

Problem set 0

$$\begin{aligned}
 1. (a) \quad \nabla f(x) &= \nabla \frac{1}{2} x^T A x + \nabla b^T x \\
 &= \frac{1}{2} x^T (A + A^T) + b^T \\
 &= x^T A + b^T \\
 &= Ax + b^T
 \end{aligned}$$

$$\begin{aligned}
 (b) \quad \nabla f(x) &= \nabla g(h(x)) \\
 &= \frac{\partial g(z)}{\partial z} \cdot \frac{\partial z}{\partial x} \quad \text{when } z = h(x).
 \end{aligned}$$

$$\begin{aligned}
 (c) \quad \nabla^2 f(x) &= \boxed{\begin{array}{c} \text{Diagram: A rectangle with a vector labeled } x^T A + b^T \text{ pointing right from the left side.} \end{array}} \\
 &= \nabla^2 \frac{1}{2} x^T A x + \nabla^2 b^T x \\
 &= \cancel{2A} = \frac{1}{2} \cdot 2A + 0 = A.
 \end{aligned}$$

$$\begin{aligned}
 (d) \quad \nabla f(x) &= \cancel{2A} \frac{\partial g}{\partial z} \cdot \frac{\partial z}{\partial x} \quad \text{when } z = a^T x \\
 &= g' \cdot a^T
 \end{aligned}$$

$$\nabla^2 f(x) =$$