MATH 6397

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Problem Set 1

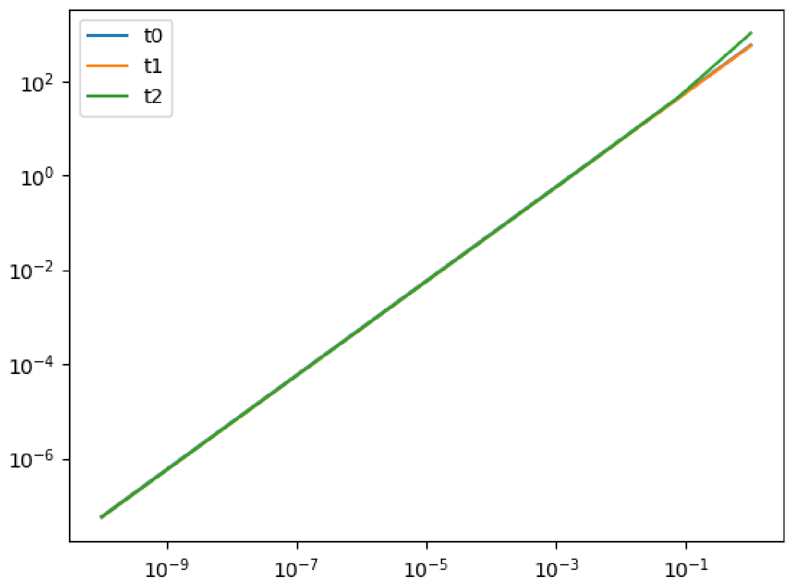
1.)

a.) We are given $f(x) = \frac{1}{2}x^T Qx + b^T x + c$

Therefore,

$$\nabla f(x) = \tfrac{1}{2}(Q^T + Q)x + b,$$
$$\nabla^2 f(x) = \tfrac{1}{2}(Q^T + Q)$$

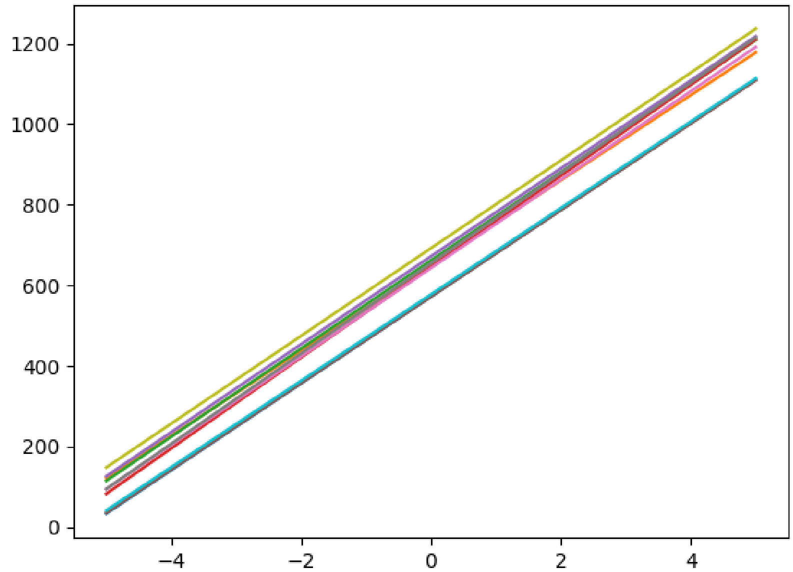
Derivative Check:



Comments: The code runs and gives us our desired result

b.)

Convexity Check:



Comments: Our function f is a convex function

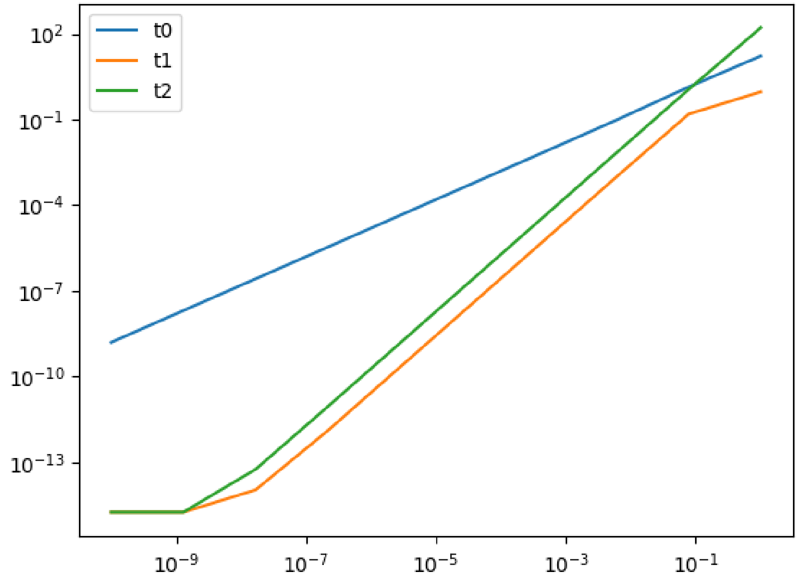
2.)

We are given $minimize_{x \in \mathbb{R}^n} \frac{1}{2} \| sin(Ax) - b \|_2^2 + \frac{\beta}{2} \| Lx \|_2^2$

Then

$$\nabla f(x) = A^T diag(cos(Ax))(sin(Ax) - b) + \beta L^T Lx,$$
$$\nabla^2 f(x) = A^T A\{1 - 2sin(Ax)(sin(Ax))^T + b^T sin(Ax)\} + \beta L^T L$$

Derivative Check:



Comments: Our code runs and produces our desired result

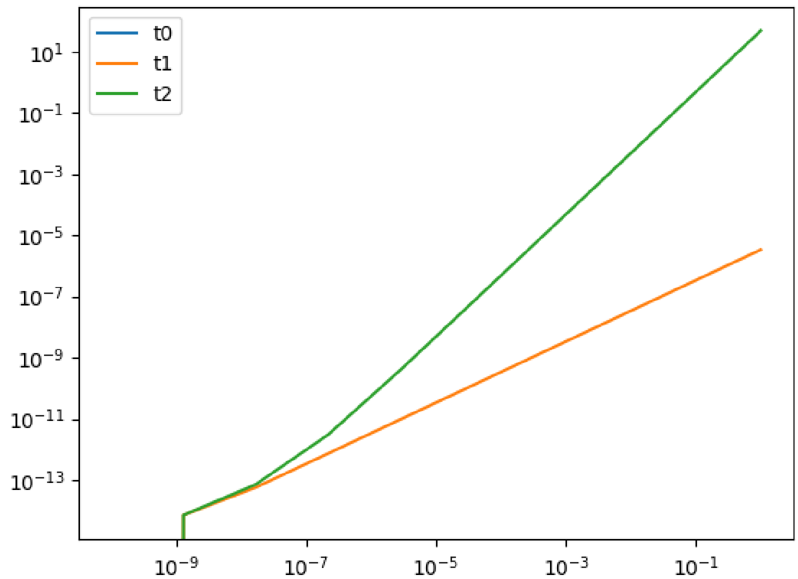
3.)

a.) We are given the optimization problem $minimize_{X \in \mathbb{R}^{m,n}} \frac{1}{2} \|\sigma(YX) - C\|_F^2$

Thus,

$$\nabla f(x) = \sum_{k=1}^{m} y_{ki}(1 - \sigma^2(\sum_{l=1}^{n} y_{kl}x_{lj}))(\sigma(\sum_{l=1}^{n} y_{kl}x_{lj}) - c_{kj}) = Y^T((1 - tanh^2(YX))(tanh(YX) - C)$$

Derivative Check:



Comments: This code runs

b.)

Comments: Still working on this code