An Introduction to Desmos

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The purpose of this document is to introduce you with Desmos, the free online graphing calculator. Desmos is a powerful tool for visualizing, exploring, and creating mathematics. Here, we will explore a few of its primary functions. Navigate a browser to www.Desmos.com and hit "Launch Calculator".

Functions

Desmos works brilliantly as a graphing calculator. Enter the function $f(x) = x^2 - 3x$ in a line at the left and its graph will immediately appear (you can enter exponents using the caret (^) key). Notice that by clicking on the graph, points of interest are immediately identified. Enter a second function $g(x) = x - 3$ and observe what happens.

Replace $g(x)$ with $g(x) = ax - 3$. Desmos automatically offers to make *a* a *slider*. Make *a* a slider, and change its value. For what values of *a* is the line tangent to the parabola?

You can add multiple sliders to multiple graphs. For example, return to $f(x)$ and type $f(x) = x^3 + bx^2 + cx$. By changing the values of *b* and *c* you can observe the effect of these coefficients on the graph of the cubic.

You can plot points in Desmos using standard notation. For example, when you enter (3,5) in a line, the point (3,5) will be graphed. More importantly, you can plot *dynamic* points: first, enter $(3, f(3))$ on a new line. Then, enter $(d, f(d))$. Make *d* a slider, and change its value.

You can restrict the domain of any function using curly brackets. Enter $y = x^3 + 4x^2 - 3\{-4 < x < 1\}$ to see how this works. Sliders also work in domain restrictions, giving another powerful demonstration tool. For example, change the above line to $y = x^3 + 4x^2 - 3\{-4 < x < k\}$ and watch what happens.

You can turn graphs on and off by clicking on the icons at the left of the associated expression. You can also change colors and styles, and copy expressions, by clicking on the "Gear" icon.

Relations

Relations can also be graphed in Desmos. Delete all previous entries, and enter $x^2 + y^2 = 1$ on a line. Now enter $x^2 + y^2 = c$, add *c* as a slider, and play around.

Now try $ax^2 + by^2 = c$ and add all sliders. Play around with the value of the sliders.

Delete the above relations. Enter $x^a + y^b = 1$ and play around with the values of *a* and *b*.

Change the relation to $x^{2a} + y^{2a} = 1$ and explore. Change the limits of the slider by clicking on its upper limit.

Try entering some other strange relations, like $\sin(x + y) = x$, or $\ln(y) = floor(\cos(x))$. Add sliders and explore. [Note: some relations may be too complicated for Desmos to process.]

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Regions

Regions can be graphed in Desmos. Clear out all previous entries, and enter $y > x^2$. You can also enter compound inequalities, for example $x > y > x^2$, or $1 < x < 3$.

The slider functionality works here, as well. For example, type $0 < y < ax$, and explore what happens for different values of *a*. The domain restriction functionality also works here: for example, $0 < y < x^2\{0 < x < 3\}$.

Lastly, you can use functions in inequalities. Delete all previous entries. Now enter $f(x) = \sin(x)$ on one line, $g(x) = \cos(x)$ on a second line, and $g(x) < y < f(x)$ on a third. Play around by changing the functions or by adding sliders.

Parametric Representations

Desmos handles parametric representations of curves especially well. While most letters are converted to sliders, Desmos reserves *t* as a parameter. For example, entering $(\cos t, \sin t)$ on a line will generate part of unit circle. Change the range of *t* to get the full circle.

Now that the circle is graphed, show a point on the circle by entering $(\cos a, \sin a)$ on a second line. Add *a* as a slider and animate it by pressing the *Play* button.

Delete all previous entries. Enter $f(x) = x^2 - 1$ on a line and $g(x) = x^3 - x$ on a second line, and turn both the graphs off. Now enter $(f(t), g(t))$ on a new line and change the domain of *t* to $-10 \le t \le 10$. Enter $(f(a), g(a))$ and animate *a*. Change the functions $f(x)$ and $g(x)$ and observe the impact on the parametric curve.

Change $f(x)$ to $\sin(x)$ and $g(x)$ to $\cos(x)$. You should see the unit circle again. Now change the coefficients of *x* in $\sin(x)$ and $\cos(x)$ and watch what happens. Use sliders to explore!

Polar

Desmos supports polar graphing. Enter $r = 1 + \cos(theta)$ to get a glimpse of what can be done. Sliders, restrictions, and inequalities all work in polar, and you can even change the coordinate grid to polar by clicking on the *Wrench* icon in the upper right corner.

Derivatives

Desmos has robust support for differentiation. To see how this works, enter a function $f(x)$, and then enter $y = f'(x)$, or $y = \frac{d}{dx} f(x)$.