Lab 4 Report

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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

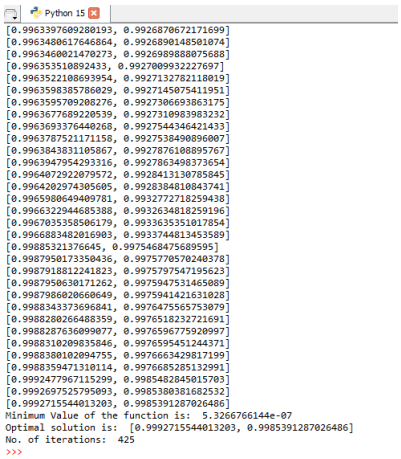

Figure 1: Optimal solution(Stationary point); the no. of iterations the routine took; the minimum value

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

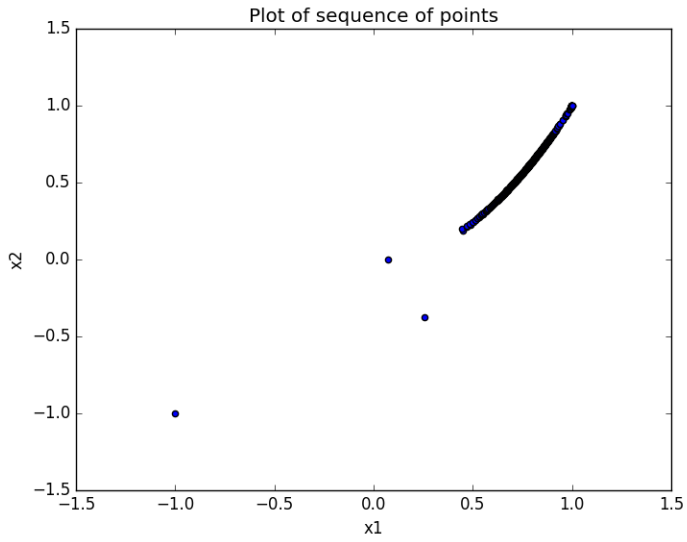

Figure 2: Plot of the sequence of points generated by the algorithm

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, 0.998283472074888]
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:  [1.00007269848144, 1.000145901680193]
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:~/ie684/lab4$ python ex2a.py
2.14826508628
2.14826508608
2.14826508582
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:~/ie684/lab4$
```

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

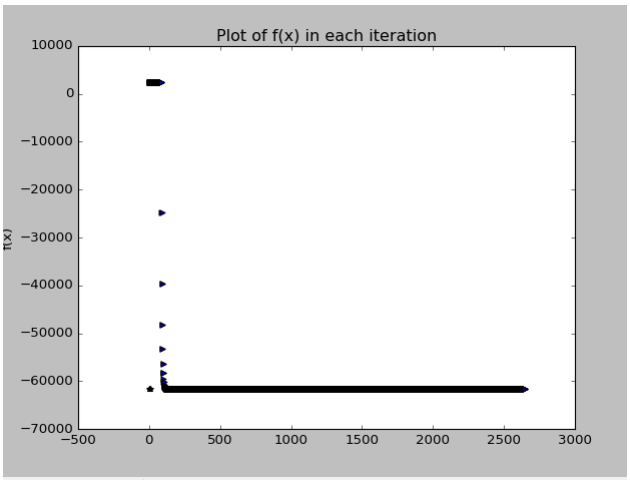

Figure 7: Plot of the functional values at each iteration

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

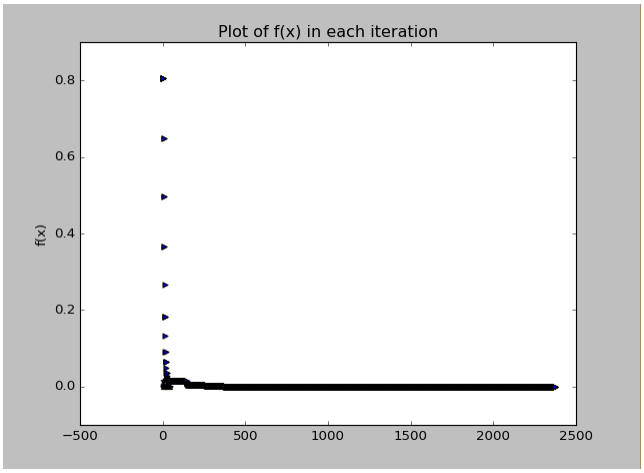

Figure 9: Plot of the functional values at each iteration

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, -0.4000000202496677]
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)

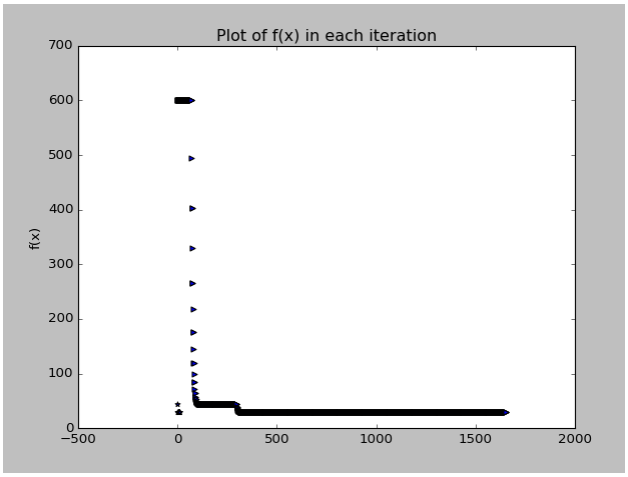

Figure 11: Plot of the functional values at each iteration

```
Minimum Value of the function is:  8.69478183823e-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]
[-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, -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, -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, -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, -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