Technion – Israel Institute of Technology



HW6

Numerical Methods

019003

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# Question 1

We were asked to solve with five optimization methods three different test functions: Rosenbrock’s banana, Easom, and Eggholder. In each method we required to implement five runs with different initial conditions.

The following tables summarize the results for the Quasi-Newton method:

Rosenbrock’s banana function:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Last step size | Change of function value in the last | X Init | Y Init | X Min | Y Min | Function minimum |
| 1 | 16 | 63 | 9.99e-06 | 6.315e-09 | 2.49 | 2.16 | 2 | 4 | 2.48e-10 |
| 2 | 28 | 108 | 6.58e-04 | 3.04e-08 | -2.79 | 5.48 | 2 | 4 | 1.58e-10 |
| 3 | 20 | 78 | 3.196e-04 | 2.55e-08 | 2.58 | 0.59 | 2 | 4 | 4.35e-11 |
| 4 | 19 | 72 | 9.41e-04 | 1.28e-06 | 2.83 | 1.59 | 2 | 4 | 8.05e-11 |
| 5 | 19 | 72 | 1.04e-04 | 4.04e-08 | -0.08 | 1.58 | 2 | 4 | 5.65e-11 |

Easom function:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Last step size | Change of function value in the last | X Init | Y Init | X Min | Y Min | Function minimum |
| 1 | 5 | 33 | 3.46e-05 | 1.78e-09 | 2.30 | 2.07 | 3.141 | 3.141 | -1 |
| 2 | 26 | 165 | 1.788e-05 | 1.6699e-10 | 0.747 | 4.074 | 2.4364 | 2.8807 | -0.4180 |
| 3 | 14 | 84 | 4.96e-05 | 3.326-09 | 4.86 | 2.46 | 3.141 | 3.141 | -1 |
| 4 | 6 | 21 | 3.136e-04 | 1.151e-07 | 3.32 | 3.88 | 3.141 | 3.141 | -1 |
| 5 | 6 | 36 | 2.99e-06 | 1.31e-11 | 1.80 | 2.96 | 3.141 | 3.141 | -1 |

Eggholder function:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Last step size | Change of function value in the last | X Init | Y Init | X Min | Y Min | Function minimum |
| 1 | 9 | 33 | 0.030 | 8.82e-05 | 481.43 | 424.82 | 522.16 | 450.31 | -976.911 |
| 2 | 5 | 21 | 0.0031 | 9.38e-07 | 407.90 | 461.15 | 439.481 | 4990.97 | -935.338 |
| 3 | 6 | 36 | 0.0042 | 2.4e-06 | 262.25 | 263.56 | 284.95 | 272.47 | -562.127 |
| 4 | 6 | 39 | 0.0027 | 1.32e-05 | 75.92 | 46.76 | 47.99 | 35.44 | -88.30 |
| 5 | 9 | 42 | 0.006 | 2.34e-05 | 202.22 | 422.24 | 242.03 | 293.379 | -540.426 |

The following tables summarize the results for the Downhill-simplex method:

Rosenbrock’s banana function:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Last step size | Change of function value in the last | X Init | Y Init | X Min | Y Min | Function minimum |
| 1 | 67 | 129 | 7.124e-05 | 1.74e-10 | 0.30 | 0.53 | 2 | 4 | 2.65e-11 |
| 2 | 50 | 92 | 8.24e-05 | 3.11e-11 | 1.20 | 1.56 | 2 | 4 | 1.02e-10 |
| 3 | 79 | 144 | 3.355e-05 | 8.93e-11 | -1.72 | -0.08 | 2 | 4 | 1.58e-10 |
| 4 | 57 | 111 | 7.60e-05 | 3.19e-10 | 1.87 | 1.94 | 2 | 4 | 1.1e-11 |
| 5 | 48 | 93 | 8.62e-05 | 3.56e-10 | 2.79 | 3.76 | 2 | 4 | 6.97e-11 |

Easom function:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Last step size | Change of function value in the last | X Init | Y Init | X Min | Y Min | Function minimum |
| 1 | 34 | 65 | 1.23e-04 | 7.344e-10 | 3.32 | 3.71 | 3.141 | 3.141 | -1 |
| 2 | 51 | 99 | 0 | 0 | 2.47 | 0.56 | 1.3 | 1.3 | -8.11e-05 |
| 3 | 30 | 61 | 6.129e-04 | 6.11e-10 | 2..77 | 3.76 | 3.141 | 3.141 | -1 |
| 4 | 58 | 112 | 0 | 0 | 0.034 | 0.88 | 1.30 | 1.30 | -8.11e-05 |
| 5 | 29 | 58 | 5.80e-05 | 6.62e-10 | 2.8 | 3.33 | 3.141 | 3.141 | -1 |

Eggholder function:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Last step size | Change of function value in the last | X Init | Y Init | X Min | Y Min | Function minimum |
| 1 | 47 | 88 | 1.16e-04 | 7.95e-11 | 355.60 | 16.75 | 442.18 | 12.78 | -443.497 |
| 2 | 51 | 98 | 1.06e-04 | 2.1e-10 | 340.22 | 201.51 | 418.56 | 208.04 | -629.633 |
| 3 | 61 | 118 | 6.1e-05 | 2.88e-10 | 74.35 | 0.22 | 91.40 | 18.56 | -111.7888 |
| 4 | 45 | 86 | 6.58e-05 | 1.25e-11 | 407.952 | 226.154 | 418.56 | 208.04 | -629.633 |
| 5 | 52 | 99 | 8.89e-05 | 5.68e-10 | 242.84 | 441.29 | 347.32 | 536.4154 | -888.9491 |

The following tables summarize the results for the Genetic method:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Iterations | Evaluations | Change of the mean function value in the last iteration | Change of best function value in the last iteration | X Init best | Y Init  best | X Min | Y Min | Function minimum |
| 1 | 67 | 129 |  | 1.74e-10 | 0.30 | 0.53 | 2 | 4 | 2.65e-11 |
| 2 | 50 | 92 |  | 3.11e-11 | 1.20 | 1.56 | 2 | 4 | 1.02e-10 |
| 3 | 79 | 144 |  | 8.93e-11 | -1.72 | -0.08 | 2 | 4 | 1.58e-10 |
| 4 | 57 | 111 |  | 3.19e-10 | 1.87 | 1.94 | 2 | 4 | 1.1e-11 |
| 5 | 48 | 93 |  | 3.56e-10 | 2.79 | 3.76 | 2 | 4 | 6.97e-11 |