

# Passaic County Community College Python One Sided Limits Interactive Tutorial

```
In [27]: import numpy as np
import sympy as sp
from sympy import oo
import sympy.plotting as symplt
import scipy as scip
import matplotlib as plt
import matplotlib.pyplot as pltt
```

Importing the basic framework for mathematical computation. Each of the following commands goes over the basics of the usage of the packages which were imported.

```
In [3]: np?
```

This is the docstring for the Numpy package, with details on it's submodules.

```
In [11]: sp?
```

```
In [10]: symplt?
```

For the documents pertaining on how to use Sympy, and it's various modules.

```
In [5]: scip?
```

```
In [6]: plt?
```

```
In [7]: pltt?
```

A theoritcal project was assigned based of the Mathematica project which I have been given.

Given the following equation:

$$f(x) = \frac{1}{(x - 10)}$$

```
In [12]: x = sp.symbols('x')
```

Now that I have declared that x is a symbol, Sympy will begin to operate and perform calculations understanding the variable x, or symbol x.

```
In [15]: f = 1/(x-10)
print(f)
```

1/(x - 10)

The function f(x) has just been declared and shown in the python script. Now I will commence to do a limit analysis on how the function behaves as it approaches 10 from both sides. The Python limit command is

implement as follows:

limit(the function(f(x)), the variable(x), the position(x0))

```
In [16]: limit_A = sp.limit(f, x, 10)
         print(limit_A)
```

oo

Analyzing the output, limit\_A, one can deduce it features an unbounded behavior approaching that number; however, one must now take into consideration the one-sided limits which Sympy can calculate. using the same command.

```
In [17]: limit_A_right = sp.limit(f,x, 10, '+')
         print(limit_A_right)
```

oo

The following calculation shows that the function approaches positive infinity as it is approached from the right side.

```
In [18]: limit_A_left = sp.limit(f,x,10, '-')
         print(limit_A_left)
```

-oo

The following calculation shows that the function approaches negative infinity as it is approached from the left side.

```
In [28]: limit_B_end_right = sp.limit(f,x, oo)
         print(limit_B_end_right)
```

0

```
In [29]: limit_B_end_left = sp.limit(f,x, -oo)
         print(limit_B_end_left)
```

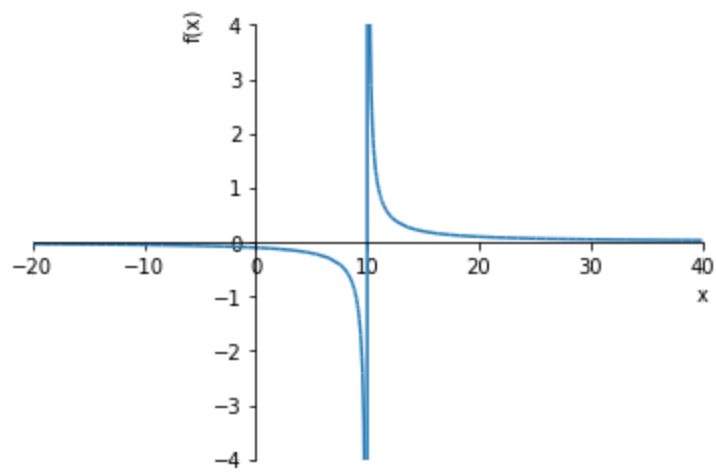
0

The both end behavior of the function as it approaches both negative, and positive infinity is 0. We could further more describe the domain as the following.

$$D : (-\infty, 10) \cup (10, \infty)$$

.

```
In [36]: f_p = sympy.plot(f, (x,-20,40), ylim=[-4,4], show=True)
```



The preceding graph shows the aspects of that were being studied such as the end behavior how adjusting the x range could show the limit approaching infinity, and it shows how the limits concur on the analysis.