# 1. Feature Scaling (Part1)

It'll enable GD to run much faster :)

$$\widehat{price} = w_1 x_1 + w_2 x_2 + b$$

$x_1$: size (feet$^2$)
range: $300 - 2{,}000$

$x_2$: # bedrooms
range: $0 - 5$

size → 1000

#bedrooms → 3-4

EX:

200 + 250 + 50 → 500

$x_1 = 2000,\ x_2 = 5,\ price = \$500k$

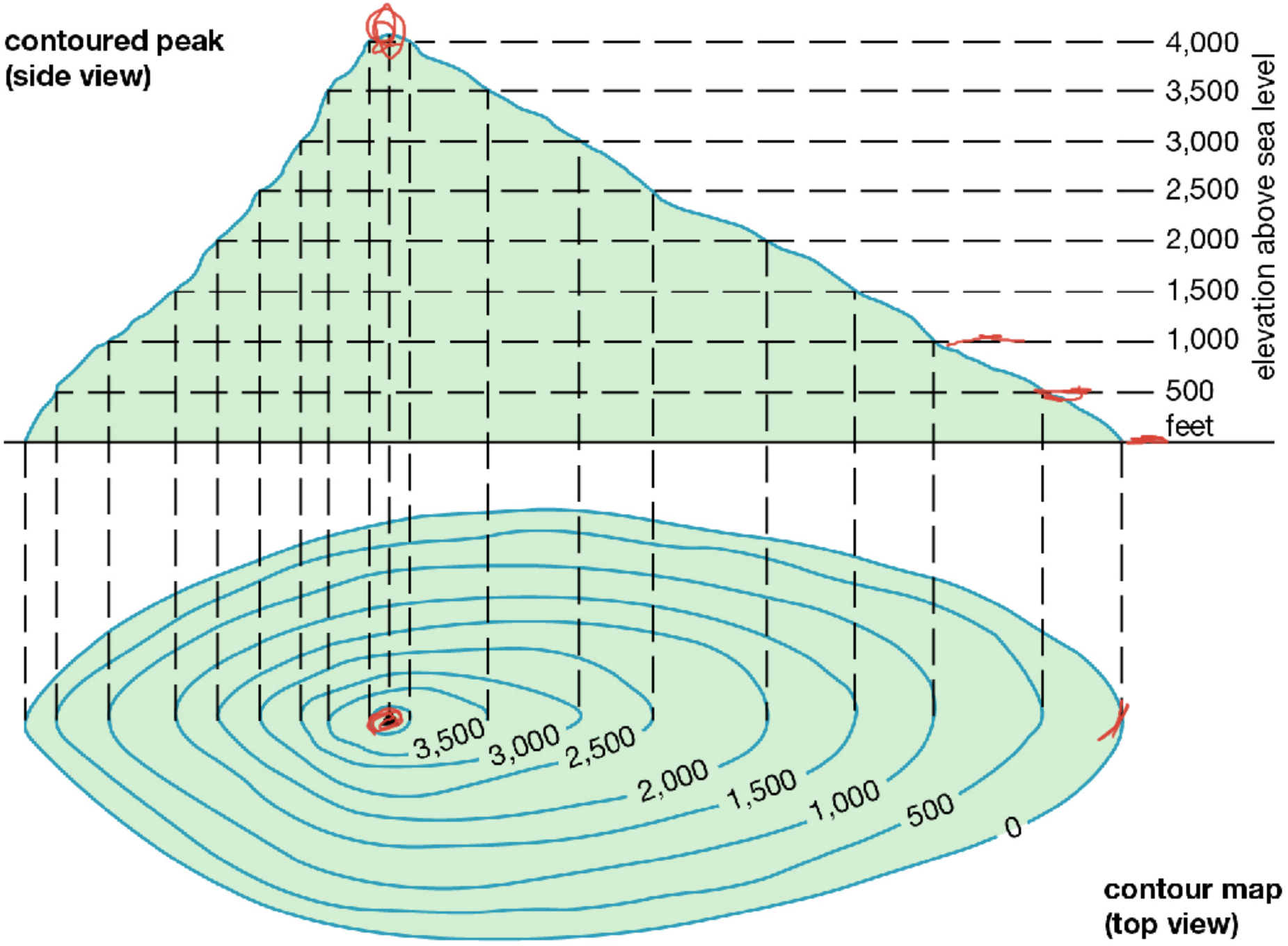
$w_1 = 0.1,\ w_2 = 50,\ b = 50$

small large

$\widehat{price} = 0.1 * 2000k + 50 * 5 + 50$

200K 250K 50K

$\widehat{price} = \$500k$ more reasonable



$x_1 = 2000,\ x_2 = 5,\ price = \$500k$

$\widehat{price} = w_1 x_1 + w_2 x_2 + b$

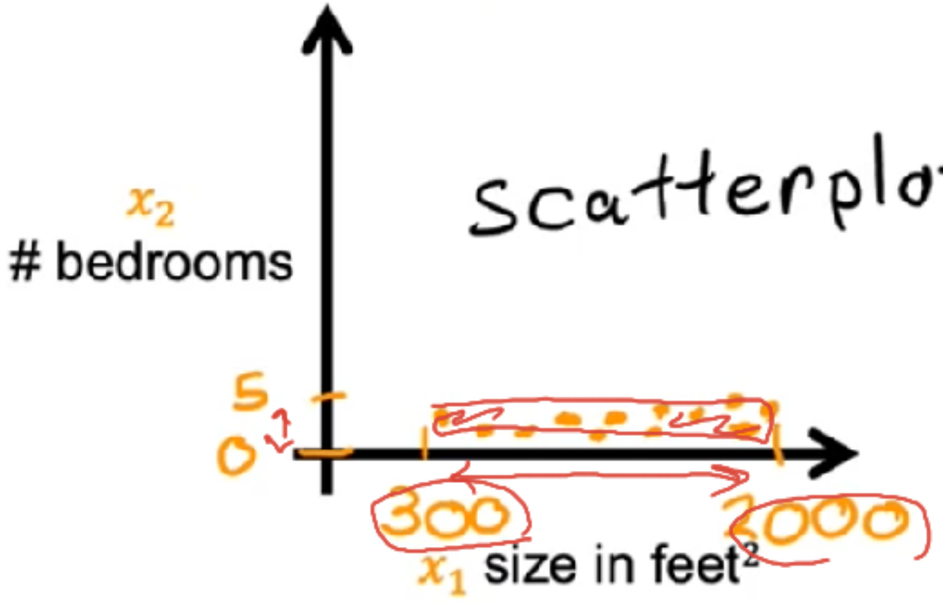
size  # bedrooms

Ex.:

$w_1$: $1 \to 200$, $3 \to 6000$ $\}$ 4000 $\mapsto$

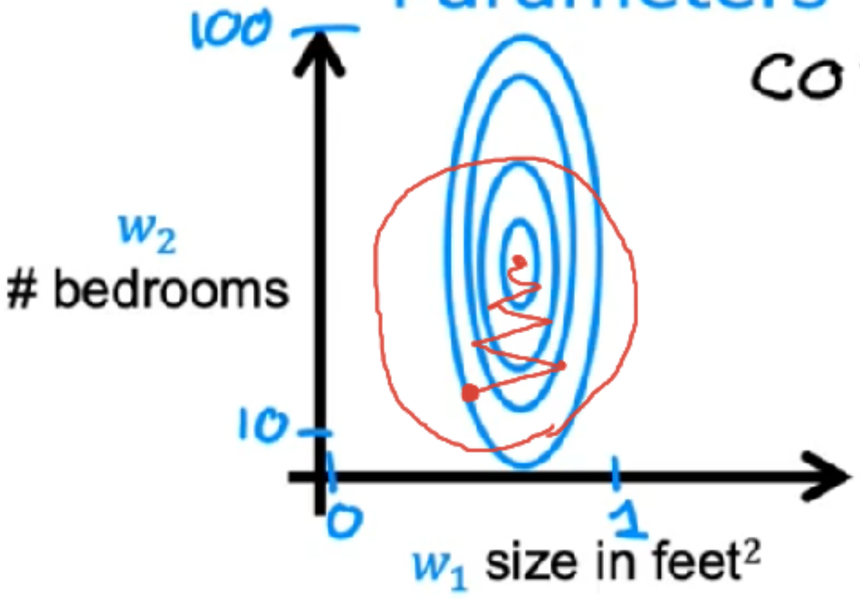
$w_2$: $1 \to 5$, $3 \to 15$ $\}$ 10 $\to$ $\mapsto$

## Features




scatterplot

## Parameters




contour plot

$J(\vec{w}, b)$

# Feature Scaling (Part1)

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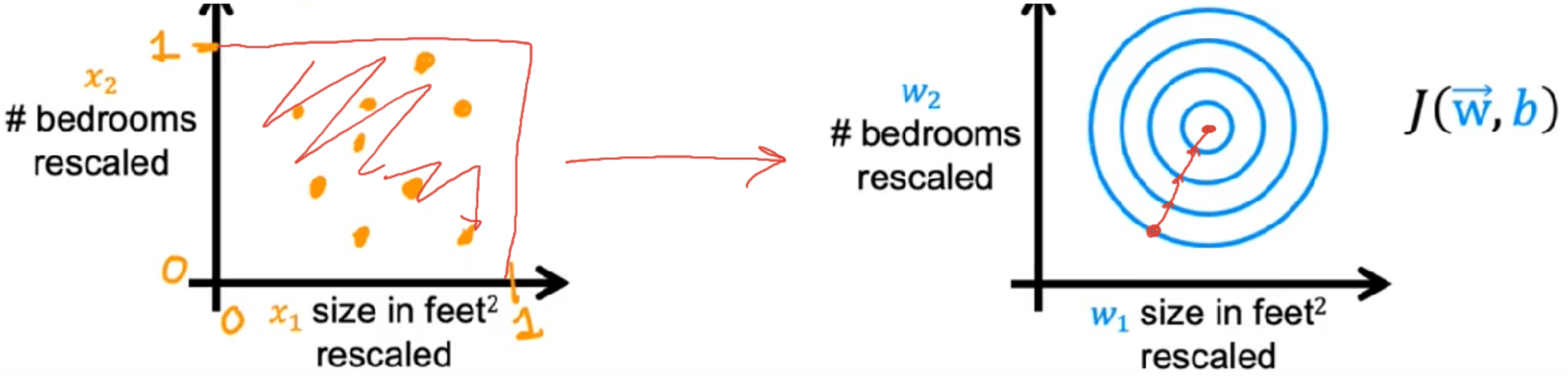
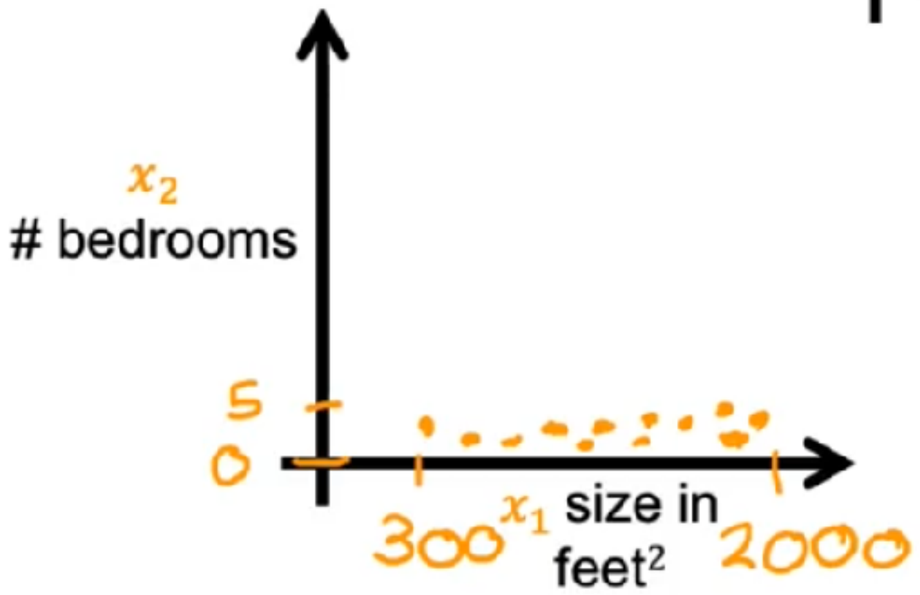
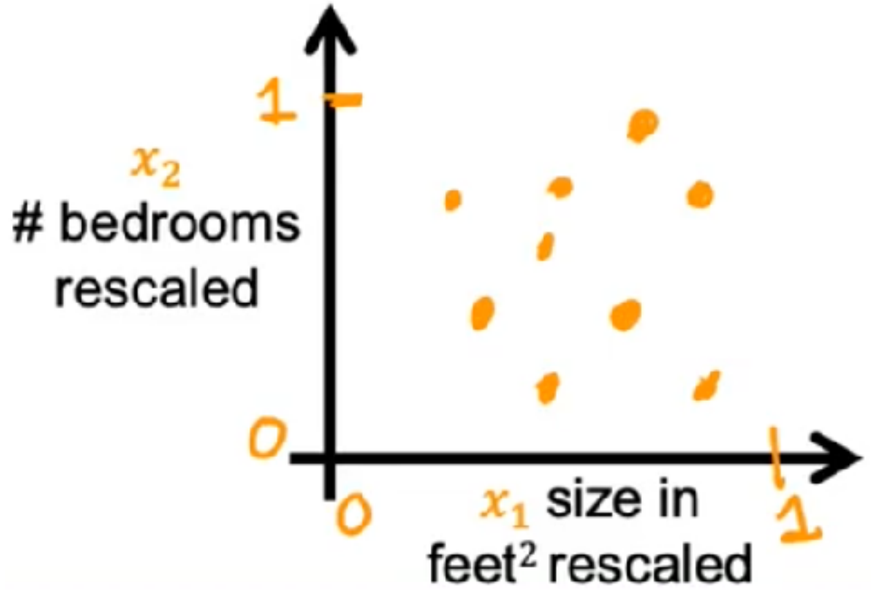


# 2. Feature Scaling  (Part2)

It'll enable GD to run much faster :)

# Feature scaling



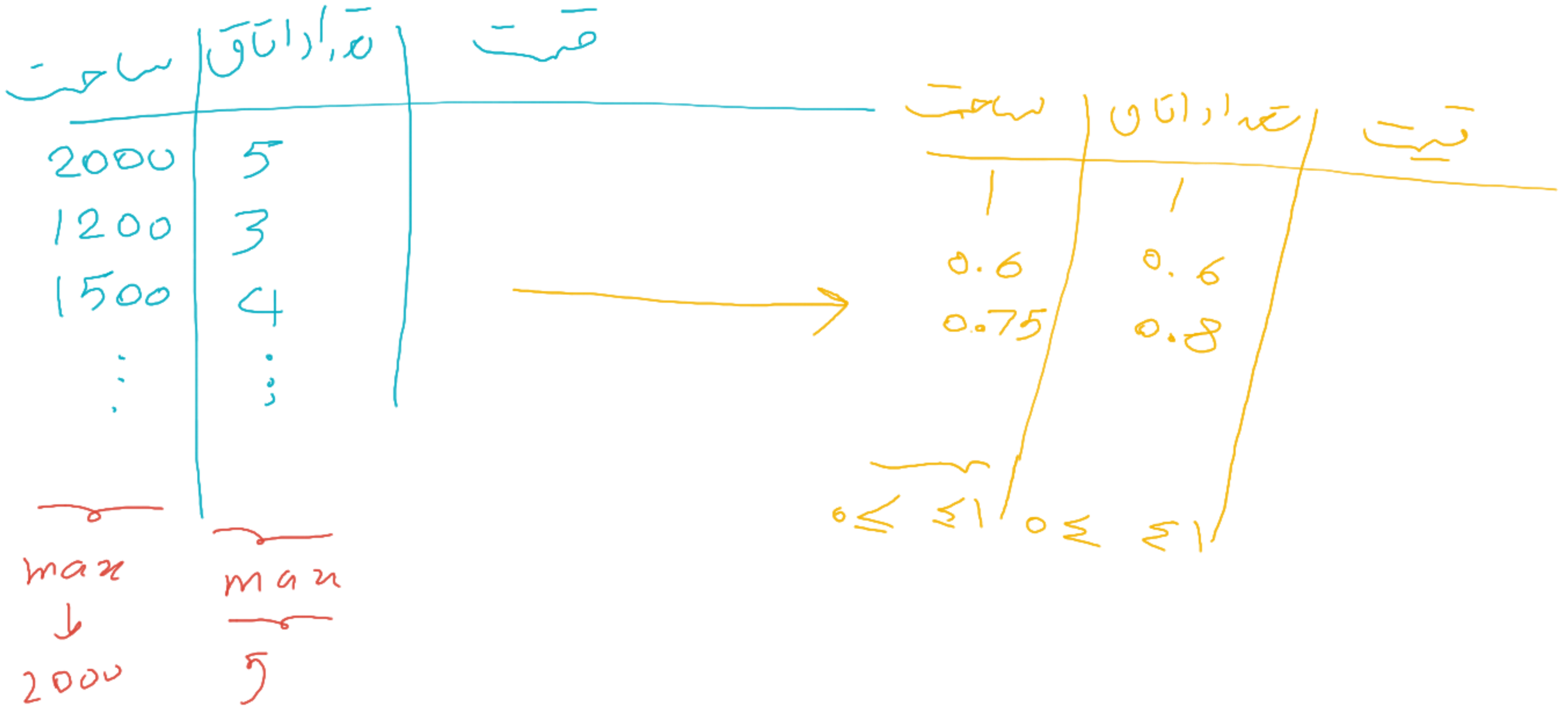




$$300 \le x_1 \le 2000 \qquad 0 \le x_2 \le 5$$

$$x_{1,scaled} = \frac{x_1}{2000} \qquad x_{2,scaled} = \frac{x_2}{5}$$

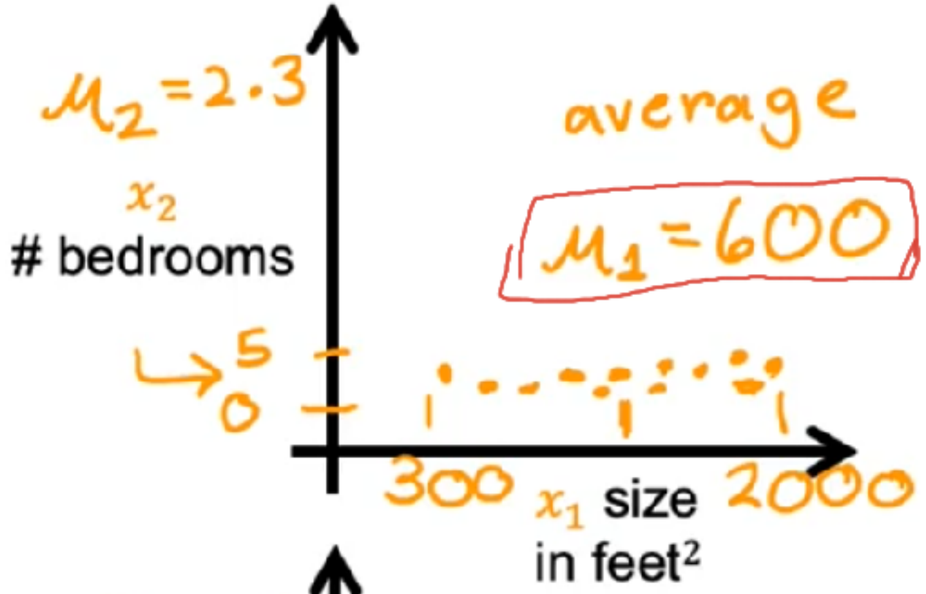
max max

$$0.15 \le x_{1,scaled} \le 1 \qquad 0 \le x_{2,scaled} \le 1$$


ساحت
تعداد اتاق
ثبت
2000
5
1200
3
1500
4
max
max
2000
5
ساحت
تعداد اتاق
ثبت
1
1
0.6
0.6
0.75
0.8
0 ≤ ≤ 1
0 ≤ ≤ 1

# Mean normalization

$x_j = \frac{x_j - \mu_j}{\max(x_j) - \min(x_j)}$




$300 \le x_1 \le 2000$

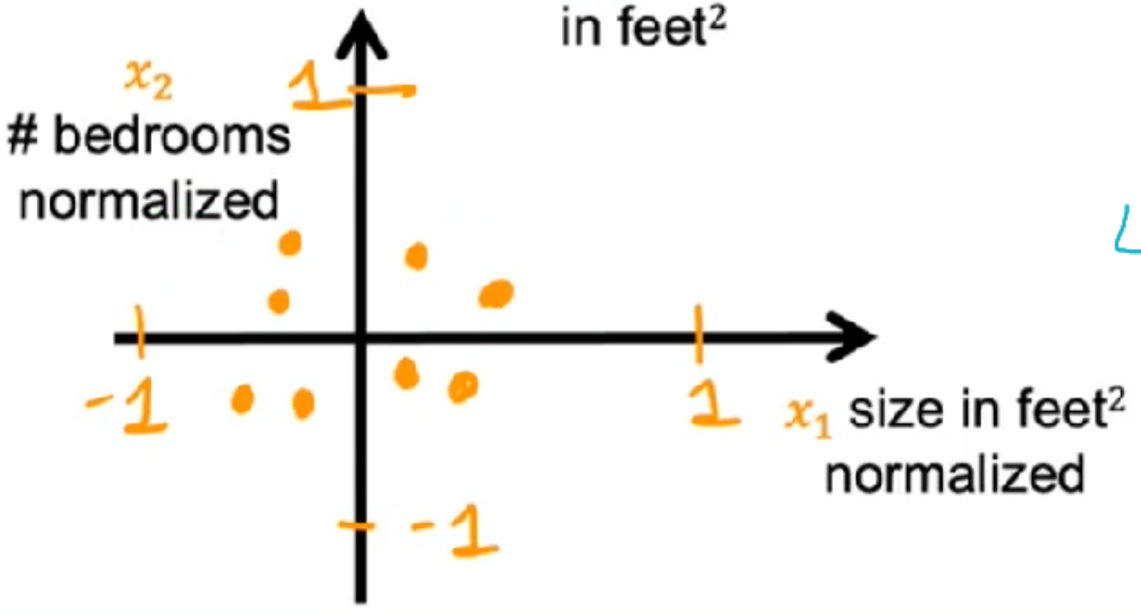
$0 \le x_2 \le 5$

$x_1 = \frac{x_1 - \mu_1}{2000 - 300}$ max-min

$x_2 = \frac{x_2 - \mu_2}{5 - 0}$ max-min

$-0.18 \le x_1 \le 0.82$

$-0.46 \le x_2 \le 0.54$



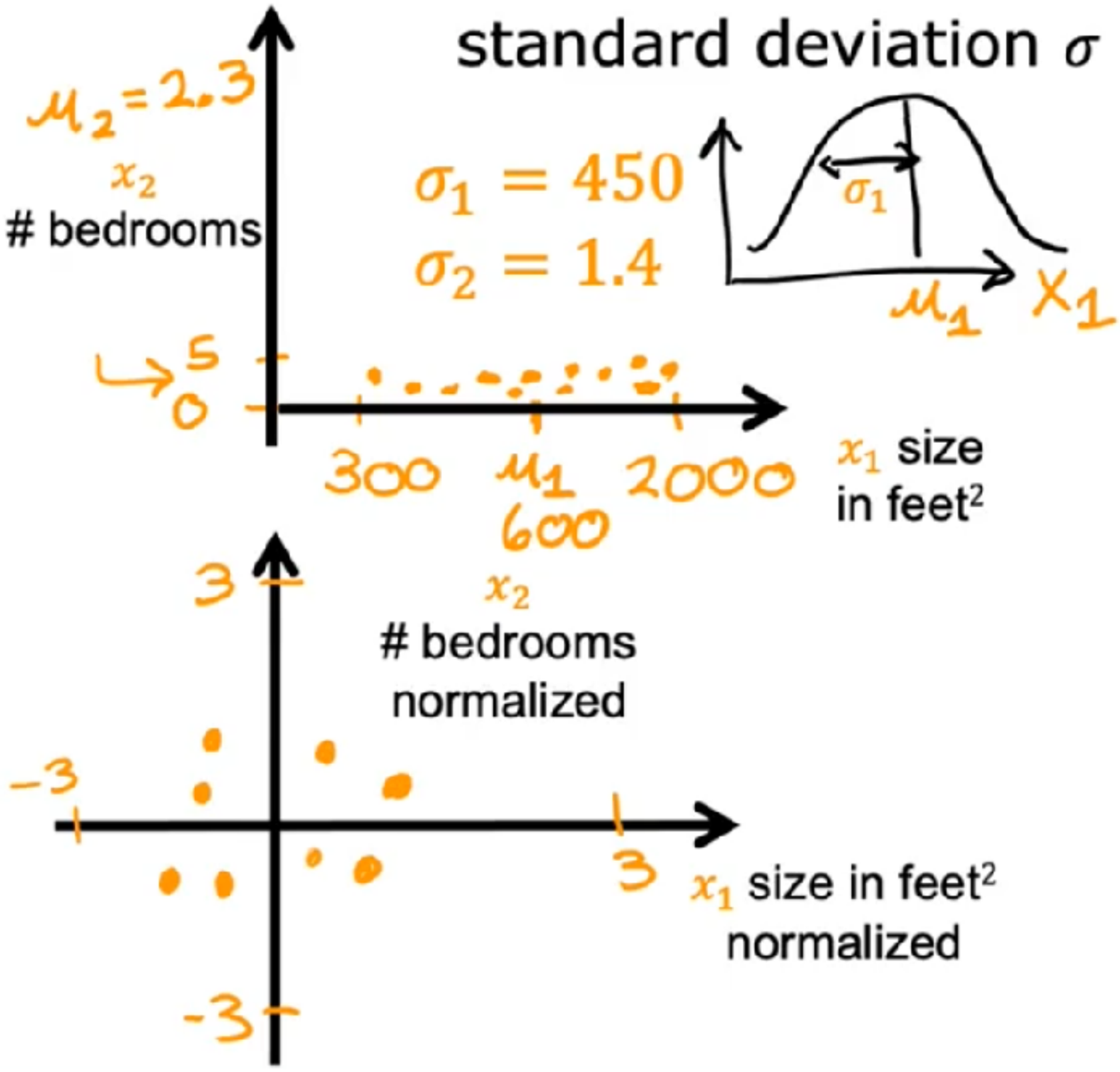

$-1 < x_j < 1$


-600
μ=600
0
300
2000
-300
0
1400


÷ 1700
-1
0
1

# Z-score normalization

$$x_j = \frac{x_j - \mu_j}{\sigma_j}$$




$$300 \le x_1 \le 2000 \qquad 0 \le x_2 \le 5$$

$$x_1 = \frac{x_1 - \mu_1}{\sigma_1} \qquad x_2 = \frac{x_2 - \mu_2}{\sigma_2}$$

$$-0.67 \le x_1 \le 3.1 \qquad -1.6 \le x_2 \le 1.9$$

## standard deviation (نماد σ)

ی های پراکندگی است که نشان می‌دهد به‌طور میانگین داده‌ها چه مقدار از مقدار متوسط فاصله دارند

ه‌های با اختلاف بیشتر از دو انحراف معیار از مقدار میانگین به عنوان داده‌های پرت در نظر گرفته و از تحلیل، خارج می‌شوند

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}, \mu = \frac{1}{N}\sum_{i=1}^{N} x_i$$

۱۲، ۱۶، ۱۸، ۲۰، ۱۵، ۱۸، ۱۴، ۱۷، ۱۳، ۱۷

mean = (۱۲+۱۶+۱۸+۲۰+۱۵+۱۸+۱۴+۱۷+۱۳+۱۷) /۱۰ = ۱۶

(۱۲−۱۶)۲=۱۶ (۱۶−۱۶)۲=۰

(۱۸−۱۶)۲=۴ (۲۰−۱۶)۲=۱۶

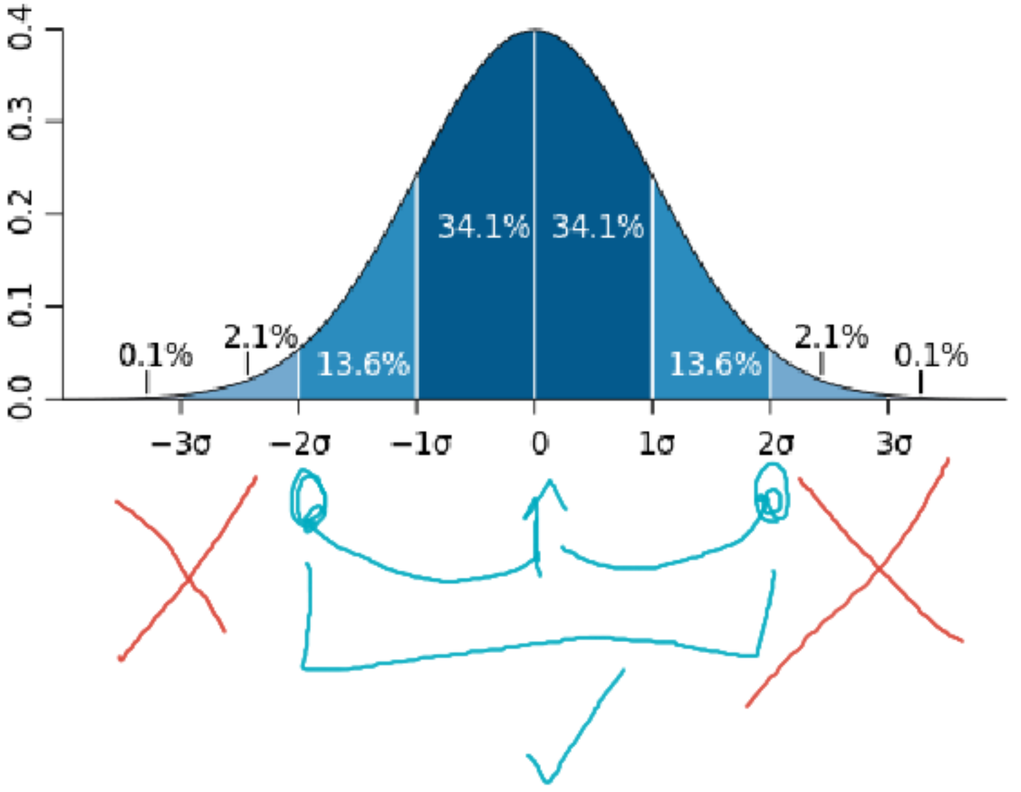
(۱۵−۱۶)۲=۱ (۱۸−۱۶)۲=۴

(۱۴−۱۶)۲=۴ (۱۷−۱۶)۲=۱

(۱۳−۱۶)۲=۹ (۱۷−۱۶)۲=۱

var = (۱۶+۰+۴+۱۶+۱+۴+۴+۱+۹+۱)/۱۰ = 5.6

sd = √5.6 = 2.36



$0 \leq x_1 \leq 3$ okay, no rescaling

$-2 \leq x_2 \leq 0.5$ okay, no rescaling

$-100 \leq x_3 \leq 100$ too large → rescale

$-0.001 \leq x_4 \leq 0.001$ too small → rescale

$98.6 \leq x_5 \leq 105$ too large → rescale