In [2]:

```
from __future__ import print_function
import matplotlib.pyplot as plt
import numpy as np
import sympy as sym
sym.init_printing(use_latex = "mathjax")
```

## Enter your name below and run the cell:

Individual cells can be run with `Ctrl + Enter`

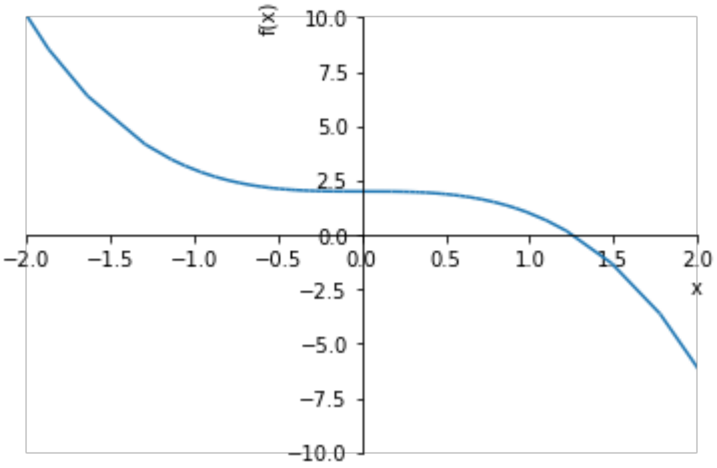
In [1]:

```
# Charlie Lai
```

In [3]:

```
x = sym.symbols('x')
expr = -x ** 3 + 2

sym.plot(expr, xlim=(-2, 2), ylim=(-10, 10));
```



In [4]:

```
sym.Derivative(expr)
```

Out[4]:

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

In [5]:

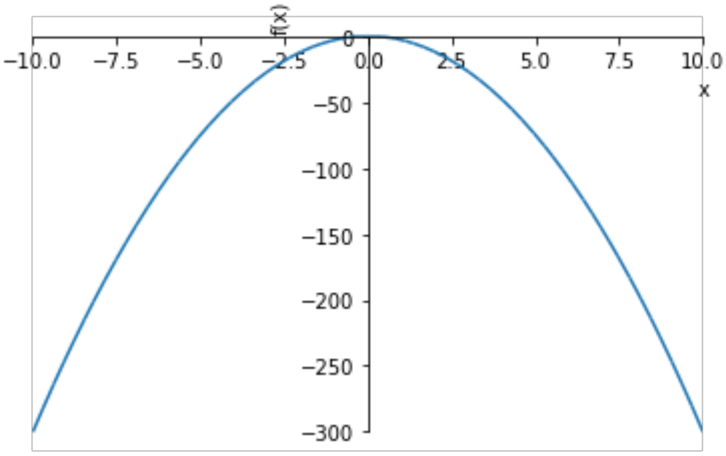
```
sym.Derivative(expr).doit()
```

Out[5]:

$$-3x^{2}$$

In [6]:

```
sym.plot(sym.diff(expr));
```



In [ ]:

```
ys = np.array([0, 1, 0, 1, 2, 0, 2, 3, 2, 1, 2, 102, 108,  95, 100,  98,

fig,ax = plt.subplots()
ax.plot([i for i in range(len(ys))], ys);
```

In [ ]:

```
def make_windows(sequence, windowsize):
    positions = len(sequence) - windowsize + 1
    windows = []
    for i in range(positions):
        windows.append(sequence[i:i+windowsize])
    return windows

def print_padded_seq(seq):
    print("[", ",".join(["{:4d}".format(i) for i in seq]), ']')

def print_sliding_windows(seq, windowsize=3):
    windows = make_windows(seq, windowsize)
    for window in windows:
        print(",".join(["{:4d}".format(i) for i in window]))
```

In [ ]:

```
series = [0, 1, 0, 2, 1, 0, 1, 101, 100, 98, 102, 101]
windowsize = 2

print_padded_seq(series)

print_sliding_windows(series, windowsize=windowsize)
check(1)
```

In [ ]:

```
convolutions = []
kernel = np.array([-1,1])
for w in make_windows(series, windowsize=2):
    w = np.array(w)
    convolved = np.dot(w,kernel)
    convolutions.append(convolved)

plt.plot(convolutions);
check(2)
```

In [ ]:

```
convolved = np.convolve([-1, 1], ys)

fig,ax = plt.subplots()
ax.plot([i for i, _ in enumerate(convolved)], convolved);
```

```
check(3)
```

**Question:** Why does the graph move up at the end? The reason the graph moves up at the end is likely due to a significant positive change in the values of the original signal ys towards the end. The convolution with the kernel [-1, 1] basically performs a first-order difference operation, which amplifies any sudden changes in the signal.