

NAME:

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## MATH-UA 252/MA-UY 3204 - Fall 2022 - Quiz #2

**Problem 1.** Let  $f: \mathbb{R}^n \rightarrow \mathbb{R}$  be a scalar-valued function. Let  $x_0, x_1, x_2, \dots$  be the sequence of Newton iterates generated by applying Newton's method to minimize  $f$ . Write down this Newton iteration.

$$x_{n+1} = x_n - \nabla^2 f(x_n)^{-1} \nabla f(x_n)$$

**Problem 2.** Write down the nonlinear least squares minimization problem. What variable are we minimizing over? What about the cost function makes this problem *nonlinear*?

$$\underset{c \in \mathbb{R}^n}{\text{minimize}} \quad \|y - f(c)\|_2^2$$

• minimizing over  $c \in \mathbb{R}^n$

•  $f(c)$  is nonlinear in  $c \Rightarrow$  nonlinear LS problem

**Problem 3.** How do you make your nonlinear least squares problem a *linear* least squares problem?

Just make  $f$  linear in  $c$ : i.e. choose  $f(c) = Ac$

$$\left( \text{now you have: } \underset{c \in \mathbb{R}^n}{\text{minimize}} \|y - Ac\|_2^2 \right) \text{ some matrix}$$

**Problem 4.** Write down the Gauss-Newton iteration for your nonlinear least squares problem.

$$c_{n+1} = c_n + \underbrace{DS(c_n)^T}_{= (DS(c_n)^T DS(c_n))^{-1} DS(c_n)^T} (y - f(c_n))$$