**Easy Math for the Programmer**

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**Intro**

 To start off with, this is going to be a tutorial covering the mathematical side of programming. I will be sharing with you techniques that I have learned in the past 5 years of my programming experience. I would recommend that before you attempt to mix math and programming together you have a thorough understanding of the programming/coding language you wish to integrate these techniques into. Even if you don’t this tutorial could still be helpful, because some of the topics I cover will help you understand the ins and outs of Algebra and Geometry.

**Shapes!**

Alright, so you have decided to pursue a mathematical interest and are reading the first part of my tutorial. In this section you will learn about shapes and how they relate. You will learn how to tell the relationships between two shapes and understand some like you have never understood before!

**Basic Relationships**

 Alright, so first of you are going to want to get a piece of paper and a pencil so that you can create “demonstrations” for yourself.

Before you build a house you must have the supplies. The supplies in this case are the building blocks of geometry, Triangles.

I am going to go ahead and give you a formula. This formula is the Area of a triangle.

Area = (Base x Height) / 2

Now, it is easy to plug in the base and the height and divide it by two on a calculator, but that is not what I am here to tell you to do! I want you to understand WHY this works. To do so will require us to look at a triangles closest relative, a rectangle.

First take a look at these two images and the formula for the Area of a rectangle. Can you make any connections?

And the Area:

Area = Base x Height

Immediately you should notice that both formulas use Base x Height and the Rectangle is made out of two triangles!

But we must understand the formula for a rectangle to understand the formula for a triangle (uggghhh).

Ok, see how

This figure

Has 9 squares? Each side is made up of 3 units? Right away you notice that 3 x 3 = 9 (Base x Height).

Basically, the dirty explanation is first we know the base is built up of 3 squares. Then we know the length of the Base is uniform throughout the entire shape. So we essentially have a ton of bases stacked up upon each other. Since we know the height (which is the same as the amount of bases stacked) we can multiply that by the length of one base to find out the total number of squares that build up the object.

So how did that relate to a triangle?

Let’s take a look at the formulas one more time.

Area of a triangle = (Base x Height) / 2

Area of a rectangle = Base x Height

The only difference is the division by 2 on the triangle. The only reason is that if we have two triangles both with a base and height equivalent to the first triangle then we put those on top of eachother to form a rectangle like so:

Then we can notice that one triangle is EXACTLY half of the rectangle formed!

So, the first step would be to figure out the area of the rectangle. Then because we know the rectangle is built up of two identical triangles we can divide the area of the rectangle by 2 to get the area of only one triangle!

Now that you know the most simplest of relationships let’s take it one step forward and look at the most “advanced”.

A circle. Because of its smooth sides it seems it would be impossibly tricky to get an accurate measure of its area. So how did mathematicians come up with:

$$A=πr^{2}$$

The answer is one we just went over. Triangles! Right now, I expect your thinking I am crazy, just as my friends did when I discovered this relationship in 8th grade. A circle is really just an infinite amount of triangles! Let’s take a look:

This is not how one would actually look, but I am not a graphics artist so this is the best representation of one I can make!

So, we know that the circles area will be equal to the sum of all the areas of the triangles added together. So if I told you that all the circles areas are precisely the same then all we need to know is the area of one!

This means we need the Base and the Height.

Look back at our circle. We know that the radius is half of the diameter which is a line that runs through the center of the circle. So the radius would meet right in the middle. Do you notice any lines on that circle that meet right in the middle? Indeed you do! The heights of the triangles are the same as the radius!

Now we need to know the base. This one could pose a problem because the base is a rounded side. But, trust me on this one and let’s go through anyways!

If we could find the circumference then we could divide it by the 4 triangles that are there to get the base of just one triangle! So that’s our solution. We will use the circumference formula:

$$c=dπ$$

But before we continue I just want to explain this one really fast.

Pi represents the universal ratio of the circumference of a circle to its diameter. So, for example I will use a square.

Alright, So first of we know the circumference of this square is 12 (count the outside edges).

We then can figure out the “diameter” which would be 3.

So the ratio is 12/3 which is also the same as 4. So to find out the circumference I can multiply 3 by the ratio 12/3 which will get me 12! It’s all like one big circle isn’t it?

Alright so now we know that, lets continue with our findings on a circle.

Suppose we where to use that formula on our circle to find out the circumference, then to find out the base of one triangle we have to divide by the number of triangles that are in our circle (we will find out soon that this number is not to terribly important) in this case 4. So far our formula looks like this:

$$\frac{dπ}{number of triangle} x radius$$

D = diameter

Radius is the height of one triangle

So now we must divide all of this by 2 to find the area of one circle.

$$\frac{dπ x radius}{\frac{Number of triangles}{2}}$$

Now we have the area of one triangle, we have to multiply it by the number of triangles!

$$\frac{dπ x radius}{\frac{Number of triangles}{2} x Number of triangles}$$

Notice something funny? We divide then multiply by the number of triangles! This causes them to cancel out!

$$\frac{dπ x radius}{2}$$

See? The number of triangles wasn’t so important after all!

Anyhow, let’s keep simplifying!

Now the next thing I notice is that I see a diameter over 2. I know that half of the diameter is the radius, so I will go ahead and take half from the diameter.

$$π x radius x radius$$

And what is the equivalent to multiplying a number by itself?

Squaring it!

$$π x radius^{2}$$

Look familiar now?

Not so crazy after all, huh.

At this point, I am confident that you can identify relationships between shapes!

**Math and how it relates**

 So basically, I loaded you up with mathematical facts, but how does this help you when it comes to programming?

Surprisingly you will find many, many, many times when knowing these properties will come in handy!

For example, I have been intermediately working on a physics engine for the gameboy (yes, I said it). I have to use math such as area to find out how fast an object should fall if its mass where equal to its area. Also, a simple form of collision detecting between circles! If you realize that a circles center point is always the same distance away from every single one of its sides, then you can realize that if the distance to another circle is equal to or closer then both of the circles radiuses added together, there is a collision!

Fascinating stuff!