

1. Multiple Features

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1 Introduction

Previously, we only considered linear regression with a single feature/variable x , now however we will consider more than 1 feature that can be used to predict something. As an example we can have features such as the size of a house, the number of bedrooms, the age of the house and the number of floors to predict the price of the house

Multiple features (variables).

Size (feet ²)	Number of bedrooms	Number of floors	Age of home (years)	Price (\$1000)
x_1	x_2	x_3	x_4	y
2104	5	1	45	460
1416	3	2	40	232
1534	3	2	30	315
852	2	1	36	178
...

Notation:

- $\rightarrow n$ = number of features $n = 4$
- $\rightarrow x^{(i)}$ = input (features) of i^{th} training example.
- $\rightarrow x_j^{(i)}$ = value of feature j in i^{th} training example.

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

$x_3^{(2)} = 2$

$m = 47$

Figure 1: Notation of multiple variables

2 Hypothesis Function with Multiple Features

Our hypothesis function now changes from a function of 1 variable to a function of multiple

$$h_{\theta}(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \dots + \theta_n x_n \quad (1)$$

for convenience lets define a 0 feature x_0 which will always have the value 1, then our hypothesis function becomes

$$h_{\theta}(x) = \theta_0 x_0 + \theta_1 x_1 + \theta_2 x_2 + \dots + \theta_n x_n \quad (2)$$

Lets define a feature vector X given as

$$X = \begin{bmatrix} x_0 \\ x_1 \\ \cdot \\ \cdot \\ x_n \end{bmatrix} \in \Re^{n+1} \quad (3)$$

And a parameter vector defined as

$$\Theta = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \cdot \\ \cdot \\ \theta_n \end{bmatrix} \in \Re^{n+1} \quad (4)$$

Our hypothesis function can then be written in matrix form as

$$\begin{aligned} h_{\theta}(x) &= \Theta^T \times X \\ &= [\theta_0 \quad \theta_1 \quad \cdot \quad \cdot \quad \cdot \quad \theta_n] \times \begin{bmatrix} x_0 \\ x_1 \\ \cdot \\ \cdot \\ x_n \end{bmatrix} \end{aligned} \quad (5)$$