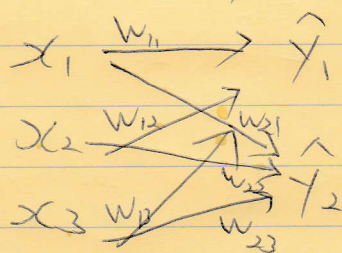


(b)  $x = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ , Calculate  $x^T x$  and  $xx^T$ . [2019-10-10]  
 See the shapes. Which one is a scalar and which one is a matrix?

$$x^T x = \underset{1 \times 3}{[1, 2, 3]} \underset{3 \times 1}{\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}} = 1+4+9 = \boxed{14}$$

$$xx^T = \underset{3 \times 1}{\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}} \underset{1 \times 3}{[1, 2, 3]} = \underset{3 \times 3}{\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix}}$$

In a neural network, several linear regression models are mixed internally as below,



$$\Rightarrow \begin{bmatrix} \hat{y}_1 \\ \hat{y}_2 \end{bmatrix} = \begin{bmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$\hat{y} = Wx$$

Commutative Law and Distributive Law

$$AB \neq BA$$

$$A(B+C) = AB+AC$$

$$(A+B)C = AC+BC$$

$$(A+B)^T = A^T + B^T$$

$$(AB)^T = B^T A^T$$

$$(ABC)^T = C^T B^T A^T$$

Product Connection

$$ABC = (AB)C = A(BC)$$

$$ABCD = ((AB)C)D = (AB)(CD) = A(BCD) = A(BC)D$$

Identity Matrix product

$$AI = IA = A$$