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Most of this I already learned in  
ESC103 and MAT185

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A **vector** is an  $n \times 1$  matrix.

e.g.,  $y = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} \in \mathbb{R}^4$

$$y_1 = 1, y_2 = 2, y_3 = 3, y_4 = 4$$

Notation:  $A, B, C$  for matrices  
 $a, b, c$  for vectors, scalars

$$\begin{bmatrix} 1 & 3 \\ 4 & 0 \\ 2 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 5 \end{bmatrix} = \begin{bmatrix} 16 \\ 4 \\ 7 \end{bmatrix}$$

$$1 \times 1 + 3 \times 5 = 16$$

$$4 \times 1 + 0 \times 5 = 4$$

$$2 \times 1 + 1 \times 5 = 7$$

e.g. House sizes,  $h_0(x) = -40 + 0.25x$

$$\begin{array}{c} 2104 \\ 1416 \\ 1534 \\ 852 \end{array} \left\{ \begin{array}{c} \begin{bmatrix} 1 & 2104 \\ 1 & 1416 \\ 1 & 1534 \\ 1 & 852 \end{bmatrix} \begin{bmatrix} -40 \\ 0.25 \end{bmatrix} = \begin{bmatrix} -40 \times 1 + 0.25 \times 2104 \\ -40 \times 1 + 0.25 \times 1416 \\ \vdots \\ h_0(1416) \end{bmatrix} \\ \text{Data Matrix} \quad \text{Parameters} \quad \text{Prediction} \end{array}$$

$h_0(2104)$

$h_0(1416)$

$$\text{Prediction} = [\text{Data Matrix}] \times [\text{Parameters}]$$

e.g.  $\begin{bmatrix} 1 & 3 & 2 \\ 4 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 5 \end{bmatrix} = \begin{bmatrix} 11 \\ 9 \end{bmatrix}$

$\hookrightarrow \begin{bmatrix} 1 & 3 & 2 \\ 4 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 5 \end{bmatrix} = \begin{bmatrix} 11 \\ 9 \end{bmatrix}$

$\hookrightarrow \begin{bmatrix} 1 & 3 & 2 \\ 4 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 1 \\ 2 \end{bmatrix} = \begin{bmatrix} 10 \\ 14 \end{bmatrix}$

e.g. House prices w/ multiple hypotheses

$$1, h_0(x) = -40 + 0.25x$$

$$2, h_0(x) = 200 + 0.1x$$

$$3, h_0(x) = -150 + 0.4x$$

$$\begin{bmatrix} 1 & 2104 \\ 1 & 1416 \\ 1 & 1534 \\ 1 & 852 \end{bmatrix} \begin{matrix} 1 & 2 & 3 \\ \begin{bmatrix} -40 & 200 & -150 \\ 0.25 & 0.1 & 0.4 \end{bmatrix} \end{matrix} = \begin{bmatrix} 486 & 410 & 692 \\ 314 & 342 & 416 \\ 344 & 353 & 464 \\ 173 & 285 & 191 \end{bmatrix}$$

1      2      3  
Sets of predictions