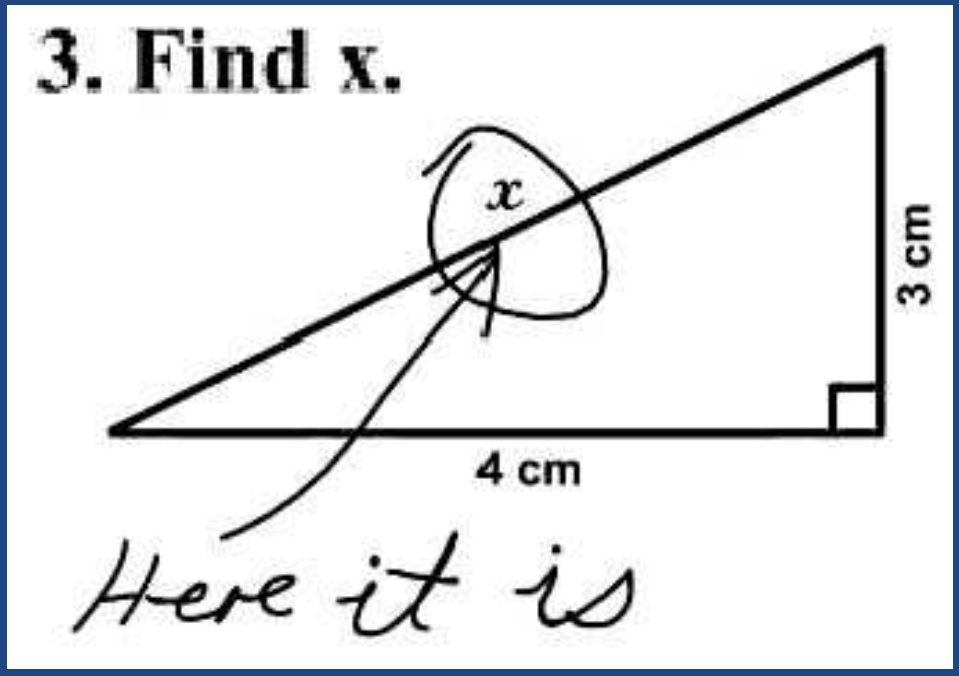
Slides #3

Variables

Chapter 2.1-2.2



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 has 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 <print>
using namespace std;

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

    // Change the value and re-display it.
    numStudents = 7;
    println("Now the value of numStudents is: {}", numStudents);
    return 0;
}
```

```
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 <print>
using namespace std;
int main() {
    int s = 90;
    int f = s * 10;
    println(f);
}
```

- What does this code output?

- Guess what is s? Any better names?

- Guess what is f? Any better names?

Variable Example

```
// Demonstrate variables
#include <print>
using namespace std;

int main() {
  int landWidth = 10;
  int landDepth = 15;
  int fenceLength = (2 * landWidth) + (2 * landDepth);

  println("For some land {}m by {}m, the total fence length is {}m.",
       landWidth, landDepth, fenceLength);

  double costPerMeter = 3.50;
  double fenceCost = fenceLength * costPerMeter;
  println("Total fence cost (at ${} /m) is ${}.",
       costPerMeter, fenceCost);
  return 0;
}
```

double type holds floating point numbers like 3.1415

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

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

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

  - double for real ("floating point") numbers

```
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.

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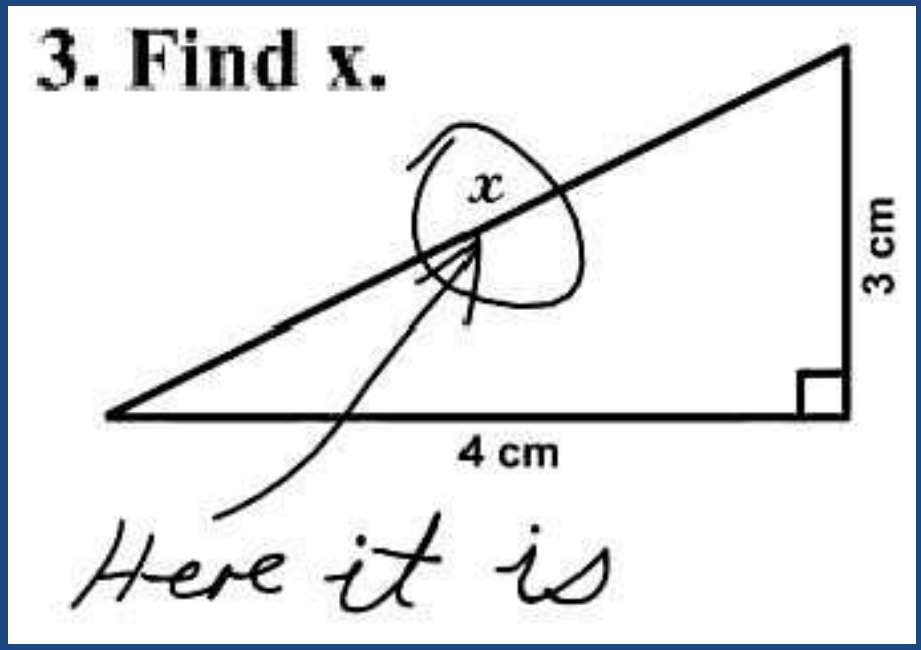
Variables - Part 2

Chapter 2.1-2.2

CMPT 130



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)
  - println() shows char's as a character (65 as 'A').

```
// Show equivalence of a number and a character
int main() {
    char aLetter = 'A';
    println("char A:  {}", aLetter);

    aLetter = 70;
    println("char 70: {}", aLetter);

    aLetter = aLetter + 1;
    println("char 71: {}", aLetter);
}
```

Output:

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

string Class

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

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

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

    println("Welcome to the great \"{}\"! :)", name);
}
```

```
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.at(0);                    //
char secondChar = name.at(1)                    //
```

- Convert something to a string:
  - `string with7 = full + to_string(7);` // = "James Bond7"

Keyboard Input
and
Basic Output Formatting

Input

- Almost every 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:
  - print: Display a prompt to user asking for input.
  - cin: Read keyboard input into a variable.

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

int main() {
    int favNum = 0;

    // Read in user's favourite number:
    print("Enter your favourite number: ");
    cin >> favNum;

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

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

Input Example

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

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

    print("What is your height in cm? ");
    int height = 0;
    cin >> height;

    print("What is the airspeed velocity of an unladen swallow? ");
    int speed = 0;
    cin >> speed;

    println("Hello Sir {}, whose height is {}cm.", name, height);
    println("A swallow's airspeed is NOT {}!", speed);
}
```

```
What is your name? Bert
What is your height in cm? 33
What is the airspeed velocity of an unladen swallow? 2
Hello Sir Bert, whose height is 33cm.
A swallow's airspeed is NOT 2!
```

println() and width

- Lineup output:..

```
int main() {
    int age = 0;
    print("Enter your age: ");
    cin >> age;
    int days = age * 365;
    int hours = days * 24;

    println("Age:        {:5}", age);
    println("Days old:   {:5}", days);
    println("Hours old:  {:5}", hours);
}
```

```
Enter your age: 2
Age:            2
Days old:     730
Hours old:  17520
```

```
Enter your age: 1234
Age:         1234
Days old:   450410
Hours old: 10809840
```

  - It won't clip if value is too many digits; just breaks output alignment.
  - Hint: Hard-code spaces into the println() string to line up the fields (e.g., after "age" above).

Making a table

```cpp
// Set width of output
#include <print>
using namespace std;

int main() {
    println("{:15}{:18}{:12}", "Name:", "Fav Food", "Fav Number");
    println("{:15}{:18}{:12}", "----------", "----------", "----------");
    println("{:15}{:18}{:12}", "Dr. Evil", "Cupcakes", 100000000);
    println("{:15}{:18}{:12}", "I.L.B. Bach", "Anchovies", 1997);
    println("{:15}{:18}{:12}", "Me", "Pizza and Cake", 0);
}
```

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

Alignment: Left, Right, Centre

- {5} uses a default alignment for the data type
- {:<5} for left {:^5} for centred {:>5} for right

```cpp
// Set width and alignment of output
#include <print>
using namespace std;

int main() {
    println("{:<15}{:^18}{:>12}", "Name:", "Fav Food", "Fav Number");
    println("{:<15}{:^18}{:>12}", "----------", "----------", "----------");
    println("{:<15}{:^18}{:>12}", "Dr. Evil", "Cupcakes", 100000000);
    println("{:<15}{:^18}{:>12}", "I.L.B. Bach", "Anchovies", 1997);
    println("{:<15}{:^18}{:>12}", "Me", "Pizza and Cake", 0);
}
```

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

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:

```
int numLights = 4;
println("I see {:>3} lights!", numLights);
```

- Keyboard Input:

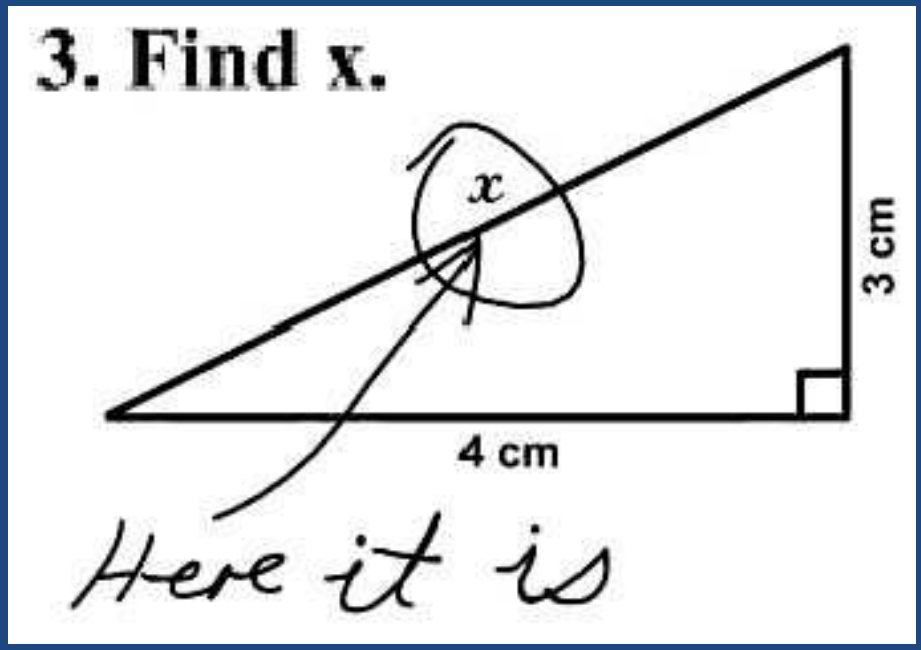
```
int age = 0;
cin >> myAge;
```

Slides #3

Variables - Part 3

Chapter 2.1-2.2

CMPT 130



Initialization, Scope, and Comments

Uninitialized Variables

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

```
// Demonstration of uninitialized variables hold a value.
#include <print>
using namespace std;

int main (){
    short g1, g2, g3, g4, g5, g6, g7, g8;
    println("{:8}{:8}{:8}{:8}", g1, g2, g3, g4);
    println("{:8}{:8}{:8}{:8}", g5, g6, g7, g8);
}
```

```
       0   32767   -2130   15762
       0       0       0       0
```

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 <print>
using namespace std;

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

    print("How many triangles? ");
    int triangles {0};
    cin >> triangles;

    int totalSides = (triangles * SIDES_TRIANGLE);

    println("# Triangles: {:>{}}", triangles, WIDTH);
    println("Total sides: {:>{}}", totalSides, WIDTH);
}
```

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

Can use an argument for the width, rather than hard coding:
“hello {:{}}” - nests a {} inside {}

Scope

- Scope is the region of the program where..

```
// Must declare variables before using them.
#include <print>
using namespace std;

int main() {
    int height = 10;
    println("Height: {}", height);    // OK.

    println("Width: {}", 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 centre:
  - 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!