Using technology to help with Ritangle

Finding approximate solutions to equation

The equations below are all solved using algebraic methods you will be familiar with.

$3x+2=11$
$\Leftrightarrow 3x=9$
$\Leftrightarrow x=3$

$x^2+x-6=0$
$\Leftrightarrow (x+3)(x-2)=0$
$\Rightarrow x=-3$ or $x=2$

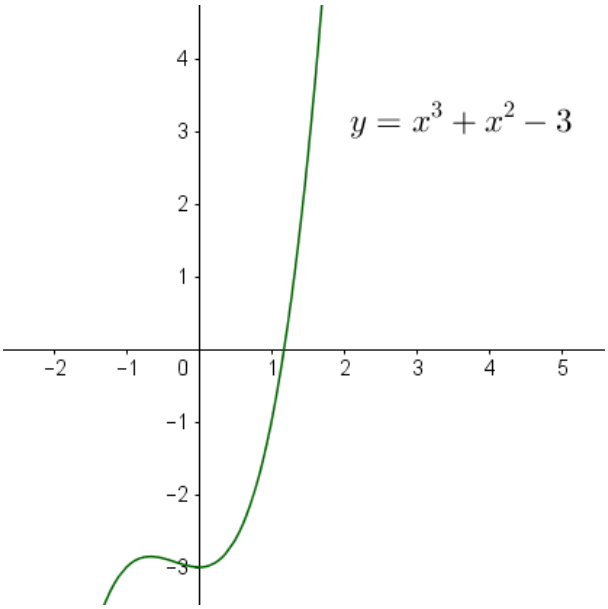
$6x^3+17x^2-26x+8=0$
$\Leftrightarrow (x+4)(3x-2)(2x-1)=0$
$\Leftrightarrow x=\frac{1}{2}$ or $x=\frac{2}{3}$ or $x=-4$

Sometimes it's not possible to do this. For example this cubic equation

$$x^3+x^2-3=0$$

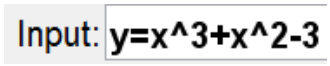
cannot be solved using factorisation like for the quadratic and the cubic equations at the top of the page.

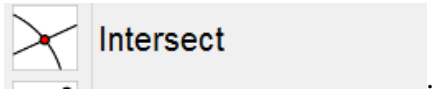
The equation $x^3+x^2-3=0$ must have at least one real root since the left hand side is a cubic. You can see from the graph below that there is a real root between $x = 1$ and $x = 2$.



Technology can provide a good approximation to the value of this root. You might know of a numerical method such as the method of bisection or the Newton-Raphson method which you could implement using a spreadsheet. Alternatively you could use some of the built-in functionality in a package like GeoGebra or Desmos. Here are three possibilities

A) Creating the point that the curve intersects the *x*-axis using GeoGebra (screenshots below from GeoGebra 5 (also known as GeoGebra Classic))

First plot the curve by typing y = x^3 + x^2 – 3 into the input bar: 

Then go to the create point menu  and click the red arrow. Select the intersect tool from the drop down menu 

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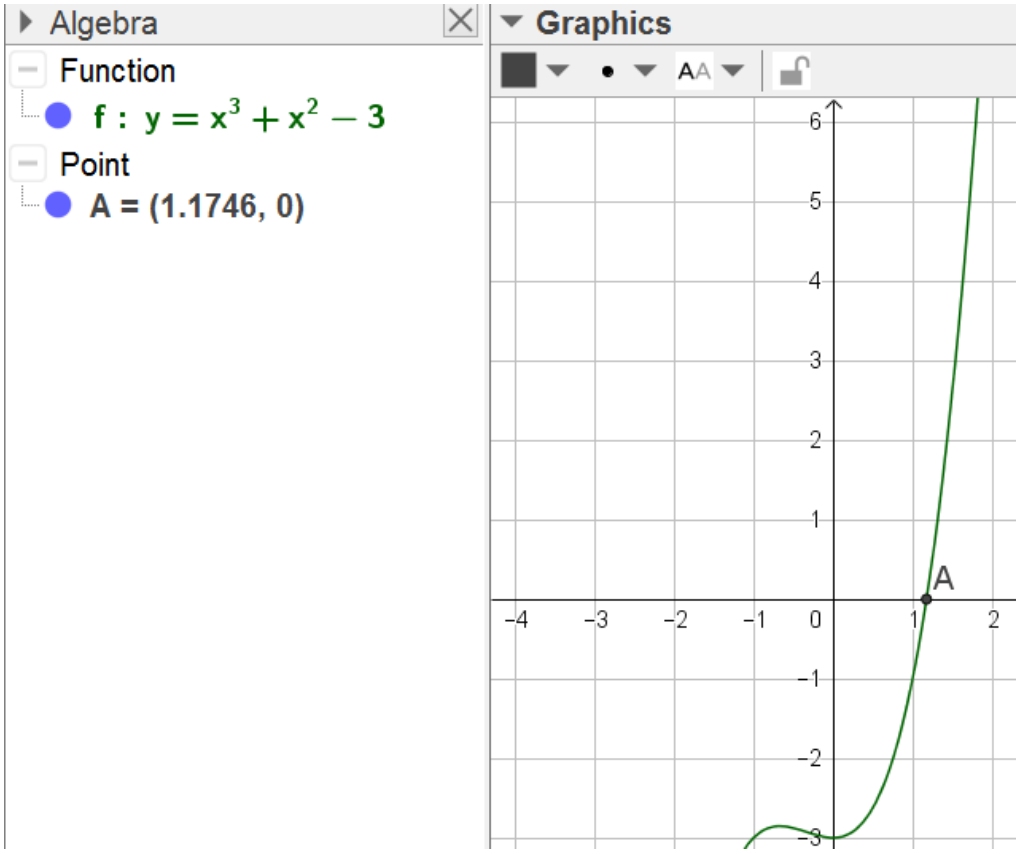
Then, in the graphics view, click on the curve followed by the *x*-axis. This should create the point where the curve intersects the *x*-axis. This is shown in the screenshot below (point A):

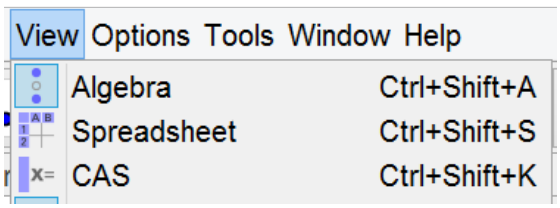


You can see from the algebra view that the *x*-coordinate of A is 1.1746 to 4 decimal places, this is the real root of the equation correct to 4 decimal places.

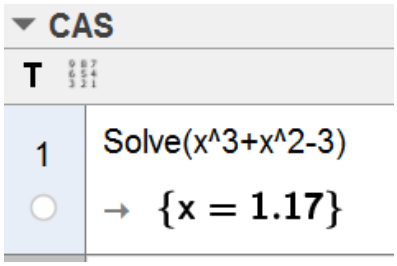
You can increase the accuracy of this using the Tools→Rounding option in GeoGebra.

B) Using the Computer Algebra System (CAS) in GeoGebra

Go to the View menu and open up the CAS view



In the first row of the CAS window type Solve(x^3+x^2-3). You should see this.

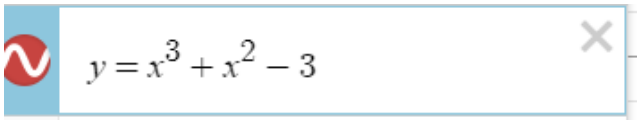


Again, you can increase the accuracy of the estimate using the Tools→Rounding option in GeoGebra.

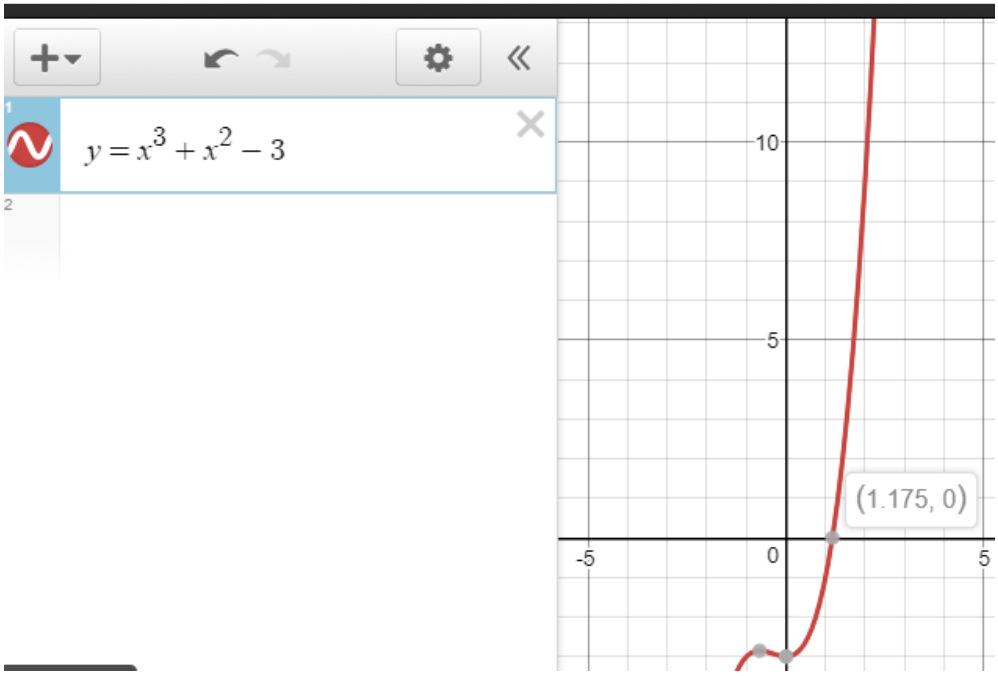
C) Plotting the curve in Desmos

Open Desmos (an online version is available here https://www.desmos.com/calculator).

On the left type y = x^3 + x^2 – 3 and press return. This should appear as



By clicking on this cell you should see that some points, including where the graph meets the *x*-axis, appear on the curve shown to the right. By hovering over the point on the *x*-axis you are shown its coordinates. This gives you an approximation to the solution of the equation.



You can get better accuracy by zooming in using the + button on the right of the screen.