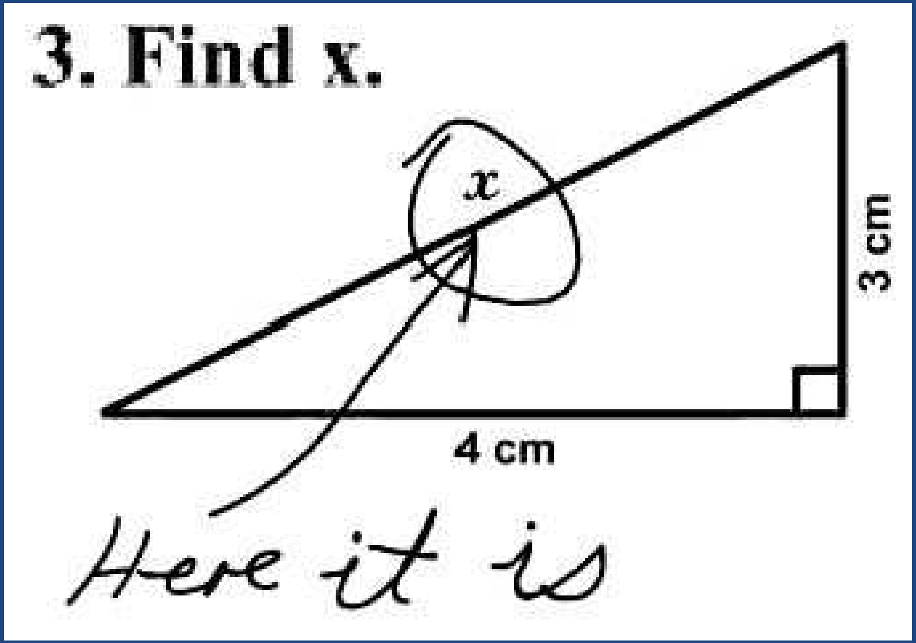
Slides #3

# Variables

Chapter 2.1-2.2

x + 2 = 5
x = 3
B.Ico
"Just a darn minute! — Yesterday you said that X equals two!"



## Topics

1) How can we store data, such as numbers?
2) How can we do calculations like:
    10 times 3?

## Variables

## Variables

- A variable stores a value.
  - It is..
  - C++ is..
    Each variable is given a type, like “integer” when it is created.
- Example:
  - the variable:

    ```
    int numStudents;
    ```
  - the variable:

    ```
    numStudents = 72;
    ```

..

Variable declarations tell the compiler the variable's type (int) and name (numStudents).

All variables must be..

"Error: Undeclared identifier"

This assignment statement copies the value (72) into the variable (numStudents).

## Example with Variables

```
// Small demonstration of variables.
#include <iostream>
using namespace std;

int main()
{
	// Create the variable, give it a value, and then display it.
	int numStudents;
	numStudents = 5;
	cout << "The value of numStudents is: " << "numStudents" << endl;
	cout << "The value of numStudents is: " << numStudents << endl;

	// Change the value and re-display it.
	numStudents = 7;
	cout << "Now the value of numStudents is: "
		<< numStudents << endl;
	return 0;
}
```

Output:

```
The value of numStudents is: numStudents
The value of numStudents is: 5
Now the value of numStudents is: 7
```

# Identifiers

- Identifier: a programmer-defined name which..
  - Ex: Variable names, or function (later...)
- Valid Identifiers:
  - First character: a-z or A-Z or _
  - Any other characters: a-z or A-Z or _ or 0-9
  - Examples:
    - height, i, x1, numStudents, NUM_PEOPLE, cur_weight
- Invalid Identifiers:
  - 2Tall, 11a, test#2, 3dGraphics

# Identifiers

- Identifiers cannot be keywords:
  - Keywords are...
  - Ex: int, return, char, for, while, switch, case...
- Tips:
  - Use meaningfully descriptive names:
    - numStudents is better than n
    - boxHeight is better than x
  - Use camel case for variables names:
    First word is lower case,
    Capitalize first letter of later words.
    - Ex: Students per course: ...

# Naming

What's in a name? that which we call a rose
By any other name would smell as sweet;
-- Shakespeare: *Romeo and Juliet.*

- A variable name *is* important:
  - It's what other programmers will read.
  - It tells us..

```
#include <iostream>
using namespace std;
int main()
{
	int s = 90;
	int f = s * 10;
	cout << f << endl;
}
```

- What does this code output?

- Guess what is s? Any better names?

- Guess what is f? Any better names?

# Variable Example

```
// Calculate the length and cost of a fence around a rectangular area
#include <iostream>
using namespace std;
int main()
{
    int landWidth = 10;
    int landLength = 15;
    int fenceLength = (2 * landWidth) + (2 * landLength);

    cout << "For some land "
            << landWidth << "m by "
            << landLength << "m, the total fence length require is "
            << fenceLength << "m.\n";


    double costPerMeter = 3.50;
    double fenceCost = fenceLength * costPerMeter;
    cout << "Total fence cost (at $" << costPerMeter
            << "/m) is $" << fenceCost << ".\n";
    return 0;
}
```

```
For some land 10m by 15m, the total fence length require is 50m.
Total fence cost (at $3.5/m) is $175.
```

double type holds floating point numbers like 3.1415

## Exercise: Bad names?

- What’s wrong with the following variable names?
  1) x
  2) 3LittlePigs
  3) sumofalltestscores
  4) numNeuronsPerClusterInLayer2ObjectDetector
  5) double

# Operations on Numbers

- Most basic math operations work on numbers.
  - int x = 10; int y = 3; int z = 0;
  - Addition z = x + y;
  - Subtraction z = x - y;
  - Multiplication z = x * y;
  - Division z = x / y;
  - Modulo z = x % y;
  - Negation z = -x;

Negation is Unary:
it takes only on argument.

+, -, *, /, % are
binary operators:
they take two arguments.

# Get real!

- Give each variable a type based on what it will hold.
  - int for integers
  - double for real ("floating point") numbers

```
int numStudents = 42;
int missionClock = -10;
int numPinkElephants = 0;

double treeHeight_m = 42.9;
double averageDogs = 0.35;
double distanceToPluto_m =  7.5E9;
        // 7.5*10^9;
```

- For each of your variables, pick the best type.

For now, all real numbers should be in doubles:

```
double dogsInClass = numStudents * averageDogs;
```

## Out Of Class Review Question

- Write a program which:
  - Create two int variables; hard-code them to be two different values.
  - Calculate their:
    - sum (+)
    - difference (-)
    - product (*)
  - Use good variable names to store each result.
  - Display each result to the screen.
  - Try making the variables double and see what happens; change their values too.

## Summary

- C++ variables are strongly typed: int, double, char, string
  - Must declare variables before use.
  - Operators: +, -, *, /, %
  - How to write a program.

Slides #3

# Variables - Part 2

Chapter 2.1-2.2

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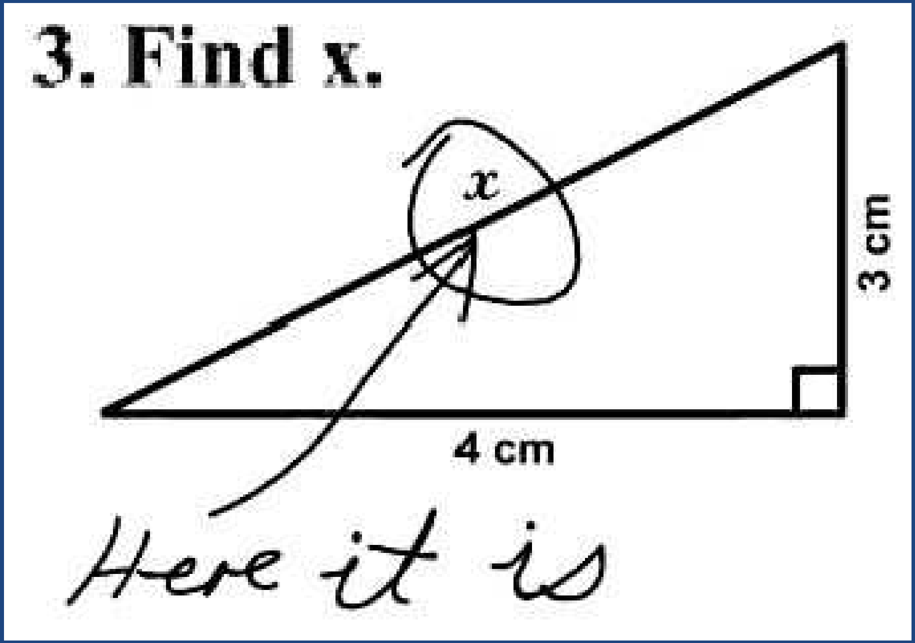
$x+2=5$
$x=3$
B.Ico
"Just a darn minute! — Yesterday you said that X equals two!"



## char and string

# char

- The char type can hold a single character.
  - Pronounced like "charred" not like "car".
- Characters are represented by the computer..
  - 'A' is 65, 'B' is 66, 'C' is 67, etc (ASCII codes)
  - cout shows char's as a character (65 as 'A').

```
char aLetter = 'A';
cout << "char A:    " << aLetter << endl;

aLetter = 70;
cout << "char 70: " << aLetter << endl;

aLetter = aLetter + 1;
cout << "char 71: " << aLetter << endl;
```

Output:

```
char A:   A
char 70: F
char 71: G
```

charExample.cpp

## string Class

- The string class stores and manipulates strings.
  - string class defined in library: #include <string>

```
// Example for string
#include <iostream>
#include <string>
using namespace std;

int main()
{
    string name;
    cout << "Who are you? ";
    cin >> name;

    cout << "Welcome to the great \"" << name << "\"! :)" << endl;
}
```

Sample Run:

```
Who are you? Me
Welcome to the great "Me"! :)
```

## Working with strings

- = String Assignment
  ```
  string name = "Bond";
  ```
- + String Concatenation
  - Use a + to join two strings together.
  ```
  string full =                    // = "James Bond"
  ```
- String Length
  - Use the "member-function" length on a string:
  ```
  int nameLen =                    // = 10 chars long.
  ```
- [ ] Get a character in a string
  ```
  char firstChar = name[0];        //
  char secondChar = name[1];       //
  ```

## Keyboard Input
## and
## Basic Output Formatting

# Input

- Almost every computer program needs input.
- Examples:
  - Calculate # pizzas for a party: input # people.
  - Calculate gas mileage: input distance and fuel used.
- Input with cin:...

```
int people = 0;
cin >> people;
```

  - >> is the...
  - cin waits for the user to type in...
  - Places the answer in the given variable.

## Prompts

- Prompting the User:
  - cout: Display a prompt to user asking for input.
  - cin: Read keyboard input into a variable.

```
#include <iostream>
using namespace std;

int main() {
	int favNum = 0;

	// Read in user's favourite number:
	cout << "Enter your favourite number: ";
	cin >> favNum;

	if (favNum < 0) {
		cout << "Now that's interesting! " << favNum << " eh?\n";
	} else {
		cout << "Your favourite number is: " << favNum << endl;
	}
}
```

```
Enter your favourite number: 42
Your favourite number is: 42
```

## Input Example

```
// Ask the user for their personal information.
#include <iostream>
#include <string>
using namespace std;

int main()
{
	cout << "What is your name? ";
	string name;
	cin >> name;

	cout << "What is your height in cm? ";
	int height = 0;
	cin >> height;

	cout << "What is the airspeed velocity of an unladen swallow? ";
	int speed = 0;
	cin >> speed;

	cout << "Hello Sir " << name << ", whose height is " << height << "cm.\n";
	cout << "A swallow's airspeed is NOT " << speed << "!\n";
}
```

bridgeKeeper.cpp

youtube clip.

# setw()

- setw() is a manipulator:
  - 
      - Great for lining up data on the screen.
  - setw() only affects the one next element.
- Example:

```
int age = 12
cout << "[" << age << "]";
cout << "[" << setw(5) << age << "]";
```

Output

```
[12]
[   12]
```

Pads with spaces when item is fewer characters than the setw()'s width.

..
if it's larger than width.

# Making a table

```
          Name:          Fav Food  Fav Number
       Dr. Evil          Cupcakes   100000000
    I.L.B. Bach         Anchovies        1997
             Me    Pizza and Cake           0
```

```
#include <iostream>
#include <iomanip>
using namespace std;
int main()
{
        const int WIDTH1 = 15;
        const int WIDTH2 = 18;
        const int WIDTH3 = 12;

        cout << setw(WIDTH1) << "Name:"
                << setw(WIDTH2) << "Fav Food"
                << setw(WIDTH3) << "Fav Number"<<endl;

        cout << setw(WIDTH1) << "Dr. Evil"
                << setw(WIDTH2) << "Cupcakes"
                << setw(WIDTH3) << "100000000"<<endl;

        cout << setw(WIDTH1) << "I.L.B. Bach"
                << setw(WIDTH2) << "Anchovies"
                << setw(WIDTH3) << "1997"<<endl;
        // . . . . . .  omitted to fit on slide.
}
```

## Review

1. What is wrong with each of these?
   a) int 1stVar = 10;
   b) int return = 0;

2. What is the value of each of these variables?
   a) int x = 5 / 2;
   b) int y = 21 % 5;
   c) double z = 4 * 1.5;

3. What statement displays variable age using 6 columns?

4. What statement reads in a number to the variable age?

## Summary

- Formatted output:

```
cout << setw(10) << “Hello”;
```

- Keyboard Input:

```
cin >> myAge;
```

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# Variables - Part 3

Chapter 2.1-2.2

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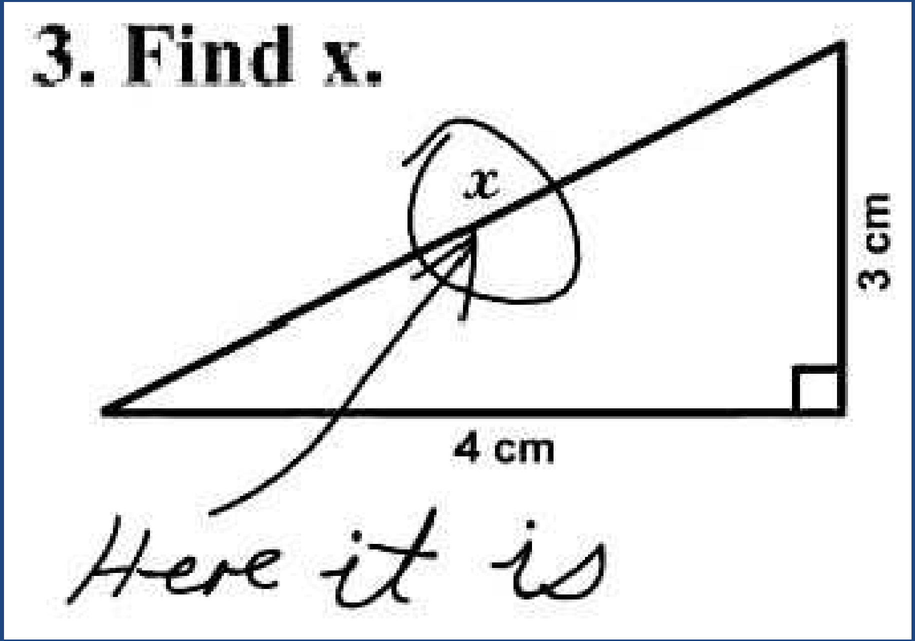

## Initialization, Scope, and Comments

## Uninitialized Variables

- Variables which are not initialized...
  - That value is garbage (unknown).

```
short g1, g2, g3, g4, g5, g6, g7, g8;
cout << setw(8) << g1;
cout << setw(8) << g2;
cout << setw(8) << g3;
cout << setw(8) << g4 << "\n";
cout << setw(8) << g5;
cout << setw(8) << g6;
cout << setw(8) << g7;
cout << setw(8) << g8 << "\n";
```

Output:

```
2052      -29221   114       8240
51        25765    -16446   2216
```

# Variable Initialization

- Variable Initialization:
  - You should always..
  - Can **initialize** with either:..

    ..

    Uniform Initializer

  - C++ does not require variable initialization; but it is a good safe practice.
- Each variable must be defined exactly once.

```
int height = 1;
int height = 1;        ..
```

# Uniform Initializer Example

```
// Show uniform initializers
#include <iostream>
#include <iomanip>
using namespace std;

int main () {
    const int SIDES_PER_TRIANGLE {3};
    const int WIDTH {5};

    cout << "How many triangles? ";
    int triangles {0};
    cin >> triangles;

    int totalSides = (triangles * SIDES_PER_TRIANGLE);

    cout << "# Triangles: " << setw(WIDTH) << triangles << endl;
    cout << "# Sides:     " << setw(WIDTH) << totalSides << endl;

    return 0;
}
```

```
How many triangles? 8
# Triangles:     8
# Sides:        24
```

## Scope

- Scope is the region of the program where..

```
int main() {
    int height = 10;
    cout << height;      // OK.

    cout << width;       // ERROR: not defined yet!
    int width = 10;
    return 0;                    ..
}
```

More on this later!

## Comments

- Good comments tell you..

- Which comment is best?
  - double rate = 0.12;      // Set to 0.12
  - double rate = 0.12;      // Set to current tax rate.
- Rule of thumb:
  - Comment the purpose of every 3-4 lines of code.

## Comment Style

- Single line comments use double slash:

```
// Insert meaningful comment here.
int i=2;
```

- Multiple line comments use /* ... and ... */

```
/*
 These are good for larger comments.

 For example, describing a function's purpose,
 Arguments, return value, and errors.
*/
```

- When changing the code...
  - An incorrect comment is worse than no comment!

## Out Of Class Review Question

- Write a program to help out at a health center:
  - Reads in two numbers from the keyboard:
    - Number of patients waiting
    - Number of nurses working
  - Calculate and display how many patients each nurse sees (and how many left over)
  - Calculate total number of people at the health centre
  - Calculate how long it will be until any nurse has a break from seeing patients (assume 10m / patient)

  - Line up output nicely on screen.
  - Use good variable names to store each result.

## Summary

- Importance of variable initialization
- Include meaningful comments!