CSE 592: Convex Optimization
HW 3

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1 Log-barrier function

1.1 Implementation

1.2 Experiments

Observations with main_quadratic and t = 3:

1. Log-Barrier method is approximation method controlled by parameter t = 3.
2. As t increases, optimal point is closer to the boundary i.e. similar to the original problem. In this case, for t = 3, solution is indeed close to the boundary.
3. Function to optimize is Quadratic and hence, Newton's method does converge much faster as it makes use of Hessian at every step to decide direction.
4. Gradient descent takes much more iterations compare to Newton's method as negative gradient does not point to the exact optimal point.
5. Gradient Descent and Newton's method does not converge to the same point. Newton is more accurate than GD as it is 2nd order optimization algorithm. Difference of 1e-5 is observed in this case. (Figure 2)

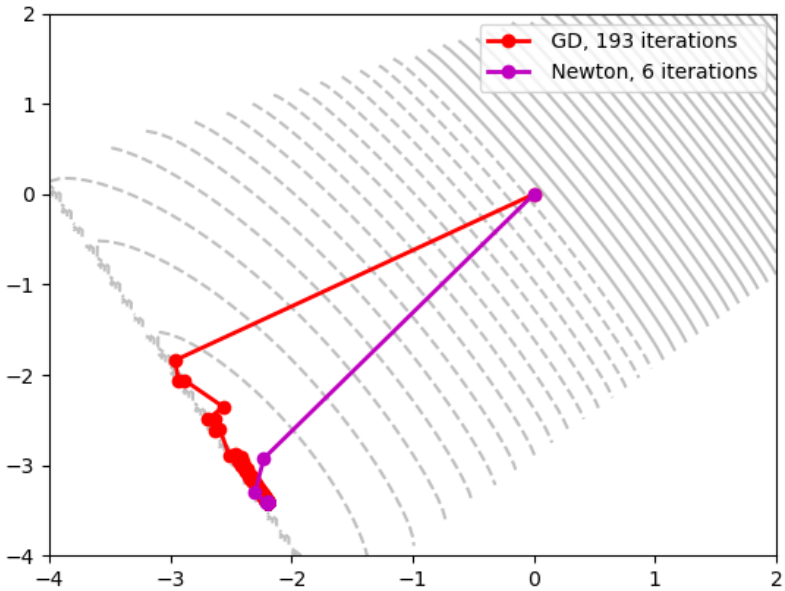

Figure 1: main_quadratic plot GD vs Newton

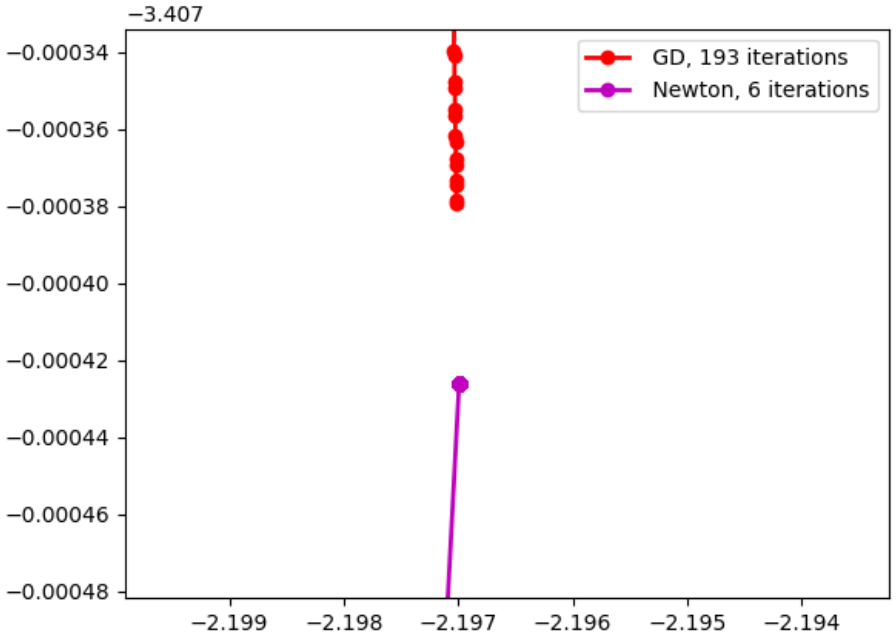

Figure 2: Optimal Point GD vs Newton

Observations with main_quadratic2- Number of iterations for GD and Newton:

1. As t increases, we are less approximating the function and we get solution closer to the original function. i.e. optimal is more closer to the boundary.
2. Number of steps required by Gradient Descent increases linearly with t (Fig 4: t = 1/8 to 60)
3. Number of steps required for Newton increases very slowly with t as Newton is optimal for Quadratic functions.

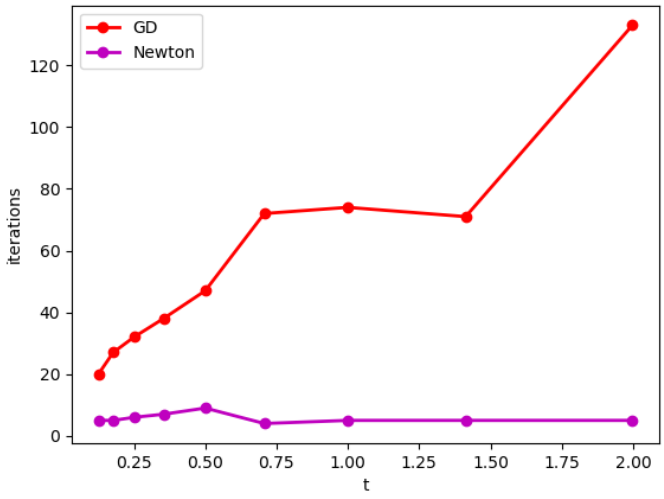

Figure 3: Number of iterations t = 1/8 to 2

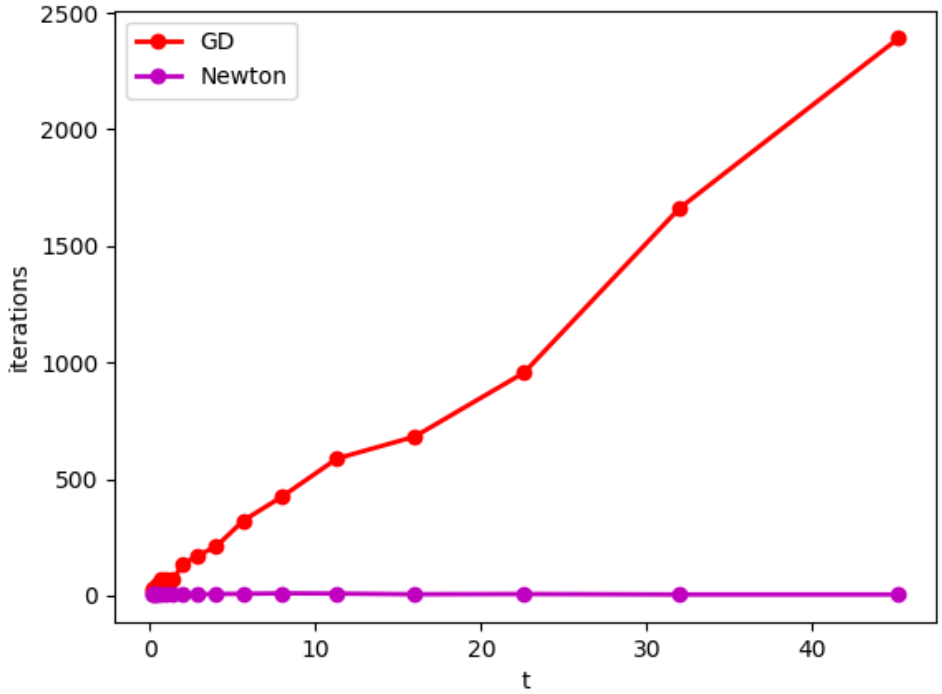

Figure 4: Number of iterations t = 1/8 to 60

2 Log barrier Method

2.1 Implementation

2.2 Experiment

1. **Dependence expected:**
   (a) Total newton iterations = inner iteration + outer iterations
   (b) For small μ, number of outer iterations will be large as t in increasing slowly, because solution will converge slowely.
   (c) As μ increases, t is increases faster and we move close to the solution with each outer iteration and hence, number of outer iteration should decreases. i.e. overall total iterations (outer + inner iteration) should decrease.
   (d) But, after certain point, increase in μ should not decrease total iterations by significant amount as with high μ, t increases fast, and hence with each outer iteration, we are moving close to the optimal iteration.

2. **Does plot meet your expectation:**
   Yes.
   As stated in 1(a), total newton iterations should decrease with increase in μ.
   After $\mu = 10$, μ does not have impact on total number of iterations

3. **Solution to this LP:** 30610.00006064
   Values of X: [[48.00000121] [30.99999886] [38.99999764] [43.00000243] [15.00000006]]

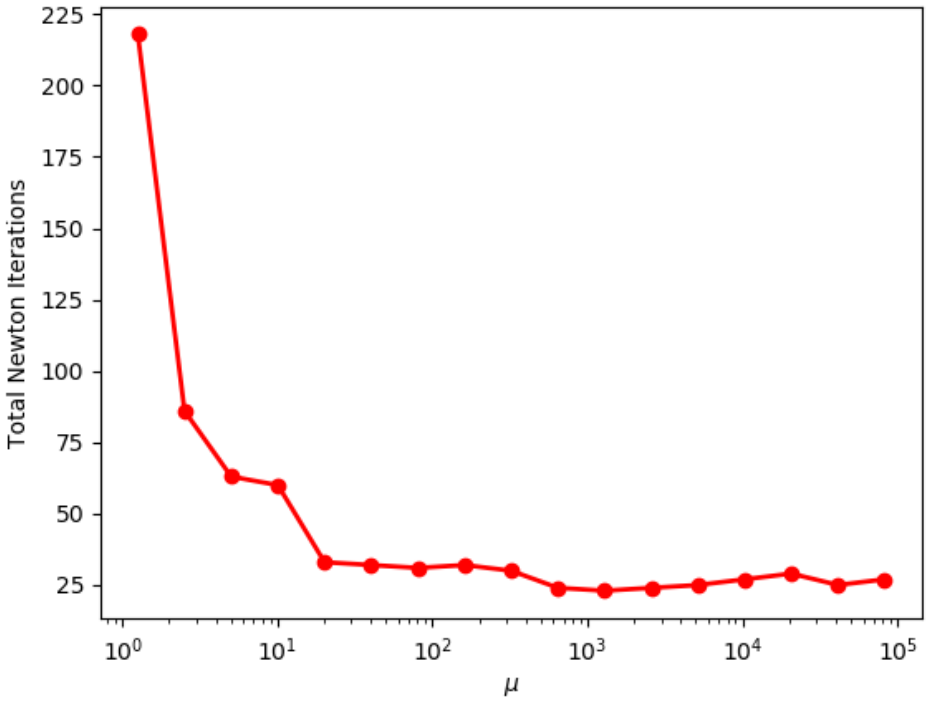

Figure 5: Total Newton Iterations vs μ