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In [1]: import matplotlib as plot
import numpy as np
import sympy as sym      #Lib for Symbolic Math
from matplotlib import pyplot
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In [2]: def objective(x):
return (x+3)**2
```

```
In [3]: def derivative(x):
return 2*(x + 3)
```

```
In [4]: def gradient_descent(alpha, start, max_iter):
x_list = list()
x= start;
x_list.append(x)
for i in range(max_iter):
    gradient = derivative(x);
    x = x - (alpha*gradient);
    x_list.append(x);
return x_list
```

```
In [5]: x = sym.symbols('x')
expr = (x+3)**2.0;
grad = sym.Derivative(expr,x)
print("{}".format(grad.doit()) )
grad.doit().subs(x,2)
```

2.0\*(x + 3)\*\*1.0

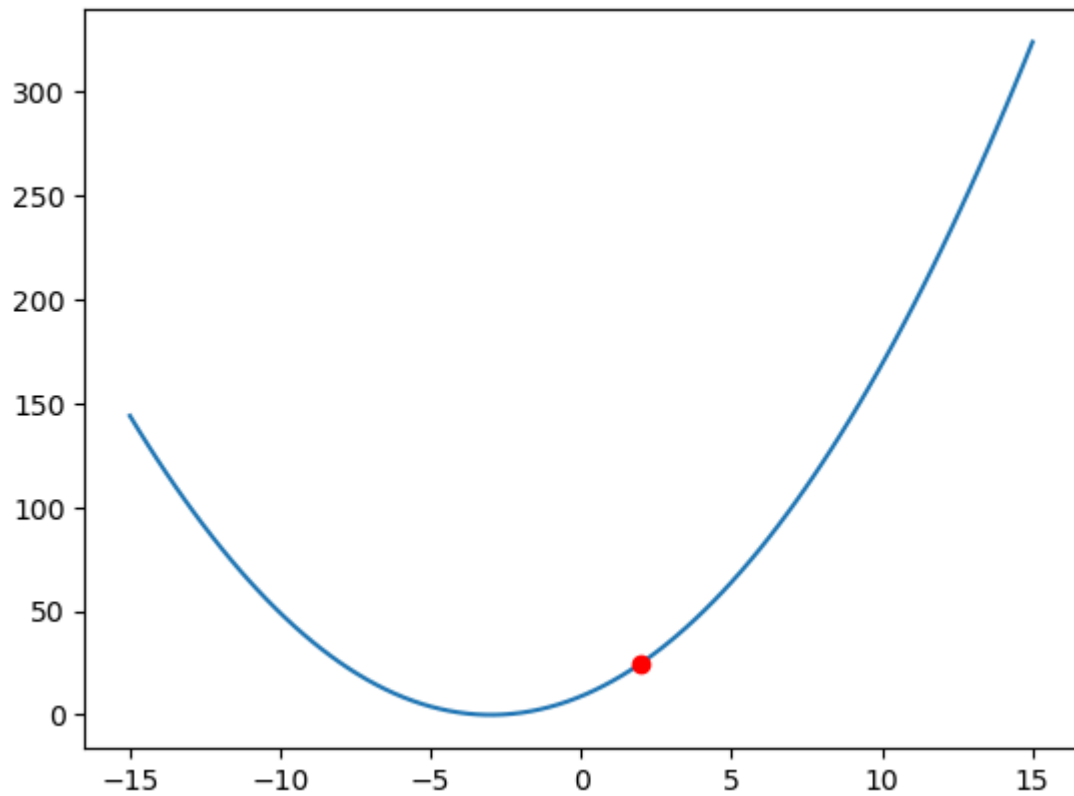
Out[5]:  $\displaystyle 10.0$

```
In [6]: def gradient_descent1(expr,alpha, start, max_iter):
x_list = list()
x = sym.symbols('x')
grad = sym.Derivative(expr,x).doit()
x_val= start;
x_list.append(x_val)
for i in range(max_iter):
    gradient = grad.subs(x,x_val);
    x_val = x_val - (alpha*gradient);
    x_list.append(x_val);
return x_list
```

```
In [15]: alpha = 0.1      #Step_size
start = 2      #Starting point
max_iter = 50   #Limit on iterations
x = sym.symbols('x')
expr = (x+3)**2; #target function
```

```
In [16]: x_cordinate = np.linspace(-15,15,100)
pyplot.plot(x_cordinate,objective(x_cordinate))
pyplot.plot(2,objective(2),'ro')
```

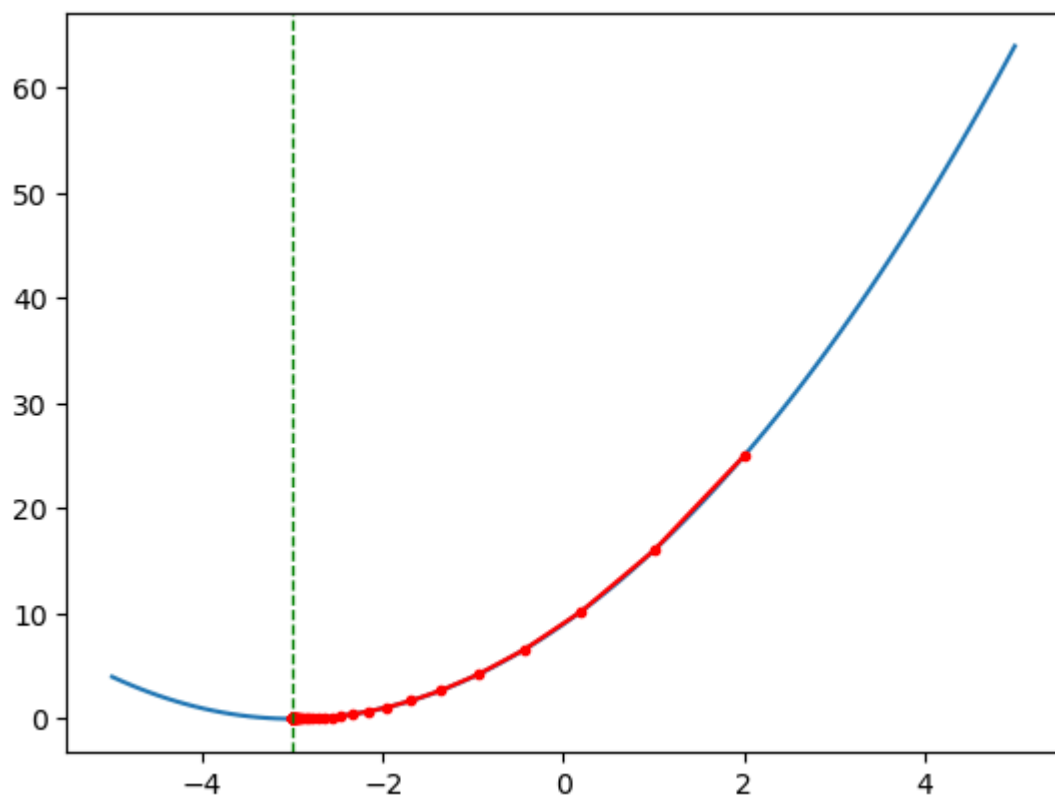
Out[16]: [`<matplotlib.lines.Line2D at 0x22b63298b10>`]



```
In [23]: X = gradient_descent(alpha,start,max_iter)

x_cordinate = np.linspace(-5,5,100)
pyplot.plot(x_cordinate,objective(x_cordinate))

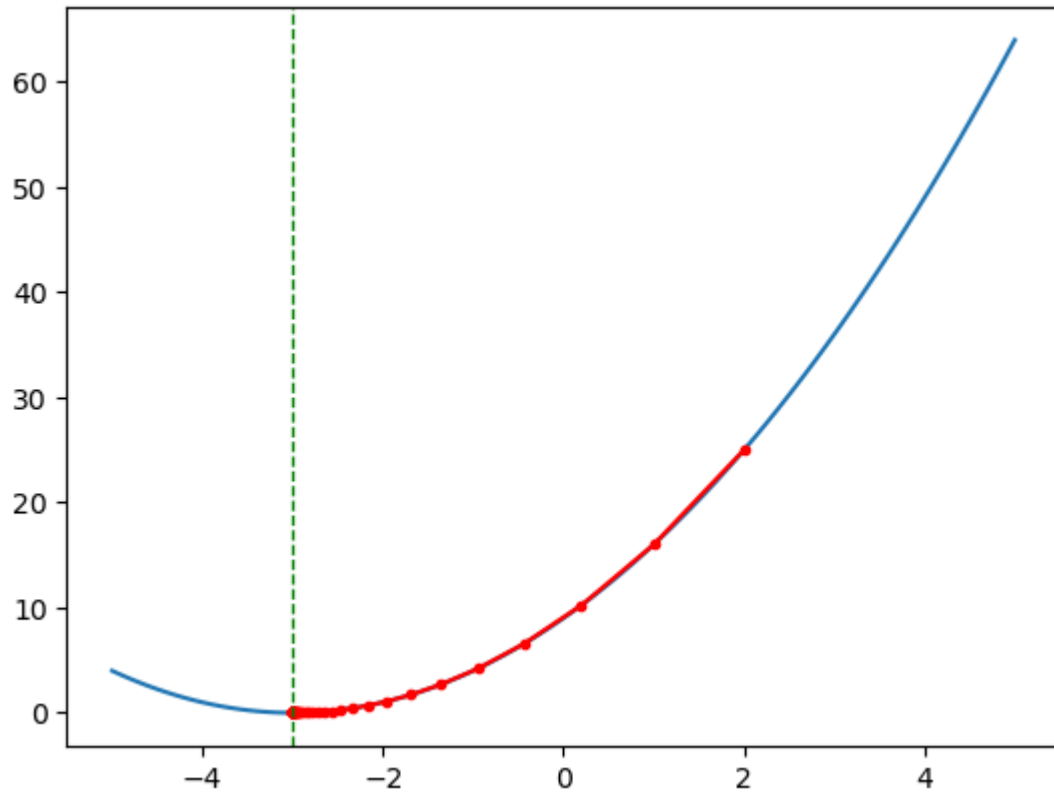
X_arr = np.array(X)
pyplot.plot(X_arr, objective(X_arr), '.-', color='red')
pyplot.axvline(-3,color='green',lw=1,ls='--',label="minimum at x=-3")
pyplot.show()
```



```
In [19]: X= gradient_descent1(expr,alpha,start,max_iter)
X_arr = np.array(X)

x_cordinate = np.linspace(-5,5,100)
pyplot.plot(x_cordinate,objective(x_cordinate))

X_arr = np.array(X)
pyplot.plot(X_arr, objective(X_arr), '.-', color='red')
pyplot.axvline(-3,color='green',lw=1,ls='--',label="minimum at x=-3")
pyplot.show()
```



In [ ]: