Reg: 2019831060

Assignment using Chain Rule:

Given,

$$f(z) = \ln(1+z)$$

By chainrole,

$$\frac{d}{dx}(f(z)) = \frac{d}{dz}(f(x))\frac{dz}{dx}$$

$$= \left(\frac{d}{dz}\left(\ln(1+z)\right) \cdot \frac{d}{dx}(x^T x)\right.$$

$$= \frac{1}{1+z} \cdot \frac{dz}{dz} \cdot 2x$$

$$\left[\because \frac{d}{dx}(x^T \cdot x) = 2x\right]$$

$$= \frac{2x}{1+x^T x}$$

(Solved)

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Chain Rule Assignment:

Given,

$$f(z) = e^{-z/2}$$

Where,

$$z = g(y), \quad g(y) = y^T S^{-1} y.$$

$$y = h(x);$$

$$h(x) = x - \mu$$

According to chainrole,

$$\frac{d}{dx}(f(z)) = \frac{d(f(z))}{dz} \times \frac{dz}{dy} \times \frac{dy}{dx}$$

$$= \frac{d}{dz}(e^{-z/2}) \cdot \frac{d}{dy}(y^T S^{-1} y) \cdot \frac{d}{dx}(x - \mu)$$

$$= \left(-\frac{1}{2} e^{-z/2}\right) \cdot \left(S^{-1} \frac{d}{dy}(y^T y)\right) \cdot 1$$

$$= \left(-\frac{e^{-z/2}}{2}\right) \cdot 2y S^{-1}$$

$$\left[\because \frac{d}{dx}(x^T \cdot x) = 2x\right]$$

$$= -e^{-z/2}(x - \mu) S^{-1}$$

(Solved)