

ML ASSIGNMENT 3

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[10]: import numpy as np
import matplotlib.pyplot as plt
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[2]: def func(x):
      return (x+3)**2
```

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

```
[7]: X_values=[]
Y_values=[]
def gradient_descent(starting_point,learning_rate,num_iterations):
    x=starting_point
    for i in range (num_iterations):
        X_values.append(x)
        Y_values.append(func(x))
        grad=gradient(x)
        x=x-learning_rate*grad
        print(f"Iteration {i+1}: x={x}, y={func(x)}")
    return x
```

```
[8]: starting_point=2
learning_rate=0.1
num_iterations=100
```

```
[9]: min_x=gradient_descent(starting_point,learning_rate,num_iterations)
print(f"The local minima occurs at x={min_x}")
```

```
Iteration 1: x=1.0, y=16.0
Iteration 2: x=0.19999999999999996, y=10.240000000000002
Iteration 3: x=-0.440000000000000017, y=6.5535999999999998
Iteration 4: x=-0.95200000000000001, y=4.194304
Iteration 5: x=-1.36160000000000001, y=2.6843545599999996
Iteration 6: x=-1.68928000000000001, y=1.7179869183999996
Iteration 7: x=-1.951424, y=1.099511627776
Iteration 8: x=-2.1611392, y=0.7036874417766399
Iteration 9: x=-2.32891136, y=0.4503599627370493
Iteration 10: x=-2.463129088, y=0.28823037615171165
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Iteration 11: $x=-2.5705032704$, $y=0.1844674407370954$
 Iteration 12: $x=-2.6564026163200003$, $y=0.11805916207174093$
 Iteration 13: $x=-2.725122093056$, $y=0.07555786372591429$
 Iteration 14: $x=-2.7800976744448$, $y=0.04835703278458515$
 Iteration 15: $x=-2.82407813955584$, $y=0.030948500982134555$
 Iteration 16: $x=-2.8592625116446717$, $y=0.019807040628566166$
 Iteration 17: $x=-2.8874100093157375$, $y=0.012676506002282305$
 Iteration 18: $x=-2.90992800745259$, $y=0.008112963841460692$
 Iteration 19: $x=-2.927942405962072$, $y=0.005192296858534868$
 Iteration 20: $x=-2.9423539247696575$, $y=0.0033230699894623056$
 Iteration 21: $x=-2.953883139815726$, $y=0.002126764793255884$
 Iteration 22: $x=-2.9631065118525806$, $y=0.0013611294676837786$
 Iteration 23: $x=-2.9704852094820646$, $y=0.0008711228593176078$
 Iteration 24: $x=-2.9763881675856516$, $y=0.0005575186299632732$
 Iteration 25: $x=-2.981110534068521$, $y=0.00035681192317650156$
 Iteration 26: $x=-2.984888427254817$, $y=0.00022835963083295564$
 Iteration 27: $x=-2.9879107418038537$, $y=0.00014615016373308945$
 Iteration 28: $x=-2.990328593443083$, $y=9.353610478917726e-05$
 Iteration 29: $x=-2.9922628747544664$, $y=5.986310706507345e-05$
 Iteration 30: $x=-2.993810299803573$, $y=3.83123885216492e-05$
 Iteration 31: $x=-2.995048239842858$, $y=2.451992865385725e-05$
 Iteration 32: $x=-2.9960385918742864$, $y=1.5692754338469342e-05$
 Iteration 33: $x=-2.9968308734994293$, $y=1.0043362776619255e-05$
 Iteration 34: $x=-2.9974646987995435$, $y=6.427752177036323e-06$
 Iteration 35: $x=-2.997971759039635$, $y=4.113761393302886e-06$
 Iteration 36: $x=-2.998377407231708$, $y=2.6328072917135587e-06$
 Iteration 37: $x=-2.998701925785366$, $y=1.6849966666971388e-06$
 Iteration 38: $x=-2.998961540628293$, $y=1.0783978666865378e-06$
 Iteration 39: $x=-2.9991692325026342$, $y=6.901746346793842e-07$
 Iteration 40: $x=-2.9993353860021075$, $y=4.417117661946878e-07$
 Iteration 41: $x=-2.999468308801686$, $y=2.826955303647891e-07$
 Iteration 42: $x=-2.9995746470413485$, $y=1.8092513943361614e-07$
 Iteration 43: $x=-2.9996597176330786$, $y=1.1579208923763523e-07$
 Iteration 44: $x=-2.999727774106463$, $y=7.410693711203819e-08$
 Iteration 45: $x=-2.99978221928517$, $y=4.7428439751781807e-08$
 Iteration 46: $x=-2.9998257754281363$, $y=3.035420144107846e-08$
 Iteration 47: $x=-2.999860620342509$, $y=1.9426688922339734e-08$
 Iteration 48: $x=-2.999888496274007$, $y=1.243308091029743e-08$
 Iteration 49: $x=-2.9999107970192056$, $y=7.9571717826062e-09$
 Iteration 50: $x=-2.9999286376153647$, $y=5.092589940842615e-09$
 Iteration 51: $x=-2.9999429100922916$, $y=3.259257562149415e-09$
 Iteration 52: $x=-2.999954328073833$, $y=2.0859248397837384e-09$
 Iteration 53: $x=-2.9999634624590668$, $y=1.3349918974486118e-09$
 Iteration 54: $x=-2.9999707699672533$, $y=8.543948143723039e-10$
 Iteration 55: $x=-2.999976615973803$, $y=5.468126811899669e-10$
 Iteration 56: $x=-2.9999812927790424$, $y=3.499601159582557e-10$
 Iteration 57: $x=-2.9999850342232337$, $y=2.2397447421860056e-10$
 Iteration 58: $x=-2.999988027378587$, $y=1.433436634977776e-10$

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Iteration 59: x=-2.9999904219028695, y=9.173994464198049e-11
Iteration 60: x=-2.9999923375222957, y=5.871356456950638e-11
Iteration 61: x=-2.9999938700178364, y=3.757668132666189e-11
Iteration 62: x=-2.999995096014269, y=2.4049076048192486e-11
Iteration 63: x=-2.9999960768114153, y=1.5391408670843192e-11
Iteration 64: x=-2.9999968614491324, y=9.850501548782124e-12
Iteration 65: x=-2.999997489159306, y=6.3043209907745444e-12
Iteration 66: x=-2.9999979913274446, y=4.034765434809332e-12
Iteration 67: x=-2.9999983930619556, y=2.5822498785634223e-12
Iteration 68: x=-2.9999987144495646, y=1.6526399220522305e-12
Iteration 69: x=-2.9999989715596516, y=1.0576895502961154e-12
Iteration 70: x=-2.9999991772477212, y=6.769213121895138e-13
Iteration 71: x=-2.999999341798177, y=4.3322963956744853e-13
Iteration 72: x=-2.9999994734385416, y=2.7726696951023927e-13
Iteration 73: x=-2.9999995787508333, y=1.7745086041172427e-13
Iteration 74: x=-2.9999996630006667, y=1.1356855066350352e-13
Iteration 75: x=-2.9999997304005332, y=7.268387247253274e-14
Iteration 76: x=-2.9999997843204267, y=4.651767834410857e-14
Iteration 77: x=-2.9999998274563415, y=2.977131407892966e-14
Iteration 78: x=-2.9999998619650734, y=1.9053640961475125e-14
Iteration 79: x=-2.9999998895720585, y=1.2194330254575965e-14
Iteration 80: x=-2.999999911657647, y=7.80437133154311e-15
Iteration 81: x=-2.9999999293261177, y=4.994797639633387e-15
Iteration 82: x=-2.999999943460894, y=3.1966704893653676e-15
Iteration 83: x=-2.9999999547687155, y=2.045869097124455e-15
Iteration 84: x=-2.9999999638149726, y=1.309356209304147e-15
Iteration 85: x=-2.9999999710519782, y=8.379879636702507e-16
Iteration 86: x=-2.9999999768415826, y=5.363122967489605e-16
Iteration 87: x=-2.999999981473266, y=3.432398699193347e-16
Iteration 88: x=-2.9999999851786128, y=2.1967351938118145e-16
Iteration 89: x=-2.99999998814289, y=1.4059105661644777e-16
Iteration 90: x=-2.999999990514312, y=8.997827286453327e-17
Iteration 91: x=-2.9999999924114498, y=5.758609463330129e-17
Iteration 92: x=-2.9999999939291597, y=3.685510164371068e-17
Iteration 93: x=-2.9999999951433276, y=2.358726677741145e-17
Iteration 94: x=-2.999999996114662, y=1.5095850047368678e-17
Iteration 95: x=-2.99999999689173, y=9.661342926036557e-18
Iteration 96: x=-2.9999999975133838, y=6.18326035608692e-18
Iteration 97: x=-2.999999998010707, y=3.957287334634505e-18
Iteration 98: x=-2.9999999984085655, y=2.532663894166083e-18
Iteration 99: x=-2.999999998726852, y=1.6209053445792253e-18
Iteration 100: x=-2.999999998981482, y=1.0373792396055266e-18
The local minima occurs at x=-2.999999998981482

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[12]: plt.figure(figsize = (8,6))
      plt.plot(X_values,Y_values,'ro-')
      plt.ylabel("X_values")

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plt.xlabel("Y_values")
plt.show()
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