Review of Sage

Author	**Aaron Tresham**
Date	**2017-06-12T18:56:46**
Project	**9189c752-e334-4311-afa9-605b6159620a**
Location	**01 - Review of Sage Assignment/Review of Sage Notes.sagews**
Original file	**Review of Sage Notes.sagews**

Review of Sage

For those of you who had a Calculus 1 lab with me last semester, you are already familiar with Sage. This worksheet is a quick review of so of the key features we covered last semester.

If you have not used Sage before, I recommend working through the Calc 1 lab "Intro to Sage." Then return to this worksheet.

Graphing

You graph a function in Sage using the "plot" command.

Example 1

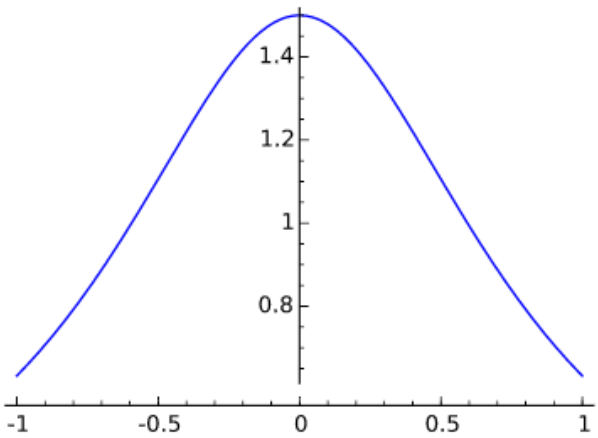
Graph $f(x) = \frac{\sqrt{x^2+9}}{3x^2+2}$.

Remember, every multiplication must be explicit in Sage. You must type 3*x^2 (3x^2 will not work).

Also, don't forget the parentheses. They are often required around the numerator and denominator of fractions.

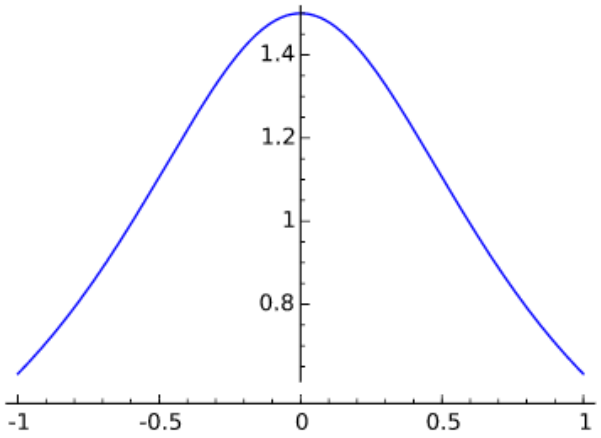
I will give the function a name first, and then I will graph it.

```
1 f(x)=sqrt(x^2+9)/(3*x^2+2)  #First, define the function.
2 plot(f(x))                  #Now make a graph.
```



It is also possible to plot a function without giving it a name. However, since we usually do more than one thing with our functions, it is usual worth it to define the function first.

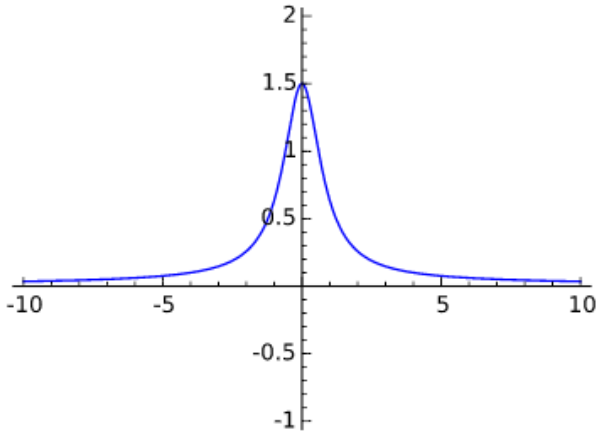
```
plot(sqrt(x^2+9)/(3*x^2+2))
```



The default plot window uses $-1 \leq x \leq 1$, and Sage choose the range on the y-axis to fit the graph to the window.

If you want to specify a new window, use the xmin, xmax, ymin, and ymax options.

```
plot(f(x),xmin=-10,xmax=10,ymin=-1,ymax=2)
```



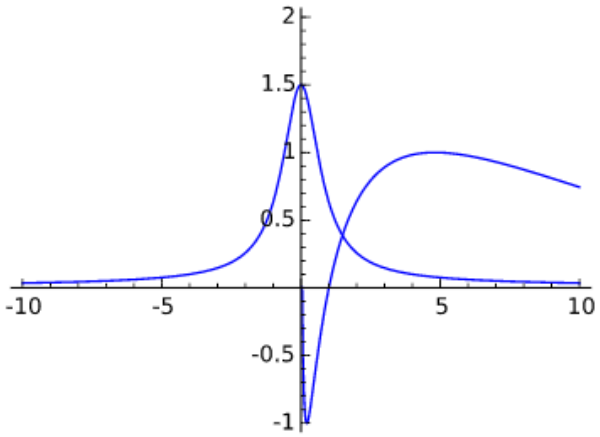
To graph more than one function, add plots together.

Example 2

Add a graph of $g(x) = \sin(\ln(x))$ to the graph of f.

Note: the domain of g is $x > 0$, so I have set xmin=0 for the plot of g. If you have xmin less than 0, Sage will give you a warning.

```
g(x)=sin(ln(x))
plot(f(x),xmin=-10,xmax=10,ymin=-1,ymax=2)+plot(g(x),xmin=0,xmax=10,ymin=-1,ymax=2)
```

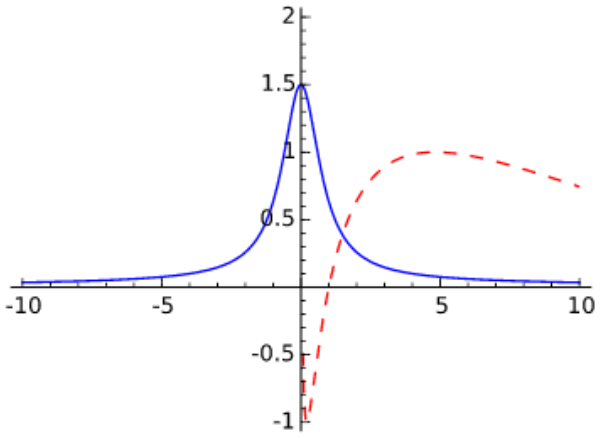


To distinguish between the two functions, you can change the color and/or the line style.

For example, to change the color to red, add color='red' to the plot (notice the quotation marks around the color name). Sage knows many colors; feel free to experiment.

To change the line style to dashed, add linestyle='dashed' to the plot (again, notice the quotation marks). You can also use 'dotted' or 'dashd instead.

```
7 plot(f(x),xmin=-10,xmax=10,ymin=-1,ymax=2)+plot(g(x),xmin=0,xmax=10,ymin=-1,ymax=2,color='red',linestyle='dashed
```



For more about graphing, refer to the Calculus 1 lab "Graphing and Solving Equations."

Limits

The "limit" command is used to find limits of functions. To take a limit as x approaches a, you add x=a to the limit command.

Example 3

Find $\lim_{x \to 1} \frac{x^2 - 1}{x - 1}$

```
8 f(x)=(x^2-1)/(x-1)
9 limit(f(x),x=1)
```

```
2
```

For one-sided limits, add dir='right' or dir='left' (notice quotation marks).

Find the following:

- $\lim_{x\to 1^+} \frac{x^2-1}{x-1}$
- $\lim_{x\to 1^-} \frac{x^2-1}{x-1}$

```
limit(f(x),x=1,dir='right') #right limit
limit(f(x),x=1,dir='left')  #left limit
```

```
2
2
```

Example 4

Find $\lim_{t\to -4} \frac{t+4}{\sqrt{t+4}}$

Any variable other than x has to be "declared." In this example, "%var t" tells Sage that t is a variable.

```
%var t
f(t)=(t+4)/sqrt(t+4)
limit(f(t),t=-4)
```

```
0
```

For more about limits, refer to the Calculus 1 lab "Limits."

Derivatives

You compute derivatives in Sage using the "derivative" command.

Example 5

Given $f(x) = 4x^6 - 8x^3 + 2x - 1$, compute the following:

- $f'(x)$
- $f''(x)$

```
f(x)=4*x^6-8*x^3+2*x-1   #Don't forget all the multiplications.
derivative(f(x),x)       #First derivative
show(_)
```

```
24*x^5 - 24*x^2 + 2
```

$$24\,x^5 - 24\,x^2 + 2$$

```
derivative(f(x),x,2)     #Second derivative
show(_)
```

```
120*x^4 - 48*x
```

$$120\,x^4 - 48\,x$$

If you want to compute particular values of the derivative, then define a new function equal to the derivative. Sage does not allow f', so I like call my derivative df, for "derivative of f." You can use any name you want (just don't call it f again).

Example 6

Given $f(x) = 4x^6 - 8x^3 + 2x - 1$, compute the following:

- $f'(1)$
- $f''(-1)$

```
f(x)=4*x^6-8*x^3+2*x-1
df(x)=derivative(f(x),x) #First, give the derivative function a name.
df(1)                    #Now use this function to calculate the value you want.
```

```
2
```

```
d2f(x)=derivative(f(x),x,2)  #I call my second derivative d2F
d2f(-1)
```

```
168
```

For more about derivatives, refer to the Calculus 1 lab "Differentiation."

Integrals

To compute an integral in Sage, use the "integral" command. Here is an indefinite integral (antiderivative). This requires two arguments: the function to be integrated and the variable of integration.

Example 7

Given $f(x) = 4x^6 - 8x^3 + 2x - 1$, compute $\int f(x)\,dx$

```
f(x)=4*x^6-8*x^3+2*x-1
integral(f(x),x)
show(_)
```

```
4/7*x^7 - 2*x^4 + x^2 - x
```

$$\frac{4}{7}\,x^7 - 2\,x^4 + x^2 - x$$

Here is a definite integral. This requires two additional arguments: the lower and upper limits of integration.

Example 8

Given $f(x) = 4x^6 - 8x^3 + 2x - 1$, compute $\int_{-1}^{1} f(x)\,dx$

```
f(x)=4*x^6-8*x^3+2*x-1
integral(f(x),x,-1,1)
```

```
-6/7
```

Example 9

Compute $\int_{-A}^{A} at^2 + bt + c\, dt$

Don't forget to declare variables first.

```
30 %var a,b,c,t,A
31 integral(a*t^2+b*t+c,t,-A,A)
32 show(_)
```

```
2/3*A^3*a + 2*A*c
```

$$\frac{2}{3}\, A^3 a + 2\, Ac$$

For more about integrals, refer to the Calculus 1 lab "Symbolic Integration."