05 - Making Decisions - Part 1

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Outline

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Introduction to Branching

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What is Truth?

In C++, 0 is false. All other values are true.
We usually use expressions which logically evaluate to true or false as conditions

Comparison Operations

Relational Operators

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- $<$ Less Than

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- $<$ Less Than
- $>$ Greater Than

Comparison Operations

Relational Operators

- `<` Less Than
- `>` Greater Than
- `<=` Less Than or Equal To

Comparison Operations

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Equality Operators

- `==` Equal

Comparison Operations

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Equality Operators

- `==` Equal
- `!=` Not Equal

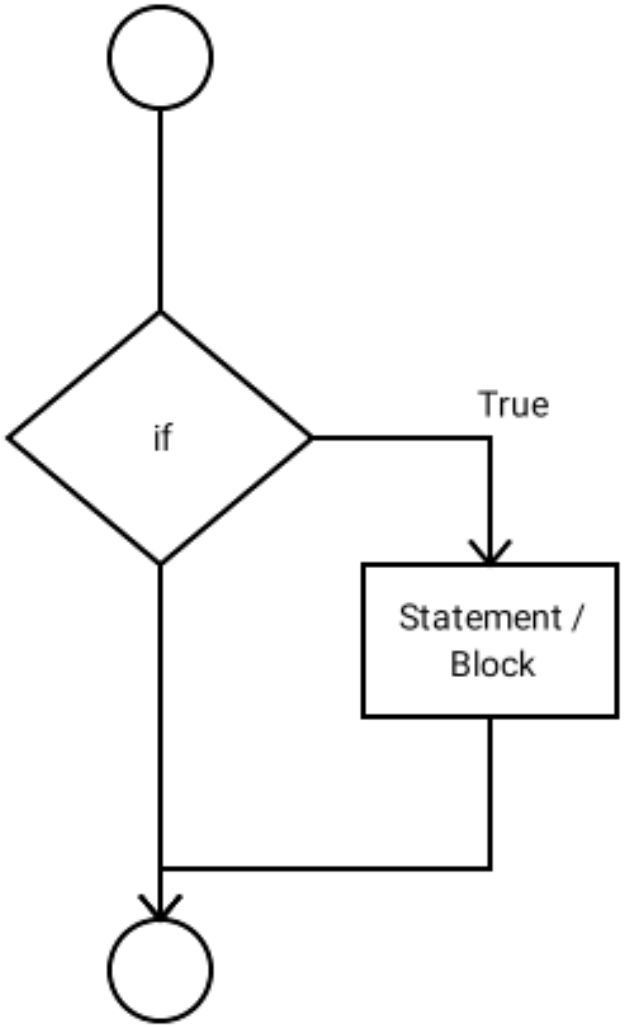
Operator Precedence (Thus Far)

Operator	Description	Associativity
`a*b`, `a/b`, `a%b`	Multiply, Divide, Modulus	Left-to-Right
`a+b`, `a-b`	Addition and Subtraction	Left-to-Right
« , »	Insertion and Extraction	Left-to-Right
`<`, `<=` `>`, `>=`	Relational Operators	Left-to-Right
`==`, `!=`	Equality Operators	Left-to-Right

`=`,
`+=`, `-=`
`*=`, `/=`
`%=`
	Assignment and Assignment	Right-to-Left

If Statement

```
if( condition )
    statement/block
```



If Statement

```
if( condition )
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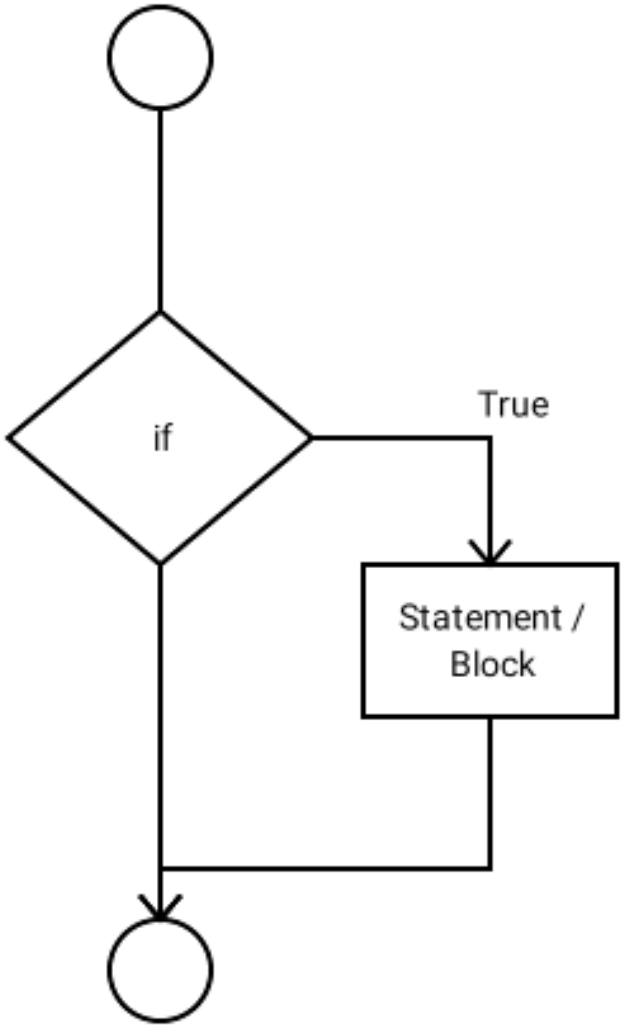
- If the *condition* is true, the *statement/block* will be executed.



If Statement

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if( condition )
    statement/block
```
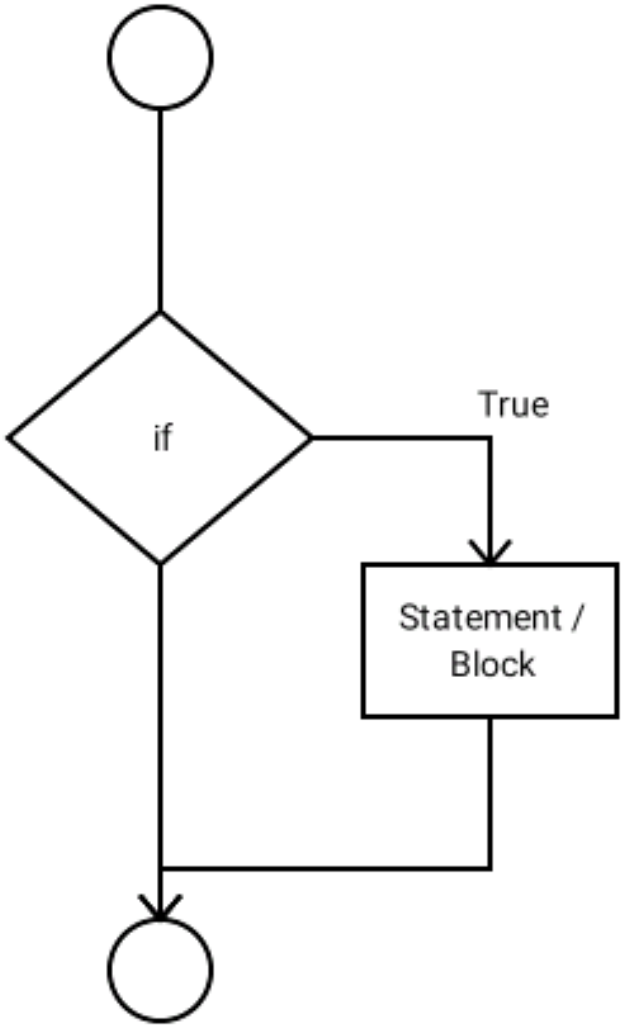

- If the *condition* is true, the *statement/block* will be executed.
- If the *condition* is false, the *statement/block* will be skipped.

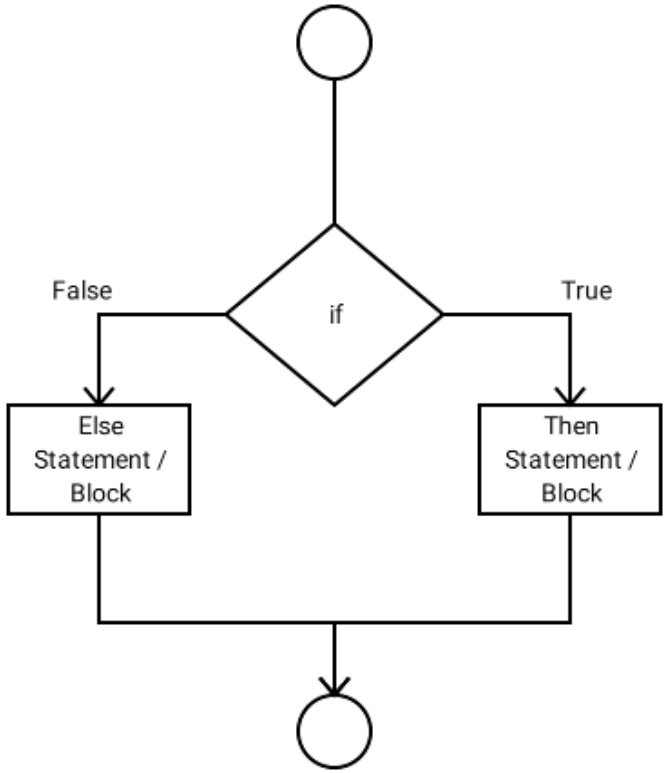


Example: even.cpp

```
int main()
{
    int num;  //the number to test

    //get the number
    cout << "Enter a number: ";
    cin >> num;

    //inform the user if it is even
    if( num % 2 == 0 ) {
        cout << "The number " << num << " is even" << endl;
    }
}
```

If Else Statement

```
if( condition )
        then statement/block
else
        else statement/block
```



If Else Statement

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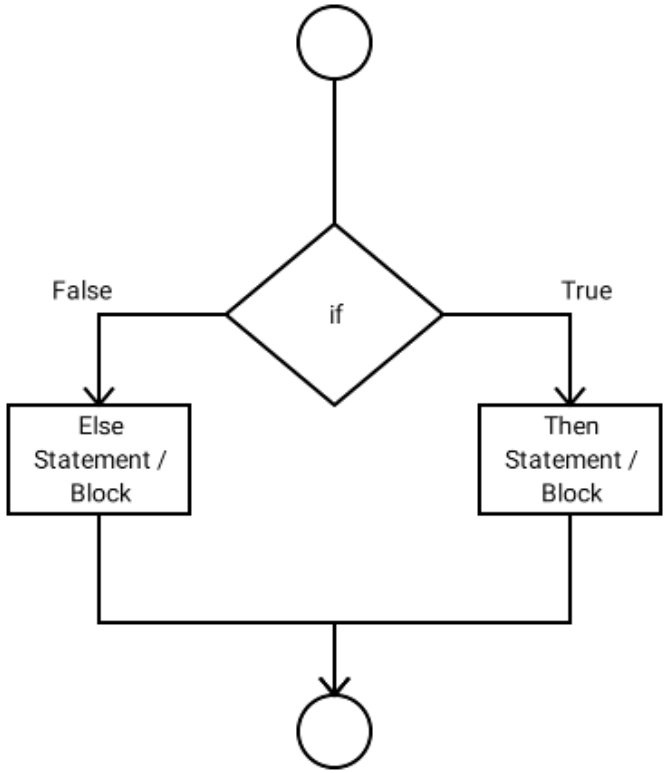

If Else Statement

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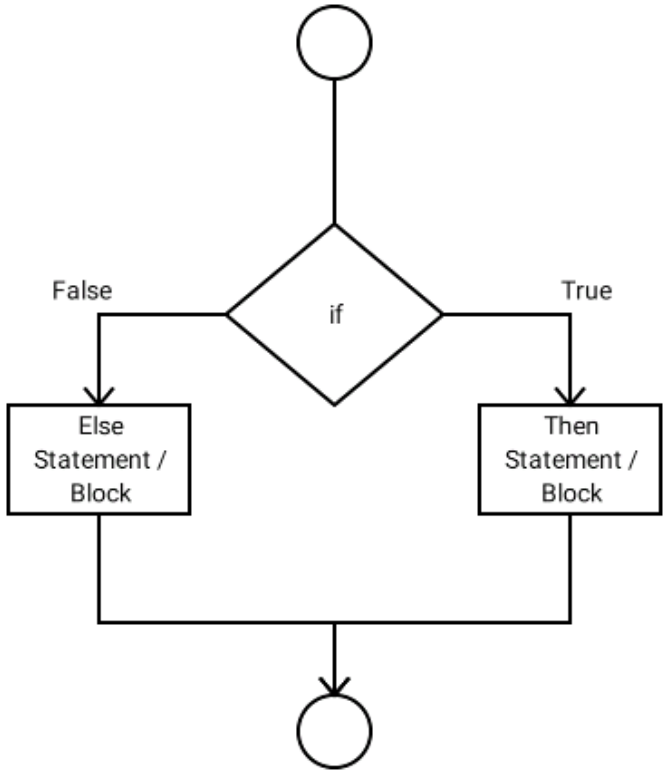
- If the *condition* is true, the *then statement/block* will be executed.
- If the *condition* is false, the *else statement/block* will be executed.



Example: even-odd.cpp

```
int main()
{
    int num;  //the number to test

    //get the number
    cout << "Enter a number: ";
    cin >> num;

    //inform the user if it is even or odd
    if( num % 2 == 0 ) {
        cout << "The number " << num << " is even" << endl;
    } else {
        cout << "The number " << num << " is odd" << endl;
    }
}
```

Best Practices

- Curly braces are optional, but always use them.

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```
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    cout << "Yes, x is 1" << endl;
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    cout << "Yes, x is 1" << endl;
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```

- Be consistent about brace styles!

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- Curly braces are optional, but always use them.
- Do this:

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if( x == 1 ) {
    cout << "Yes, x is 1" << endl;
}
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- Not this:

```
if( x == 1 )
    cout << "Yes, x is 1" << endl;
```

- Be consistent about brace styles!
- Always indent the contents of the if's block.

Outline

Pythagoras

- Pythagoras lived in Croton around 500 BC.

URL: `https://www.youtube.com/watch?v=Vn4rwks1eMk`

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- Founded a mystery cult, called the Pythagoreans.
- The Pythagoreans kept all their math secret.
- The Pythagoreans died under siege by burning themselves to death on a funeral pyre made of their mathematical works.

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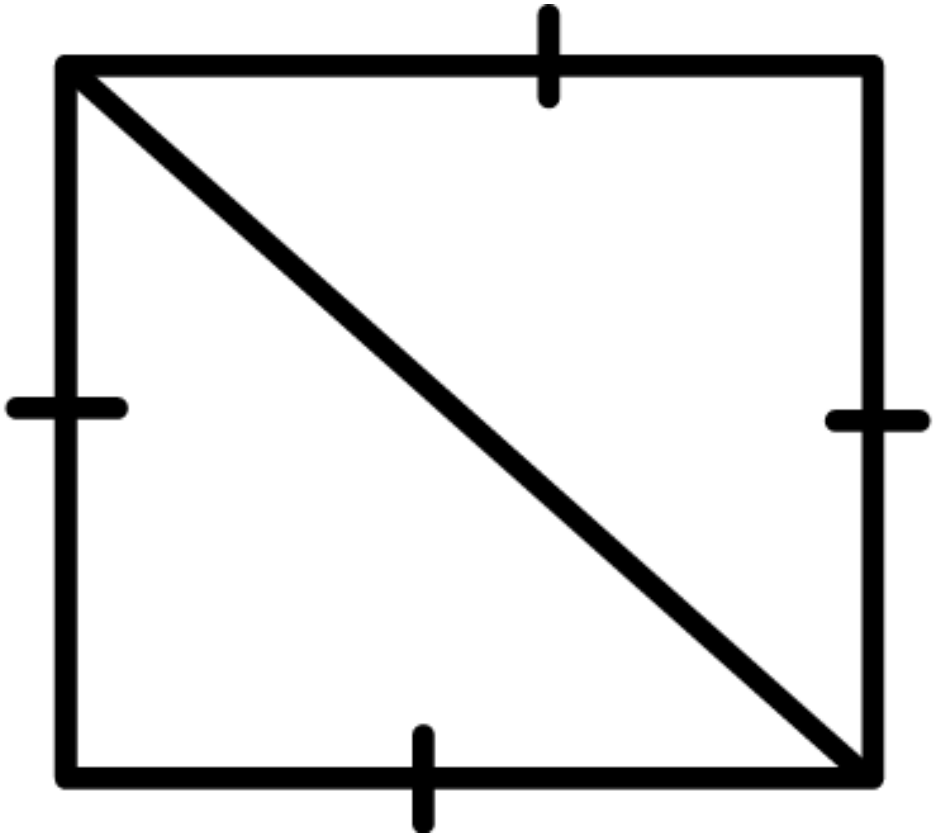
The Problem

One day, a student discovered that irrational numbers necessarily exist, even in simple observable shapes!



The Solution

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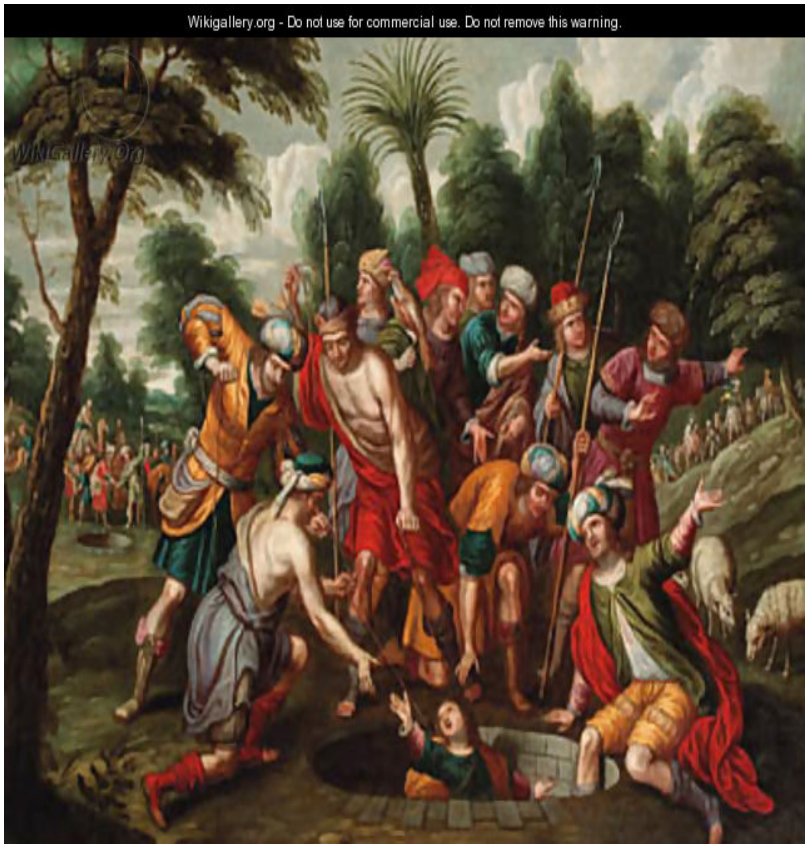
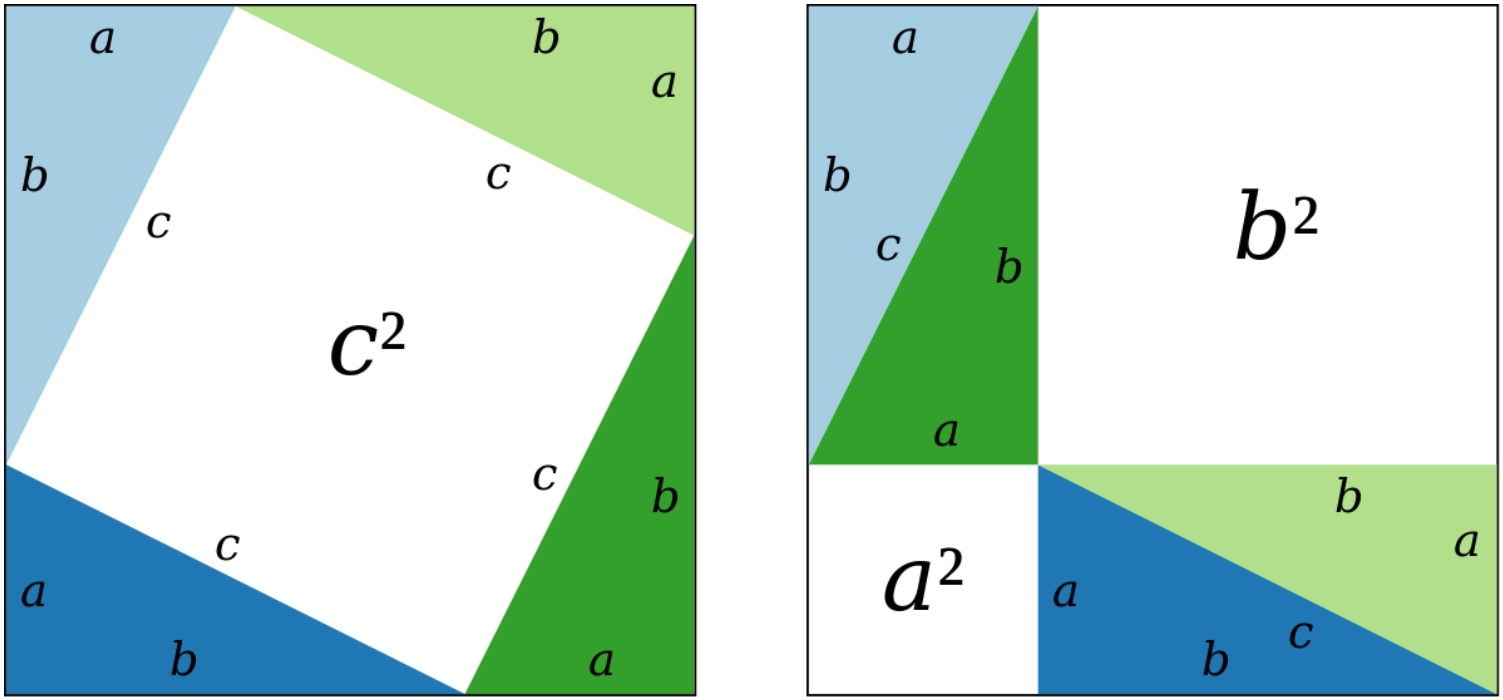


Image Source: `http://www.wikigallery.org/wiki/painting_285033/Peeter-Sion/Joseph-lowered-into-the-well-by-his-brothers`

The Real Solution



$$c^2 = a^2 + b^2$$

Image Source: `https://commons.wikimedia.org/wiki/File:Pythagoras-proof-anim.svg`

Pythagoras Design

Let's design a program that can compute any side of a right triangle!
It can find a leg:

```
I know how to find:
  1.) A Leg
  2.) A Hypotenuse
Which do you want? 2
A=3
C=5
A=3
B=4
C=5
```

Pythagoras Design

It can find the hypotenuse:

```
I know how to find:
  1.) A Leg
  2.) A Hypotenuse
Which do you want? 2
A=3
B=4
A=3
B=4
C=5
```

pythagoras.cpp: Variables

```
double a, b, c;   //triangle sides
int choice;       //the user's choice
```

pythagoras.cpp: Getting the Choice

```
//get the user's choice
cout << "I know how to find: " << endl
     << "  1.) A Leg" << endl
     << "  2.) A Hypotenuse" << endl
     << "Which do you want? ";
cin >> choice;
```

pythagoras.cpp: Making the Decision

```
//perform the user's choice
if(choice == 1) {
    //find a leg
} else {
    //find the hypotenuse
}
```

pythagoras.cpp: Find a Leg

```
//get A and C
cout<< "A=";
cin >> a;
cout << "C=";
cin >> c;

//solve for b
b = sqrt(c*c - a*a);
```

pythagoras.cpp: Find the Hypotenuse

```
//get A and B
cout << "A=";
cin >>  a;
cout << "B=";
cin >> b;

//solve for c
c = sqrt(a*a + b*b);
```

pythagoras.cpp: Display the Results

```
//print the results
cout << "A=" << a << endl
     << "B=" << b << endl
     << "C=" << c << endl;
```

Challenge: Modify `quadratic.cpp`

Make the following changes to the behavior of the quadratic program we wrote last time.

1. Only display the roots if the equation has real roots.
2. If there are no real roots of the equation, display the message "No real roots."
3. If both roots are the same, only display one root. (Do not repeat roots.)

Week 3 Lab Requirements

For full credit you must have:

1. `circle.cpp`
2. `pythagoras.cpp`
3. `quadratic.cpp` (as modified on the previous slide).

Be sure to add, commit, and push!