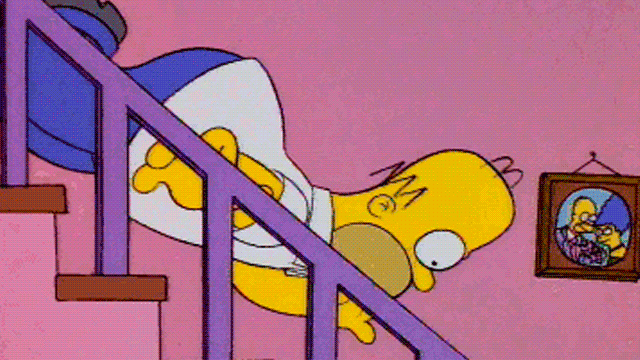
# **Implement Gradient Descent in Python**

# **What is gradient descent ?**

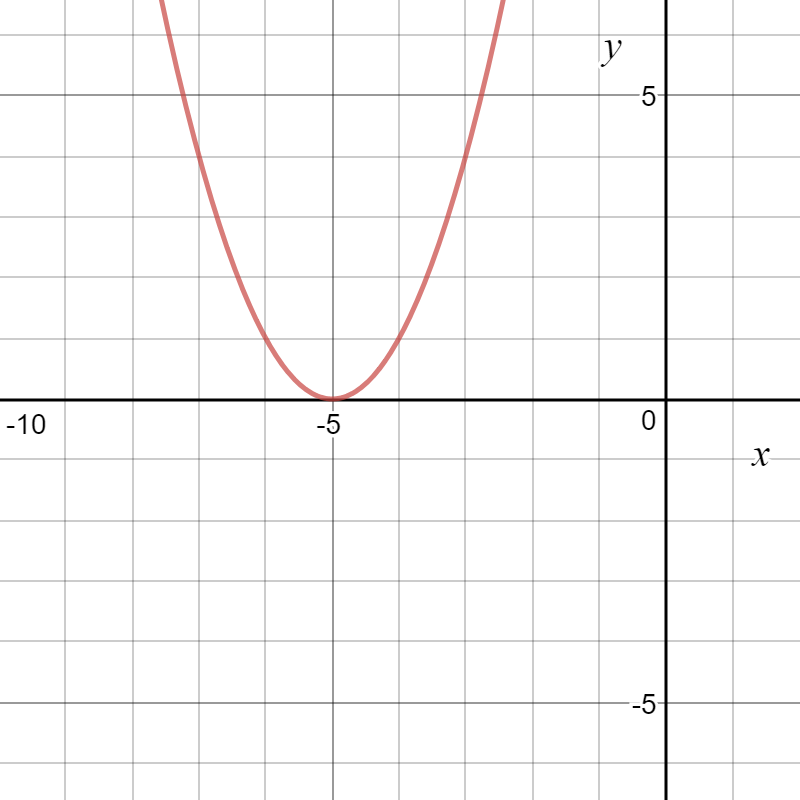
It is an optimization algorithm to find the minimum of a function. We start with a random point on the function and move in the **negative direction** of the **gradient of the function** to reach the **local/global minima**.



Homer descending !

# **Example by hand :**

**Question** : Find the local minima of the function y=(x+5)² starting from the point x=3



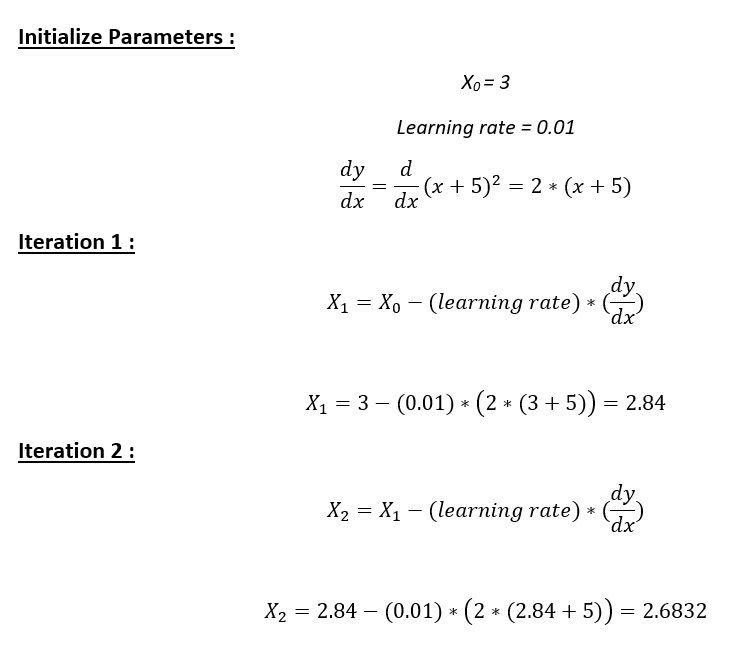
**Solution :** We know the answer just by looking at the graph. y = (x+5)² reaches it’s minimum value when x = -5 (i.e when x=-5, y=0). Hence x=-5 is the local and global minima of the function.

Now, let’s see how to obtain the same numerically using gradient descent.

**Step 1** : Initialize x =3. Then, find the gradient of the function, dy/dx = 2\*(x+5).

**Step 2** : Move in the direction of the negative of the gradient ([Why?](https://www.khanacademy.org/math/multivariable-calculus/multivariable-derivatives/gradient-and-directional-derivatives/v/why-the-gradient-is-the-direction-of-steepest-ascent)). But wait, how much to move? For that, we require a learning rate. Let us assume the **learning rate → 0.01**

**Step 3** : Let’s perform 2 iterations of gradient descent



**Step 4** : We can observe that the X value is slowly decreasing and should converge to -5 (the local minima). However, how many iterations should we perform?

Let us set a precision variable in our algorithm which calculates the difference between two consecutive “x” values . If the difference between x values from 2 consecutive iterations is lesser than the precision we set, stop the algorithm !

# **Gradient descent in Python :**

**Step 1** : Initialize parameters

cur\_x = 3 # The algorithm starts at x=3

rate = 0.01 # Learning rate

precision = 0.000001 #This tells us when to stop the algorithm

previous\_step\_size = 1 #

max\_iters = 10000 # maximum number of iterations

iters = 0 #iteration counter

df = lambda x: 2\*(x+5) #Gradient of our function

**Step 2** : Run a loop to perform gradient descent :

i. Stop loop when difference between x values from 2 consecutive iterations is less than 0.000001 or when number of iterations exceeds 10,000

while previous\_step\_size > precision and iters < max\_iters:

prev\_x = cur\_x #Store current x value in prev\_x

cur\_x = cur\_x - rate \* df(prev\_x) #Grad descent

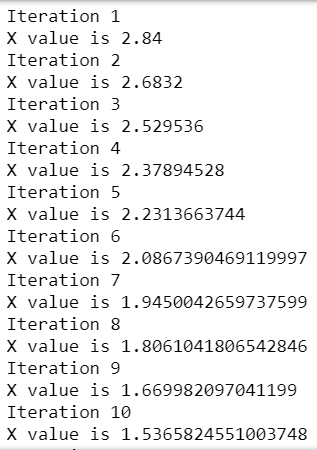
previous\_step\_size = abs(cur\_x - prev\_x) #Change in x

iters = iters+1 #iteration count

print("Iteration",iters,"\nX value is",cur\_x) #Print iterations

print("The local minimum occurs at", cur\_x)

**Output** : From the output below, we can observe the x values for the first 10 iterations- which can be cross checked with our calculation above. The algorithm runs for 595 iterations before it terminates. The code and solution is embedded below for reference.



Connect on [LinkedIn](https://www.linkedin.com/in/rohan-joseph-b39a86aa/).

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" prev\_x = cur\_x #Store current x value in prev\_x\n",

" cur\_x = cur\_x - rate \* df(prev\_x) #Grad descent\n",

" previous\_step\_size = abs(cur\_x - prev\_x) #Change in x\n",

" iters = iters+1 #iteration count\n",

" print(\"Iteration\",iters,\"\\nX value is\",cur\_x) #Print iterations\n",

" \n",

"print(\"The local minimum occurs at\", cur\_x)"

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