**ENGSCI CT2 2023 Lab 2 Univariate Minimisation Answer Worksheet**

**Name**

**ID Number**

**Question 1:** Your answer…

|  |  |
| --- | --- |
|  |  |
| a + tau\*(b - a) | a + (1 - tau) \* (b - a) |

**Question 2:** Your answer…

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | (x’k, x’’k, bk ) | (ak, x’’k, x’k) |
|  | (ak, x’k, x’’) | (x’’k, x’k, bk) |

**Question 3: Code submission of golden.py**

**Question 4: GS & quadratic-only Brent’s method on f0, f1 starting from [a,b]=[0,3]**

*Using the plots and logging output from task1.py, comment on the performance of both the golden section method and the quadratic-only Brent’s method (as provided in brent.py), and discuss how their performance is affected by the function being minimized. Briefly discuss reasons for the behaviours you observe.*

Answer the following by completing the tables below*: “comment on the performance of both the golden section method and the quadratic-only Brent’s method (as provided in brent.py), “*

*Golden Section Method:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Experiment | Function | Minimum for | Starting Interval of Uncertainty | ? | Method converges? (Y/N) | Method converges to minimum? (Y/N) | If method did not converge to minimum, explain what happened and why. (If the answer is the same as another answer, just say “Same as C2” for example.) |
| A0 |  | 2 | [0,3] | Y | Y | Y |  |
| A1 |  | 2 | [0,3] | Y | Y | Y |  |

*Quadratic-only Brents Method:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Experiment | Function | Minimum for | Starting Interval of Uncertainty | ? | Method converges? (Y/N) | Method converges to minimum? (Y/N) | If method did not converge to minimum, explain what happened and why. (If the answer is the same as another answer, just say “Same as C2” for example.) |
| A0 |  | 2 | [0,3] | Y | Y | Y |  |
| A1 |  | 2 | [0,3] | Y | Y | Y |  |

*“…discuss how their performance is affected by the function being minimized. “*

Your Answer:

* As both functions (f0­ and f1) are well-behaved over the region [0,3], this means there is only one local minimum within the region. Because of this, both methods will yield correct results by ‘flowing’ downhill towards the one minimum point. Both of them converge fairly quickly (after 10-17 iterations) to the correct minimum point.

*“Briefly discuss reasons for the behaviours you observe.”*

Your Answer:

* This behaviour is observed because, as mentioned above, both graphs are well behaved on the provided domain, so converge correctly to the minimum value.

**Question 5: GS & quadratic-only Brent’s method on f0, f1 starting from [a,b]=[0,1]**

*Using these plots, and logging output from your code, carefully explain and contrast*

*what has happened for each of the two functions for each method.*

Complete the tables below to answer the following: *Using these plots, and logging output from your code, carefully explain ~~and contrast~~ what has happened for each of the two functions for each method.*”

*Golden Section Method:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Experiment | Function | Minimum for | Starting Interval of Uncertainty | ? | Method converges? (Y/N) | Method converges to minimum? (Y/N) | If method did not converge to minimum, explain what happened and why. (If the answer is the same as another answer, just say “Same as C2” for example.) |
| B0 |  | 2 | [0,1] | N | Y | N |  |
| B1 |  | 2 | [0,1] | N | Y | N |  |

*Quadratic-only Brents Method:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Experiment | Function | Minimum for | Starting Interval of Uncertainty | ? | Method converges? (Y/N) | Method converges to minimum? (Y/N) | If method did not converge to minimum, explain what happened and why. (If the answer is the same as another answer, just say “Same as C2” for example.) |
| B0 |  | 2 | [0,1] | N | Y | Y |  |
| B1 |  | 2 | [0,1] | N | Y | N |  |

“*Using these plots, and logging output from your code, carefully ~~explain and~~ contrast*

*what has happened for each of the two functions for each method.*”

Your Answer:

* Using the golden section search, both graphs undergo the same process, where the method tries to minimise over the domain [0,1]. However as the functions are not well-behaved over this domain, there is no singular minimum to converge to. The minimum is to the right of the domain, so the method (in both cases) pushes as far to the right as possible within the given domain, and results in choosing the point at x=1.
* Using the Jarrat (quadratic only) method, it does not have to remain within the given domain, so for f0 this method is able to escape the domain [0,1] and find the correct minimum point at x=2. However, for f1­­, the method is incapable of doing this and gets stuck in the region of approximately x=0.4 . This method is worse for f1 as it ends up further from the correct value, but is better for f0 as it reaches the correct value.

**Question 6: GS + Quadratic-only Brent’s on x2, x4, x6, x8**

*Using the plots and output from task3.py, comment on and contrast the perfor-*

*mance of the golden section method and quadratic-only Brent’s method on these*

*functions. Gve brief explanations for the key differences and trends you observe in*

*the runs.*

Answer the following by completing the tables below:

*Using the plots and output from task3.py, comment on ~~and contrast~~ the perfor-*

*mance of the golden section method and quadratic-only Brent’s method on these*

*functions.*

Golden Section Method

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Experiment | Function | Minimum for | Starting Interval of Uncertainty | ? | Method converges? (Y/N) | Method converges to minimum? (Y/N) | If method did not converge to minimum, explain what happened and why. (If the answer is the same as another answer, just say “Same as C2” for example.) |
| C2 |  | 0 | [-0.3,1] | Y |  |  |  |
| C3 |  | 0 | [-0.3,1] | Y |  |  |  |
| C4 |  | 0 | [-0.3,1] | Y |  |  |  |
| C5 |  | 0 | [-0.3,1] | Y |  |  |  |
| C6 |  | 0 | [-0.3,1] | Y |  |  |  |

Quadratic-only Brent’s Method

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Experiment | Function | Minimum for | Starting Interval of Uncertainty | ? | Method converges? (Y/N) | Method converges to minimum? (Y/N) | If method did not converge to minimum, explain what happened and why. (If the answer is the same as another answer, just say “Same as C2” for example.) |
| C2 |  | 0 | [-0.3,1] | Y |  |  |  |
| C3 |  | 0 | [-0.3,1] | Y |  |  |  |
| C4 |  | 0 | [-0.3,1] | Y |  |  |  |
| C5 |  | 0 | [-0.3,1] | Y |  |  |  |
| C6 |  | 0 | [-0.3,1] | Y |  |  |  |

*Using the plots and output from task3.py~~, comment on~~ and contrastthe performance of the golden section method and quadratic-only Brent’s method on these functions.*

Your answer:

*Give brief explanations for the key differences and trends you observe in the runs.*

Your answer:

**Question 7: Code submission of the FullBrent code**

**Question 8:** *Using the plots and log output, compare and contrast the performance of the FullBrent implementation on f2 and f5, giving an explanation for the observed differences. Be sure to look carefully at the log output.*