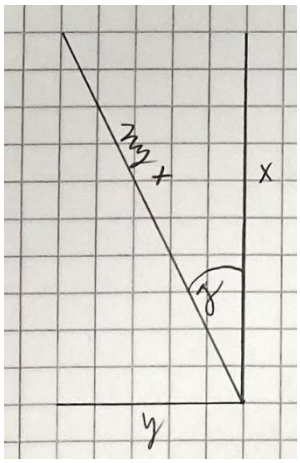
Mathematics

Mathematics used to move this robot is called inverse kinematic, it's a brunch in mathematics used for determining angel between at least 2 lines knowing length of all lines, and coordinates of the end of an arm. This is highly used for animations and robotics.

It is not very important to know how this work, its ok to just know how to use it, but if you like to know then read the text below.

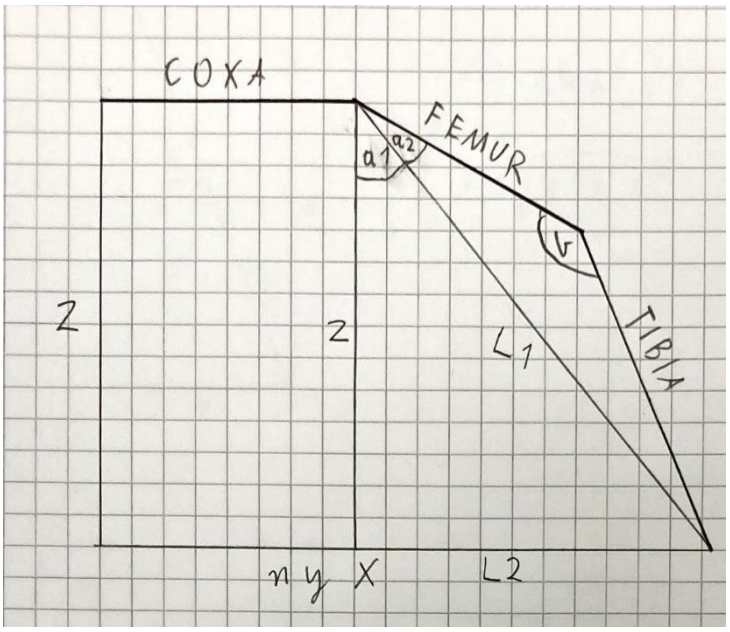
Here is mathematics that enable computer to move a leg by changing the coordinates of the end of the leg It is not very important to know how this work, its ok to just know how to use it, but if you like to know then read the text below.



$$\gamma = a\tan(\frac{y}{x})$$

$$ny\,x = \sqrt{x^2 + y^2}$$

The first thing that computer must calculate is gamma, the gamma is the servo that move the leg in right and left. The x that you see is the coordinate that says how long from the center of mentioned servo is endpoint of the leg. With endpoint I mean the farthest point of the leg, the one completely at the end. Y coordinate can be both positive and negative, but I cannot be equal to zero, positive will mean that the leg is moving in one direction and if it is negative will it move at the other direction, the farthest number is from center the farther will be the endpoint. Combine the two coordinates and you get 2D visualization of the leg. If you look closely, you will see that this is a right triangle, just move the y line up and you get will see it. Using trigonometry, we can find the value of angel gamma by using inverse tangus function. The last thing we need to do is finding new x (ny x) it is necessary because in the next calculations will use x and as you might see the new x is longer the x. Remember that x and new x are actually distance that the leg will reach, will move to, So imagine now that new x and x are the same lengths, by changing just angle y robot will not move just to right, it will go right and back to the center, it will a fragment of ellipse, not straight line. So, to make the leg to move in straight lines x must be corrected, and we will do it by using Pythagoras, because the lines make right triangle.



$$L2 = ny\,x - coxa$$

$$L1 = \sqrt{L2^2 + z^2}$$

$$a2 = a\cos\left(\frac{L^2 + FEMUR^2 - TIBIA^2}{2 \cdot TIBIA \cdot FEMUR}\right)$$

$$a1 = a\tan\left(\frac{z}{L1}\right)$$

$$b = a\cos\left(\frac{TIBIA^2 + FEMUR^2 - L^2}{2 \cdot TIBIA \cdot FEMUR}\right)$$

In my robot lengths of legs and coordinates are in millimeters but if they are the same you can use any system. The 3 constants in the robot are length of the joints they are coxa, femur and tibia fancy names. Between them are servos that move the robot, in the view above you can see the leg in z and x coordinates, changing the coordinates will change the angel of servos. So, the first that calculation does is finding the length of L2, its jest new x – coxa, with z you can find L1 using Pythagoras, with inverse tangus you can find a1. At the other triangle you can see that we know all sides length, but none angles, that's why we use cosine rule, with it we can find any angel in a triangle when we know just lengths of sides. That's how we find a2 and b. Now just add a1 and a2 together and you got it. That's all.