

[Md Mehnajul Islam  
2019831079]

### Chan Rule Assignment (1)

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

By chainrule :

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

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

$$= \frac{1}{1+z} \times \frac{dz}{dz} \times 2x \quad \left[ \begin{array}{l} \text{From matrices} \\ \text{derivate rule} \end{array} \right]$$

$$= \frac{2x}{1+x^T x} \quad \left[ \frac{d}{dx} (x^T x) = 2x \right]$$

(Ans)

## Chain Rule Assignment (2)

Given,  $f(z) = e^{-\frac{z}{2}}$

where,  $z = g(y)$ ,  $g(y) = y^T S^{-1} y$ ,

$y = h(x)$ ,  $h(x) = x - \mu$ .

According to chainrule:

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

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

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

$$= \left(-\frac{e^{-z/2}}{2}\right) \times (2y \cdot S^{-1}) \quad \left[ \begin{array}{l} \text{By applying} \\ \text{matrix} \\ \text{derivative rule} \end{array} \right]$$

$$= -e^{-z/2} (x - \mu) S^{-1} \quad \left[ \frac{d}{dx}(x^T x) = 2x \right]$$

(Ans)