

Multiple Features

LR with Multiple Variables

- Linear regression with multiple variables is also known as "multivariate linear regression".
- We now introduce notation for equations where we can have any number of input variables.

Multiple features (variables).

Size (feet ²)	Price (\$1000)
x	y
2104	460
1416	232
1534	315
852	178
...	...

$$h_{\theta}(x) = \theta_0 + \theta_1 x$$

Windows'u Etkinleştir
Windows'u etkinleştirmek için Ayarlar'a gidin.

Multiple features (variables).

Size (feet ²)	Number of bedrooms	Number of floors	Age of home (years)	Price (\$1000)
2104	5	1	45	460
1416	3	2	40	232
1534	3	2	30	315
852	2	1	36	178
...

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Multiple features (variables).

Size (feet ²) x_1	Number of bedrooms x_2	Number of floors x_3	Age of home (years) x_4	Price (\$1000) y
2104	5	1	45	460
1416	3	2	40	232
1534	3	2	30	315
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...

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Notation:

→ n = number of features $n = 4$

$x^{(i)}$ = input (features) of i^{th} training example.

$x_j^{(i)}$ = value of feature j in i^{th} training example.

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$$x^{(2)} = \begin{bmatrix} 1416 \\ 3 \\ 2 \\ 40 \end{bmatrix}$$

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$n = 4$

$m = 47$

$$x^{(2)} = \begin{bmatrix} 1416 \\ 3 \\ 2 \\ 40 \end{bmatrix}$$

$$x_3^{(2)} = 2$$

Windows'u Etkinleştir
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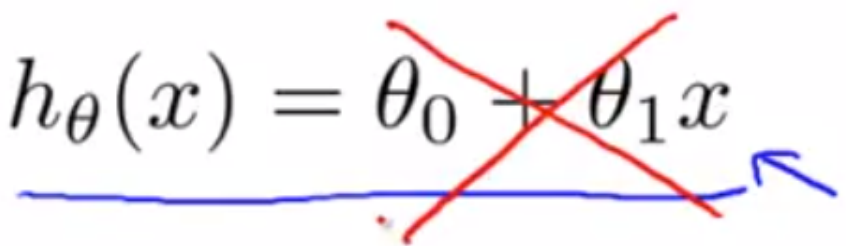
Hypothesis:

Previously: $h_{\theta}(x) = \theta_0 + \theta_1 x$

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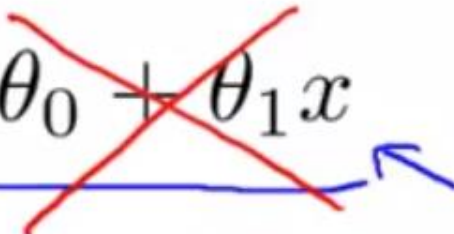
Hypothesis:

Previously: $h_{\theta}(x) = \theta_0 + \theta_1 x$

A handwritten red 'X' is drawn over the entire equation $h_{\theta}(x) = \theta_0 + \theta_1 x$. Below the equation, a blue horizontal line is drawn, ending with a blue arrow pointing to the right.

Windows'u Etkinleştir
Windows'u etkinleştirmek için Ayarlar'a gidin.

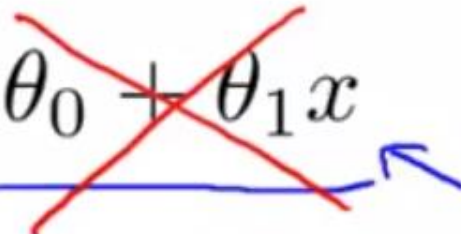
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$$h_{\Theta}(x) = \Theta_0 + \Theta_1 x_1 + \Theta_2 x_2 + \Theta_3 x_3 + \Theta_4 x_4$$

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Hypothesis:

Previously: $\underline{h_{\theta}(x) = \theta_0 + \theta_1 x}$ 

$$h_{\theta}(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_3 + \theta_4 x_4$$

$$\text{e.g. } h_{\theta}(x) = 80 + 0.1x_1 + 0.01x_2 + 3x_3 - 2x_4$$

$$\rightarrow h_{\theta}(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \cdots + \theta_n x_n$$

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$$\rightarrow h_{\theta}(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \cdots + \theta_n x_n$$

For convenience of notation, define $x_0 = 1$.

$$\rightarrow h_{\theta}(x) = \theta_0 + \theta_1 \underline{x_1} + \theta_2 \underline{x_2} + \dots + \theta_n \underline{x_n}$$

For convenience of notation, define $x_0 = 1$. $(x_0^{(i)} = 1)$

$$x = \begin{bmatrix} x_0 \\ x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} \in \mathbb{R}^{n+1}$$

$$\rightarrow h_{\theta}(x) = \underline{\theta_0} + \underline{\theta_1} \underline{x_1} + \underline{\theta_2} \underline{x_2} + \dots + \underline{\theta_n} \underline{x_n}$$

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$$\rightarrow h_{\theta}(x) = \underline{\theta_0} + \underline{\theta_1} \underline{x_1} + \underline{\theta_2} \underline{x_2} + \dots + \underline{\theta_n} \underline{x_n}$$

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$$h_{\theta}(x) = \theta_0 x_0 + \theta_1 x_1 + \dots + \theta_n x_n$$

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$$\theta = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \theta_2 \\ \vdots \\ \theta_n \end{bmatrix} \in \mathbb{R}^{n+1} !$$

$$h_{\theta}(x) = \theta_0 x_0 + \theta_1 x_1 + \dots + \theta_n x_n$$

$$= \theta^T x.$$

$$\rightarrow h_{\theta}(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \dots + \theta_n x_n$$

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$$h_{\theta}(x) = \theta_0 x_0 + \theta_1 x_1 + \dots + \theta_n x_n$$

$\downarrow = 1$

$$= \boxed{\theta^T x}$$

$\begin{bmatrix} \theta_0 & \theta_1 & \dots & \theta_n \end{bmatrix}$
 θ^T
 $(n+1) \times 1$
 matrix
 $\theta^T x$

$\begin{bmatrix} x_0 \\ x_1 \\ \vdots \\ x_n \end{bmatrix}$
 x

Multivariate linear regression. \leftarrow

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- This is a vectorization of our hypothesis function for one training example

$$h_{\theta}(x) = [\theta_0 \quad \theta_1 \quad \dots \quad \theta_n] \begin{bmatrix} x_0 \\ x_1 \\ \vdots \\ x_n \end{bmatrix} = \theta^T x$$