
    char letter;

    letter = 'A';
    cout << letter << endl;
    letter = 'B';
    cout << letter << endl;
    return 0;
}
```

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char

- Character constants can only hold a single character
- String constants are used to store a series of characters
- To indicate the end of a string, a null terminator is used

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Questions

- Q.2 How are the character 'A' and the string constant "A" stored in memory?
- Q.3 Is the escape character \n a character or a string?
- Q.4 How do we declare a `char` variable and assign it a value?

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`string` Class (2.9)

- `string` is the data type used to store more than one character
- Not built into C++ but provided by standard C++
- Need to include the preprocessor directive
 - `#include <string>`
 - `string` is not a keyword
 - why?

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`string` Questions

- Q.5 How do we declare a variable of type `string`?
- Q.6 How do we assign a value to the variable?
- Q.7 How do we output a string constant and a string variable? What is output?

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Floating-Point Data Types (2.10)

- **float, double, long double**
 - positive and negative
 - no unsigned float!
- Computers store floating-point numbers in a manner similar to scientific notation
- Examples of floating-point numbers are: 1.0, -2.3, -0.3, 12E5, -1E-2, 1.4e+8
- 2,353.99 is **not** a **double**
- 2353.99 is a **double**

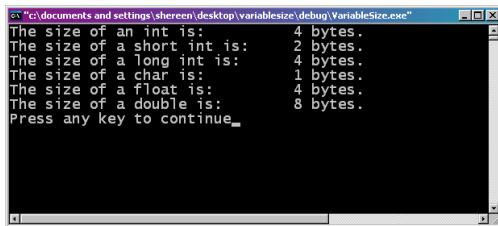
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Variable Sizes

- On my machine the sizes are



```
cs:"c:\documents and settings\shereen\Desktop\variablesize\debug\VariableSize.exe"
The size of an int is:      4 bytes.
The size of a short int is: 2 bytes.
The size of a long int is: 4 bytes.
The size of a char is:     1 bytes.
The size of a float is:    4 bytes.
The size of a double is:   8 bytes.
Press any key to continue_
```

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Variable Size Program (2.12)

```
// page 58, program 2-17
#include <iostream>

using namespace std;

int main()
{
    cout << "The size of an int is:\t\t" << sizeof(int) << " bytes.\n";
    cout << "The size of a short int is:\t\t" << sizeof(short) << " bytes.\n";
    cout << "The size of a long int is:\t\t" << sizeof(long) << " bytes.\n";
    cout << "The size of a char is:\t\t" << sizeof(char) << " bytes.\n";
    cout << "The size of a float is:\t\t" << sizeof(float) << " bytes.\n";
    cout << "The size of a double is:\t\t" << sizeof(double) << " bytes.\n";

    return 0;
}
```

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Variable Ranges

Type	Size	Values
<code>int</code>	4 bytes	-2,147,483,648 to 2,147,483,647
<code>short int</code>	2 bytes	-32,768 to 32,767
<code>long int</code>	4 bytes	-2,147,483,648 to 2,147,483,647
<code>unsigned int</code>	4 bytes	0 to 4,294,967,295
<code>char</code>	1 byte	256 character values
<code>float</code>	4 bytes	$\pm 3.4e-38$ to $\pm 3.4e38$
<code>double</code>	8 bytes	$\pm 1.7e-308$ to $\pm 1.7e308$

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How to Choose a Numeric Data Type

- Ask yourself the following questions
 - What are the largest and smallest numbers that may be stored?
 - How much memory does the variable use?
 - Is the variable signed (positive and negative)?
 - How many decimal places of precision does the variable need?

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Examples

- Remember, the format for declaring variables is:
 - `data-type identifier;`
- You can declare variables of the different data types as follows
 - `int num1;`
 - `double num2;`
 - `char letter;`

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Problem

- What variables will you need for the following program?
- page 71, #4.
- Write a program that computes the tax and tip on a restaurant bill. The user will enter the original bill and the tax rate. Assume a 15% tip. Display the tax amount, tip amount, and total bill on the screen.

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Summary

- In today's lecture we covered
 - Identifiers
 - Data types
 - How data that is used by a program can be declared and stored
- We have covered sections 2.7 – 2.12 of your textbook
- Homework: page 68: 15-18, 25, 27,

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