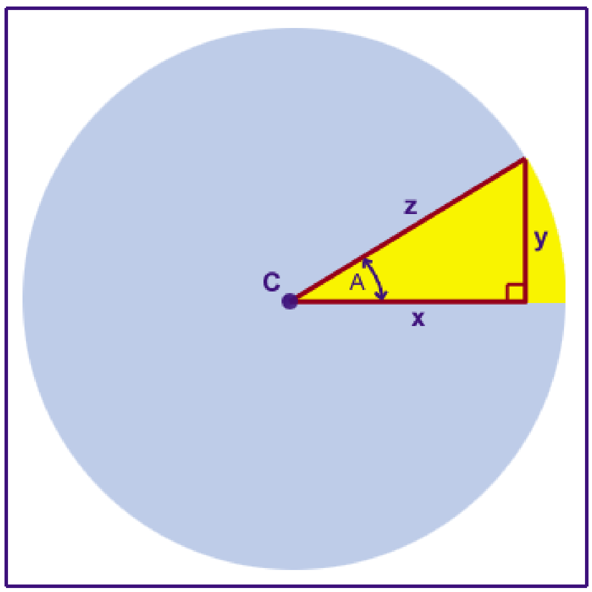
Trig and ArcTangents

Prepared by: Teton Multimedia (www.TetonMultimedia.com)

Trigonometry is easy. The reason some people believe it is difficult is simply that they were told it is difficult. So they believe. The key to making it easy is simply to realize that it *is* easy.

Trigonometry and its various functions are based on the similarity of triangles (and circles). In particular, it focuses on “right triangles” nested within circles as shown below. Note that a right triangle has a square, or 90˚ corner as shown. The long side (z) is a radius of the circle, and is referred to as the “hypotenuse.” Side x is referred to as the “adjacent” side. It is the shorter side that touches the center of the circle. The remaining side (y) is referred to as the “opposite” side (it is opposite from angle A).



A very handy rule regarding all right triangles:

1.1

$$z^2 = x^2 + y^2$$

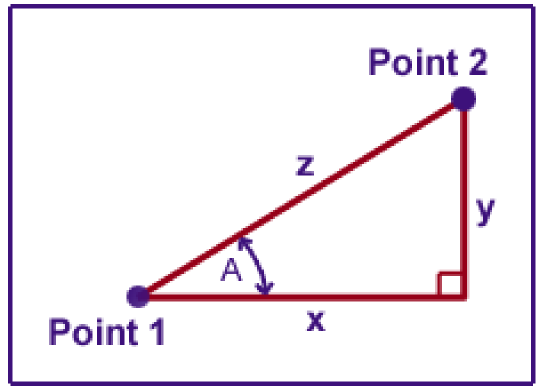
This means that if you know the length of any two sides, then you can calculate the length of the remaining side.

What else does this mean and why should you care? Specifically as applied to horizontal and vertical distances (as referenced via LocH and LocV in Director lingo), the distance between two points (z) can be calculated from their horizontal and vertical distances. Specifically,

1.2

$$z^2 = (LocH_1 - LocH_2)^2 + (LocV_1 - LocV_2)^2$$

Then take the square root of the result to find z. Note that in equation 1.2, the subscripts 1 and 2 refer to the points shown here.



From this basic discussion we can move directly to trigonometric functions. For angle A above, the sine function (sin) is defined as

1.3 sin(A) = y / z

The cosine function (cos) is defined as

1.4 cos(A) = x / z

And the tangent function (tan) is defined as

1.5 tan(A) = y / x

In addition, each angle (A) has exactly one corresponding value for each of the sin, cos, and tan functions. This means that if we call Director's sin function for angle A, the result will be the same as y / z . However, if we don't know y and z, but we do know A, then calling the sin function makes perfect sense.

Now suppose we know the tan of angle A, but we don't know angle. How do we then find angle A? Simply by calling the ArcTan function. For example:

2.1 tan(A) = y / x

2.2 A = ArcTan(tan(A)) = ArcTan(y / x)

This implies that if we know lengths x and y, and if they meet at a right angle as shown above, then we can find angle A (also as shown above). The ArcTan function is essentially a lookup within a table of angles (Arcs) Vs. tangents. You could build this table yourself using a protractor, ruler, pencil, calculator and equation 1.5. But programming languages are nice enough to do this for you. And their functions are far more accurate than you could be with a set of office measuring tools.

Now it is true that some programming languages offer other built-in "Arc" functions such as "ArcSin" and "ArcCos". But some, such as Director, do not. This is simply because these other functions are redundant. For example, if we know the sin of an angle, then we can find the tan, and *then* the Arc. Yes there is an extra step, but we can find the Arc without an ArcSin function. The steps are as follows. Assume that we know the sine of A, but not A itself.

3.1 $\sin(A) = V$

Where V is the known value. Then

3.2 $\sin(A) = V = y / z$

Note that due to the similarity of triangles, we can choose a convenient value for z, from which y is then implicit. (We are dealing with *ratios* of numbers, rather than their actual magnitudes.) So let's choose z = 1. Then

3.3 $\sin(A) = V = y$

Now getting back to equation 1.1, and substituting V into y, we have

3.4 $1^2 = x^2 + V^2$

Rearranging gives us

3.5 $x = (V_2 – 1)^{0.5}$

where the superscript "0.5" has the same meaning as "square root". From equation 3.3 we have y (we know V), and from equation 3.5 we have x. Given x and y, we can calculate tan(A) from equation 1.5. Using the result in a call to ArcTan gives us A.

In conclusion, and as noted above, this means that we can "make do" when only the ArcTan function is built-in. The ArcSin and ArcCos functions are not necessary.