Polynomials - roots, graphs, equations

To find the value of a specific polynomial for some values of the variable, we use the function polvalue which will calculate the polynomial value in a given point.

$$a := y^3 - 4y^2 + 6y - 7$$

$$\text{polvalue}(a, 4) = 17$$

In the above canvas we have defined the polynomial and found it's value for y = 4. If we have the polynomial with more than one variable, use the function **replace symbols** where we can define which variables we want to replace and specify the values we wish to replace them with. For example

$$b := x^3 - 2xyz + 4y^2 z + 5x - 4y + 2z - 8$$

$$\text{replace symbols}\left(b, \begin{bmatrix} x \\ y \\ z \end{bmatrix}, \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}\right) = 32$$

We have replaced the variables x, y and z with values 1, 2 and 3 respectively and found the value of polynomial defined in the MatDeck variable b. The number of variables you want to change in the polynomial is left for you to choose.

$$\text{replace symbols}\left(b, \begin{bmatrix} x \\ z \end{bmatrix}, \begin{bmatrix} 1 \\ 2 \end{bmatrix}\right) = -8y + 2 + 8y^2$$

or

$$\text{replace symbols}(b, y, 5) = x^3 - 10xz + 102z + 5x - 28$$

To find the roots of certain polynomials use the function **polroots** which will return a vector of all the roots.

$$c := x^3 + 2x^2 - 5x + 1$$

$$\text{polroots}(c) = \begin{bmatrix} 0.222 + 0i \\ -3.507 + 0i \\ 1.285 + 0i \end{bmatrix}$$

The function **polroots** can return both real and complex roots.

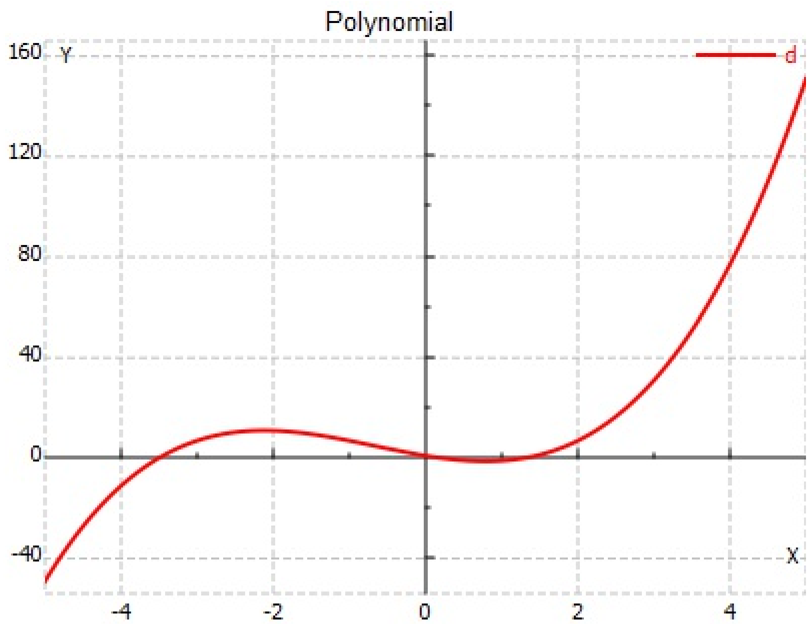
$$\text{roots2pol}\left(\begin{bmatrix} 0.22 \\ -3.5 \\ 1.29 \end{bmatrix}, y\right) = y^3 + 1.99\ y^2 - 5.001\ y + 0.993$$

Keep in mind that this function uses the numerical method to find the polynomial, so if you specify the roots more accurately, the resulting polynomial will be more accurate, for example

$$\text{roots2pol}\left(\begin{bmatrix} 0.221876 \\ -3.507019 \\ 1.285143 \end{bmatrix}, y\right) = y^3 + 2\ y^2 - 5\ y + 1$$

If you want to plot a polynomial, use the function **curve2d.** We will plot the polynomial at a interval of [-5 , 5] with a set of 200 points.

$$d := \text{curve2d}\left(x^3 + 2\ x^2 - 5\ x + 1\ , -5\ , 5\ , 200\right)$$



We can see that the plotted curve is crossing the x-axis at three different points, so the function has three roots and their values are calculated using the function polroots as shown below below

$$\text{polroots}(c) = \begin{bmatrix} 0.222 + 0i \\ -3.507 + 0i \\ 1.285 + 0i \end{bmatrix}$$

By solving the non equation with the specified polynomial we can determine the sign of that polynomial. Use the function **nonlinneqsolve** to calculate the function sign. The second argument is the symbol for which we are solving the non equation for

$$\text{nonlinneqsolve}\left(x^3+2x^2-5x+1<0\ ,\ x\right)=\left[(-\text{inf},-3.507)\ \ (0.222\ ,1.285)\right]$$

The intervals where the function is negative

$$\text{nonlinneqsolve}\left(x^3+2x^2-5x+1>0\ ,\ x\right)=\left[(-3.507\ ,0.222)\ \ (1.285\ ,\text{inf})\right]$$

The intervals where the function is positive

To find where the function is decreasing and where it's increasing, we must first calculate the derivative of the polynomial and observe the sign of the derivative function. To find the first symbolic derivative of a polynomial, use the function **derivative**

$$\frac{d}{dx}\left(x^3+2x^2-5x+1\right)=3x^2+4x-5$$

$$\text{nonlinneqsolve}\left(\frac{d}{dx}\left(x^3+2x^2-5x+1\right)<0\ ,\ x\right)=(-2.12\ ,0.786)$$

The interval where the polynomial is falling

$$\text{nonlinneqsolve}\left(\frac{d}{dx}\left(x^3+2x^2-5x+1\right)>0\ ,\ x\right)=\left[(-\text{inf},-2.12)\ \ (0.786\ ,\text{inf})\right]$$

The interval where the polynomial is growing

The points in which the polynomial have changed have a tendency to go from decreasing to increasing and vice versa. These are the points where the first symbolical derivative is equal to zero (roots of first derivative).

$$\text{polroots}\left(\frac{d}{dx}\left(x^3+2x^2-5x+1\right)\right)=\begin{bmatrix}-2.12+0i\\0.786+0i\end{bmatrix}$$

To find the area which a polynomial creates with the x-axis at a interval of [-2.1196 , 0.7863], calculate the value of the definite integral using the function for numerical integration, **integrateg**.

$$\int_{-2.1196}^{0.7863} x^3 + 2x^2 - 5x + 1 \, dx = 14.314$$