

Lab 4 Report

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IE 684

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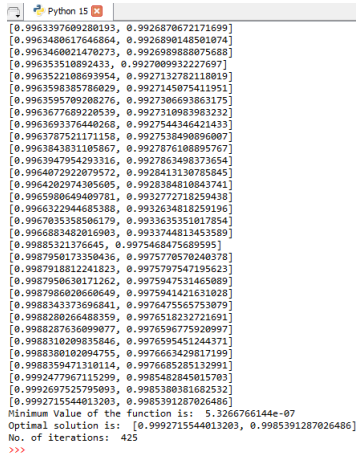
1 Solution 1

file: ex1b.py

1.1 Subpart 1

we assumed that the algorithm converges if the L2 Norm of the grad function is close to zero.

1.2 Subpart 4



```
[0.9963397609208193, 0.9926870672171699]
[0.9963480617646864, 0.9926890148501074]
[0.9963460021470273, 0.9926989888075688]
[0.9963535108892433, 0.9927009932227697]
[0.9963522108693954, 0.9927132702118019]
[0.9963598385786829, 0.9927145075411951]
[0.9963595709208276, 0.9927306693863175]
[0.9963677689220539, 0.9927310983983232]
[0.9963693376440268, 0.9927544346421433]
[0.9963787521171158, 0.9927538490896007]
[0.9963843831105867, 0.9927876108895767]
[0.9963947954293316, 0.9927863498373654]
[0.9964072922079572, 0.9928413130785845]
[0.9964202974305605, 0.9928384810843741]
[0.9965980649409781, 0.9932772718259438]
[0.9966322944685388, 0.9932634818259196]
[0.9967035358586179, 0.9933635351017854]
[0.9968834803016903, 0.9933744813453500]
[0.99885321376645, 0.9975468475689595]
[0.9987950173350436, 0.9975770570240378]
[0.9987918812241825, 0.9975797547195623]
[0.9987950630171262, 0.997554475331465009]
[0.9987986020606049, 0.9975941421631028]
[0.9988343373696841, 0.9976475565753079]
[0.9988280266488359, 0.997651822721691]
[0.9988287636090907, 0.997659677920997]
[0.9988310209835846, 0.9976595451244371]
[0.9988380102094755, 0.9976663429817199]
[0.9988359471310114, 0.9976685285132991]
[0.9992477967115299, 0.9985402845015703]
[0.9992697525795093, 0.9985380381682532]
[0.9992715544013203, 0.9985391287026486]
Minimum Value of the function is: 5.3266766144e-07
Optimal solution is: [0.9992715544013203, 0.9985391287026486]
No. of iterations: 425
>>>
```

Figure 1: Optimal solution(Stationary point); the no. of iterations the routine took; the minimum value

The Stationary points of the given function is: [0.999271,0.998539]

1.3 Subpart 5

The no. of iterations taken by the algorithm is 425. [Refer above picture]

1.4 Subpart 6

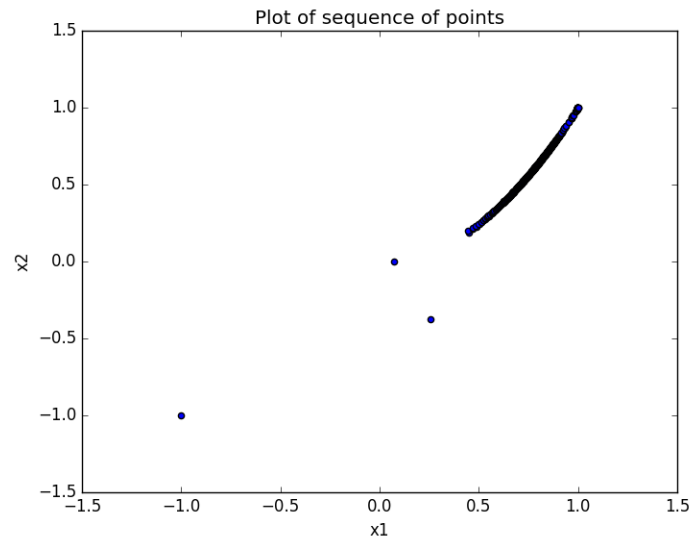


Figure 2: Plot of the sequence of points generated by the algorithm

The sequence of points converges slowly to a stationary point. The pattern is a bit spiral in nature.

1.5 Subpart 7

No. of iterations when starting point is $[0,0] = 557$

No. of iterations when starting point is $[0.5,0.5] = 146$

No. of iterations when starting point is $[3,0] = 218$

Refer below for the outputs.

```
Minimum Value of the function is: 7.36250086617e-07
Optimal solution is: [0.999142062150574, 0.9982834720748888]
No. of iterations: 557
```

Figure 3: No. of iterations taken by the algorithm when starting point is $[0,0]$

```
Minimum Value of the function is: 3.46497653607e-10
Optimal solution is: [0.9999814864864849, 0.999963166899576]
No. of iterations: 218
```

Figure 4: No. of iterations taken by the algorithm when starting point is $[3,0]$

There is no observable pattern in the no. of iterations taken to converge to a stationary point.

```

Minimum Value of the function is: 5.31001246029e-09
Optimal solution is: [1.00007269040144, 1.000145901600193]
No. of iterations: 146

```

Figure 5: No. of iterations taken by the algorithm when starting point is $[0.5, 0.5]$

2 Solution 2

2.1 Subpart 1

file: ex2a.py

Refer figures 6 and 7

```

aakash.b@passpoli:~/ie604/lab4$ python ex2a.py
2.14826508628
2.14826508608
2.14826508592
2.14826508563
2.14826508554
2.14826508546
2.14826508539
2.14826508535
2.14826508535
Minimum Value of the function is: -61567.3940535
No. of iterations: 9
aakash.b@passpoli:~/ie604/lab4$

```

Figure 6: No. of iterations taken by the algorithm and the minimum value

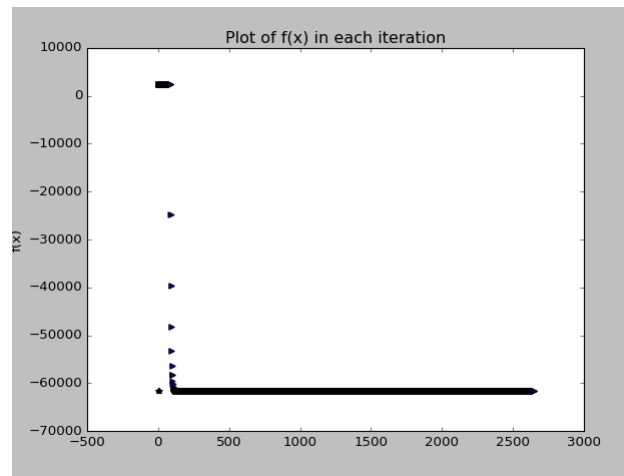


Figure 7: Plot of the functional values at each iteration

2.2 Subpart 2

file: ex2b.py

Refer figures 8 and 9

```

Minimum Value of the function is: 1.05471187339e-14
Optimal solution is: [-7.030044303382557e-08, 9.329686932761782e-13, -5.0556636435446986e-26, -1.5537333325945724e-20, 9.960306139783325e-18, 5.155408822069296e-13, -6.577198921053714e-11, -4.412417112664377e-09, -6.055273049876634e-08, -3.967948076659822e-07]
No. of iterations: 45
aakash.b@passpoli:~/ie684/lab4$

```

Figure 8: No. of iterations taken by the algorithm and the minimum value

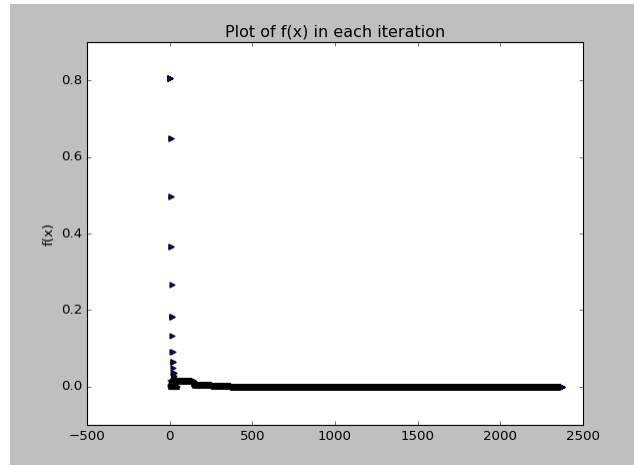


Figure 9: Plot of the functional values at each iteration

2.3 Subpart 3

file: ex2c.py

Refer figures 10 and 11

```

Minimum Value of the function is: 30.0
Optimal solution is: [-0.5999999979075508, -0.40000000202496677]
No. of iterations: 12

```

Figure 10: No. of iterations taken by the algorithm and the minimum value

3 Solution 3

files:

ex3a.py

ex3b.py

ex3c.py

ex3d.py

For ex1:

No. of iterations in Steepest Descent= 425 (figure 1)

No. of iterations in Coordinate Descent= 3887 (figure 12)

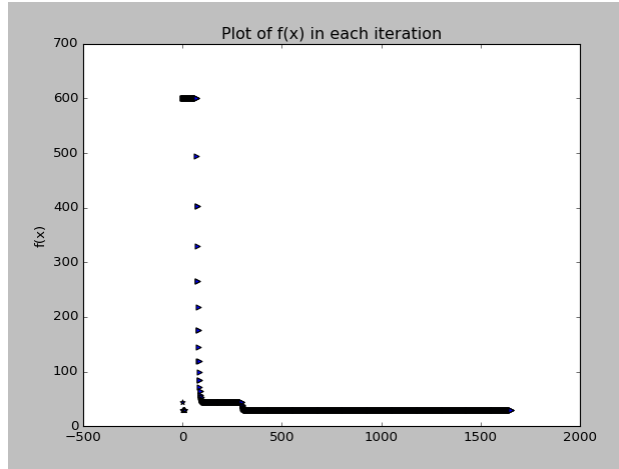


Figure 11: Plot of the functional values at each iteration

```
Minimum Value of the function is: 8.69479183823e-10
Optimal solution is: [0.9999705448757646, 0.9999409537308542]
No. of iterations: 3887
aakash.b@passpoli:~/ie684/lab4$
```

Figure 12: Output for ex3a.py

For ex2a:

No. of iterations in Steepest Descent= 9 (figure 6)

No. of iterations in Coordinate Descent= Was taking a lot of time (code running perfectly)

For ex2b:

No. of iterations in Steepest Descent= 45 (figure 8)

No. of iterations in Coordinate Descent= 3 (figure 13)

For ex2c:

No. of iterations in Steepest Descent= 12 (figure 10)

No. of iterations in Coordinate Descent= 19 (figure 14)

α^* was found by increasing the interval in both ways. i.e. we searched along the ray $y + \alpha * d$ and $y - \alpha * d$.

We needed grad of f in this algorithm for computing the convergence criterion. Our convergence criteria was the L2 norm of the gradient to be zero.

```

aakash.b@passpoli:~/ie684/lab4$ python ex3c.py
[-1, -1, -1, -1, -1, -1, -1, -1, -1]
[-1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06, -1.3685923217235007e-06]
[-3.9339945705144397e-07, -3.9339945705144397e-07, -6.003212689778998e-07, -6.003212689778998e-07, -6.003212689778998e-07, -6.003212689778998e-07, -9.15702783878762e-07, -9.15702783878762e-07, -9.15702783878762e-07]
[-3.9339945705144397e-07, -3.9339945705144397e-07, -6.003212689778998e-07, -6.003212689778998e-07, -6.003212689778998e-07, -6.003212689778998e-07, -9.15702783878762e-07, -9.15702783878762e-07, -9.15702783878762e-07]
Minimum Value of the function is: 4.89386309255e-13
Optimal solution is: [-3.9339945705144397e-07, -3.9339945705144397e-07, -6.003212689778998e-07, -6.003212689778998e-07, -6.003212689778998e-07, -6.003212689778998e-07, -9.15702783878762e-07, -9.15702783878762e-07, -9.15702783878762e-07]
No. of iterations: 3
aakash.b@passpoli:~/ie684/lab4$ █

```

Figure 13: Output for ex3c.py

```

Minimum Value of the function is: 30.0
Optimal solution is: [-0.5999999922007153, -0.4000000074673021]
No. of iterations: 19

```

Figure 14: Output for ex3d.py