

# Assignment4

August 4, 2025

```
[7]: cur_x = 2 # The algorithm starts at x = 2
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-9) #Gradient of our function
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)
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Iteration 1
x value is 2.14
Iteration 2
x value is 2.2772
Iteration 3
x value is 2.4116560000000002
Iteration 4
x value is 2.54342288
Iteration 5
x value is 2.6725544224
Iteration 6
x value is 2.799103333952
Iteration 7
x value is 2.92312126727296
Iteration 8
x value is 3.0446588419275007
Iteration 9
x value is 3.1637656650889507
Iteration 10
x value is 3.2804903517871717
Iteration 11
x value is 3.3948805447514285
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Iteration 12
x value is 3.5069829338564
Iteration 13
x value is 3.616843275179272
Iteration 14
x value is 3.7245064096756866
Iteration 15
x value is 3.8300162814821728
Iteration 16
x value is 3.9334159558525292
Iteration 17
x value is 4.034747636735479
Iteration 18
x value is 4.134052684000769
Iteration 19
x value is 4.231371630320754
Iteration 20
x value is 4.326744197714339
Iteration 21
x value is 4.420209313760052
Iteration 22
x value is 4.511805127484851
Iteration 23
x value is 4.601569024935154
Iteration 24
x value is 4.6895376444364505
Iteration 25
x value is 4.775746891547722
Iteration 26
x value is 4.8602319537167675
Iteration 27
x value is 4.943027314642432
Iteration 28
x value is 5.024166768349583
Iteration 29
x value is 5.103683432982591
Iteration 30
x value is 5.181609764322939
Iteration 31
x value is 5.2579775690364805
Iteration 32
x value is 5.332818017655751
Iteration 33
x value is 5.406161657302636
Iteration 34
x value is 5.478038424156583
Iteration 35
x value is 5.548477655673452
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Iteration 36
x value is 5.617508102559983
Iteration 37
x value is 5.685157940508783
Iteration 38
x value is 5.751454781698607
Iteration 39
x value is 5.816425686064635
Iteration 40
x value is 5.880097172343342
Iteration 41
x value is 5.942495228896475
Iteration 42
x value is 6.003645324318546
Iteration 43
x value is 6.063572417832175
Iteration 44
x value is 6.122300969475531
Iteration 45
x value is 6.17985495008602
Iteration 46
x value is 6.2362578510843
Iteration 47
x value is 6.291532694062614
Iteration 48
x value is 6.3457020401813615
Iteration 49
x value is 6.398787999377734
Iteration 50
x value is 6.45081223939018
Iteration 51
x value is 6.501795994602376
Iteration 52
x value is 6.551760074710328
Iteration 53
x value is 6.600724873216122
Iteration 54
x value is 6.6487103757518
Iteration 55
x value is 6.695736168236764
Iteration 56
x value is 6.741821444872029
Iteration 57
x value is 6.786985015974588
Iteration 58
x value is 6.831245315655097
Iteration 59
x value is 6.874620409341995
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Iteration 60
x value is 6.917128001155155
Iteration 61
x value is 6.9587854411320516
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x value is 6.999609732309411
Iteration 63
x value is 7.039617537663223
Iteration 64
x value is 7.078825186909959
Iteration 65
x value is 7.117248683171759
Iteration 66
x value is 7.154903709508324
Iteration 67
x value is 7.191805635318158
Iteration 68
x value is 7.227969522611795
Iteration 69
x value is 7.263410132159558
Iteration 70
x value is 7.298141929516367
Iteration 71
x value is 7.33217909092604
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x value is 7.365535509107519
Iteration 73
x value is 7.398224798925368
Iteration 74
x value is 7.430260302946861
Iteration 75
x value is 7.461655096887924
Iteration 76
x value is 7.492421994950165
Iteration 77
x value is 7.522573555051162
Iteration 78
x value is 7.552122083950139
Iteration 79
x value is 7.581079642271137
Iteration 80
x value is 7.609458049425714
Iteration 81
x value is 7.6372688884372
Iteration 82
x value is 7.664523510668456
Iteration 83
x value is 7.691233040455087
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Iteration 84
x value is 7.717408379645985
Iteration 85
x value is 7.743060212053065
Iteration 86
x value is 7.768199007812004
Iteration 87
x value is 7.792835027655763
Iteration 88
x value is 7.816978327102648
Iteration 89
x value is 7.840638760560595
Iteration 90
x value is 7.863825985349383
Iteration 91
x value is 7.886549465642395
Iteration 92
x value is 7.9088184763295475
Iteration 93
x value is 7.9306421068029564
Iteration 94
x value is 7.952029264666898
Iteration 95
x value is 7.97298867937356
Iteration 96
x value is 7.993528905786089
Iteration 97
x value is 8.013658327670367
Iteration 98
x value is 8.033385161116959
Iteration 99
x value is 8.05271745789462
Iteration 100
x value is 8.071663108736727
Iteration 101
x value is 8.090229846561993
Iteration 102
x value is 8.108425249630754
Iteration 103
x value is 8.12625674463814
Iteration 104
x value is 8.143731609745377
Iteration 105
x value is 8.16085697755047
Iteration 106
x value is 8.177639837999461
Iteration 107
x value is 8.194087041239472
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Iteration 108
x value is 8.210205300414682
Iteration 109
x value is 8.226001194406388
Iteration 110
x value is 8.24148117051826
Iteration 111
x value is 8.256651547107895
Iteration 112
x value is 8.271518516165736
Iteration 113
x value is 8.286088145842422
Iteration 114
x value is 8.300366382925574
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x value is 8.416682037453176
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Iteration 132
x value is 8.513659954116267
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x value is 8.586239872561391
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x value is 8.60262477360796
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Iteration 300
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Iteration 324
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x value is 8.993421995686631
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Iteration 348
x value is 8.993808834964293
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x value is 8.993932658265006
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x value is 8.994054005099706
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x value is 8.994172924997711
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Iteration 372
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x value is 8.996411801794224
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x value is 8.996553894443172
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x value is 8.996821421958384
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Iteration 385
x value is 8.997068180820337
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x value is 8.997126817203931
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x value is 8.997240595242655
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x value is 8.997604490273586
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Iteration 396
x value is 8.997652400468114
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x value is 8.997699352458753
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x value is 8.997745365409578
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x value is 8.997961988904533
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x value is 8.998002749126442
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x value is 8.998230750530984
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x value is 8.998334796553758
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x value is 8.99840073861023
Iteration 416
x value is 8.998432723838025
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x value is 8.998464069361265
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x value is 8.998693287007315
Iteration 426
x value is 8.998719421267168
Iteration 427
x value is 8.998745032841825
Iteration 428
x value is 8.998770132184989
Iteration 429
x value is 8.998794729541288
Iteration 430
x value is 8.998818834950463
Iteration 431
x value is 8.998842458251453
Iteration 432
x value is 8.998865609086424
Iteration 433
x value is 8.998888296904695
Iteration 434
x value is 8.9989105309666
Iteration 435
x value is 8.998932320347269
Iteration 436
x value is 8.998953673940322
Iteration 437
x value is 8.998974600461516
Iteration 438
x value is 8.998995108452286
Iteration 439
x value is 8.999015206283241
Iteration 440
x value is 8.999034902157577
Iteration 441
x value is 8.999054204114426
Iteration 442
x value is 8.999073120032138
Iteration 443
x value is 8.999091657631496
```

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Iteration 444
x value is 8.999109824478866
Iteration 445
x value is 8.999127627989289
Iteration 446
x value is 8.999145075429503
Iteration 447
x value is 8.999162173920913
Iteration 448
x value is 8.999178930442495
Iteration 449
x value is 8.999195351833645
Iteration 450
x value is 8.999211444796972
Iteration 451
x value is 8.999227215901032
Iteration 452
x value is 8.99924267158301
Iteration 453
x value is 8.99925781815135
Iteration 454
x value is 8.999272661788323
Iteration 455
x value is 8.999287208552557
Iteration 456
x value is 8.999301464381507
Iteration 457
x value is 8.999315435093877
Iteration 458
x value is 8.999329126391999
Iteration 459
x value is 8.99934254386416
Iteration 460
x value is 8.999355692986876
Iteration 461
x value is 8.99936857912714
Iteration 462
x value is 8.999381207544596
Iteration 463
x value is 8.999393583393704
Iteration 464
x value is 8.99940571172583
Iteration 465
x value is 8.999417597491313
Iteration 466
x value is 8.999429245541487
Iteration 467
x value is 8.999440660630658
```

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Iteration 468
x value is 8.999451847418044
Iteration 469
x value is 8.999462810469684
Iteration 470
x value is 8.99947355426029
Iteration 471
x value is 8.999484083175084
Iteration 472
x value is 8.999494401511582
Iteration 473
x value is 8.99950451348135
Iteration 474
x value is 8.999514423211723
Iteration 475
x value is 8.999524134747489
Iteration 476
x value is 8.99953365205254
Iteration 477
x value is 8.999542979011489
Iteration 478
x value is 8.999552119431259
Iteration 479
x value is 8.999561077042634
Iteration 480
x value is 8.99956985550178
Iteration 481
x value is 8.999578458391746
Iteration 482
x value is 8.999586889223911
Iteration 483
x value is 8.999595151439433
Iteration 484
x value is 8.999603248410644
Iteration 485
x value is 8.99961118344243
Iteration 486
x value is 8.999618959773581
Iteration 487
x value is 8.99962658057811
Iteration 488
x value is 8.999634048966547
Iteration 489
x value is 8.999641367987216
Iteration 490
x value is 8.999648540627472
Iteration 491
x value is 8.999655569814923
```

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Iteration 492
x value is 8.999662458418625
Iteration 493
x value is 8.999669209250252
Iteration 494
x value is 8.999675825065246
Iteration 495
x value is 8.99968230856394
Iteration 496
x value is 8.999688662392662
Iteration 497
x value is 8.99969488914481
Iteration 498
x value is 8.999700991361912
Iteration 499
x value is 8.999706971534675
Iteration 500
x value is 8.999712832103981
Iteration 501
x value is 8.999718575461902
Iteration 502
x value is 8.999724203952663
Iteration 503
x value is 8.99972971987361
Iteration 504
x value is 8.999735125476137
Iteration 505
x value is 8.999740422966614
Iteration 506
x value is 8.999745614507281
Iteration 507
x value is 8.999750702217137
Iteration 508
x value is 8.999755688172794
Iteration 509
x value is 8.999760574409338
Iteration 510
x value is 8.999765362921151
Iteration 511
x value is 8.999770055662728
Iteration 512
x value is 8.999774654549473
Iteration 513
x value is 8.999779161458484
Iteration 514
x value is 8.999783578229314
Iteration 515
x value is 8.999787906664729
```

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Iteration 516
x value is 8.999792148531434
Iteration 517
x value is 8.999796305560805
Iteration 518
x value is 8.999800379449589
Iteration 519
x value is 8.999804371860597
Iteration 520
x value is 8.999808284423384
Iteration 521
x value is 8.999812118734917
Iteration 522
x value is 8.99981587636022
Iteration 523
x value is 8.999819558833016
Iteration 524
x value is 8.999823167656356
Iteration 525
x value is 8.999826704303228
Iteration 526
x value is 8.999830170217164
Iteration 527
x value is 8.999833566812821
Iteration 528
x value is 8.999836895476564
Iteration 529
x value is 8.999840157567032
Iteration 530
x value is 8.999843354415692
Iteration 531
x value is 8.999846487327378
Iteration 532
x value is 8.99984955758083
Iteration 533
x value is 8.999852566429213
Iteration 534
x value is 8.999855515100629
Iteration 535
x value is 8.999858404798616
Iteration 536
x value is 8.999861236702642
Iteration 537
x value is 8.99986401196859
Iteration 538
x value is 8.999866731729218
Iteration 539
x value is 8.999869397094635
```

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Iteration 540
x value is 8.999872009152742
Iteration 541
x value is 8.999874568969688
Iteration 542
x value is 8.999877077590293
Iteration 543
x value is 8.999879536038486
Iteration 544
x value is 8.999881945317716
Iteration 545
x value is 8.999884306411362
Iteration 546
x value is 8.999886620283135
Iteration 547
x value is 8.999888887877473
Iteration 548
x value is 8.999891110119924
Iteration 549
x value is 8.999893287917525
Iteration 550
x value is 8.999895422159174
Iteration 551
x value is 8.99989751371599
Iteration 552
x value is 8.99989956344167
Iteration 553
x value is 8.999901572172837
Iteration 554
x value is 8.99990354072938
Iteration 555
x value is 8.999905469914792
Iteration 556
x value is 8.999907360516495
Iteration 557
x value is 8.999909213306164
Iteration 558
x value is 8.99991102904004
Iteration 559
x value is 8.99991280845924
Iteration 560
x value is 8.999914552290054
Iteration 561
x value is 8.999916261244254
Iteration 562
x value is 8.999917936019369
Iteration 563
x value is 8.99991957729898
```

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Iteration 564
x value is 8.999921185753001
Iteration 565
x value is 8.999922762037942
Iteration 566
x value is 8.999924306797183
Iteration 567
x value is 8.99992582066124
Iteration 568
x value is 8.999927304248015
Iteration 569
x value is 8.999928758163055
Iteration 570
x value is 8.999930182999794
Iteration 571
x value is 8.999931579339798
Iteration 572
x value is 8.999932947753
Iteration 573
x value is 8.999934288797942
Iteration 574
x value is 8.999935603021983
Iteration 575
x value is 8.999936890961543
Iteration 576
x value is 8.999938153142311
Iteration 577
x value is 8.999939390079465
Iteration 578
x value is 8.999940602277876
Iteration 579
x value is 8.999941790232318
Iteration 580
x value is 8.999942954427672
Iteration 581
x value is 8.999944095339119
Iteration 582
x value is 8.999945213432337
Iteration 583
x value is 8.99994630916369
Iteration 584
x value is 8.999947382980416
Iteration 585
x value is 8.999948435320807
Iteration 586
x value is 8.99994946661439
Iteration 587
x value is 8.999950477282102
```

```
Iteration 588
x value is 8.99995146773646
The local minimum occurs at 8.99995146773646
```

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[ ]:
```