

05 - Making Decisions - Part 1

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Outline

- 1 Branching
- 2 Thinking With Branches

Introduction to Branching

- Branching is when a program selects between multiple paths of execution.
- Programs make choices according to statements which are either true or false.

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

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

Equality Operators

- == Equal
- != Not Equal

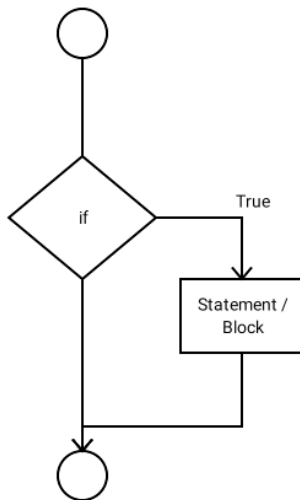
Operator Precedence (Thus Far)

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
\ll , \gg	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 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

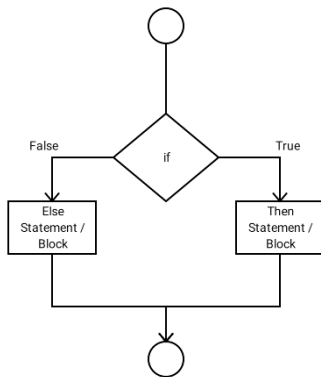
    //get the number
    cout << "Enter a number: ";
    cin >> num;

    //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 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.

- Do this:

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

- 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.

Pythagoras

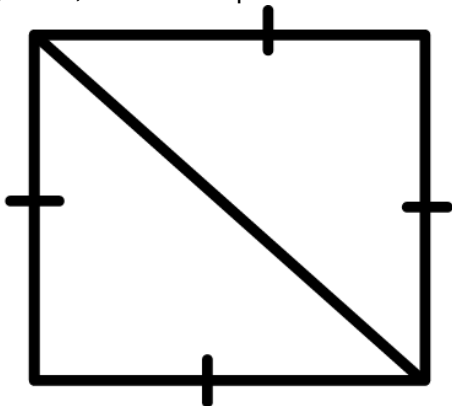
- Pythagoras lived in Croton around 500 BC.
- Taught that everything could be quantified by whole units (integers).
- Founded a mystery cult, called the Pythagoreans.
- The Pythagoreans kept all their math secret.
- The Pythagoreans died under siege by burning themselves to death on a funeral pyre made of their mathematical works.



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

The Problem

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



The Solution

This caused Pythagoras a lot of distress.
Luckily, his students found a solution!

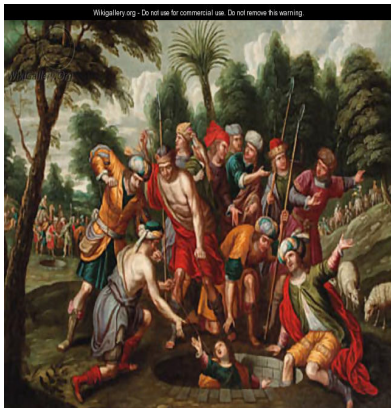
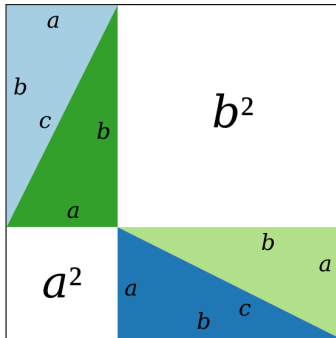
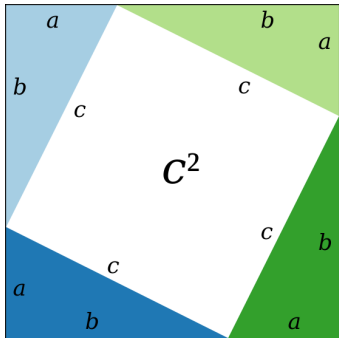


Image Source: http://www.wikigallery.org/wiki/painting_285033/Peeter-Sion/

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!