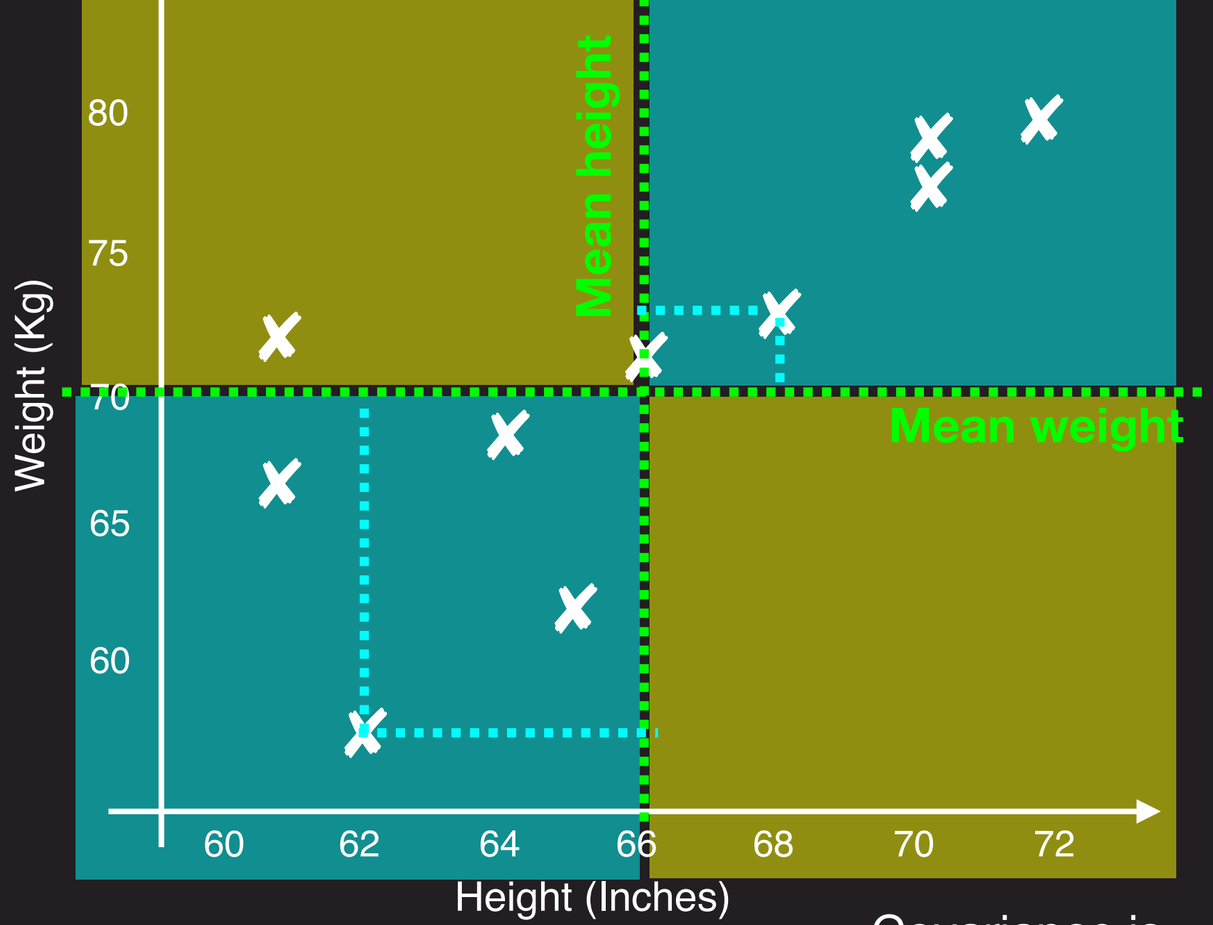
| Height (inches) | Weight (kg) | |
|---|---|---|
| 68 | 72 | |
| 62 | 58 | |
| 64 | 67 | |
| 61 | 72 | |
| 70 | 79 | |
| 66 | 61 | |
| 61 | 68 | |
| 65 | 64 | |
| 71 | 80 | |
| 72 | 79 | |
| $\bar{h} = 66$ | $\bar{w} = 70$ | |




**Positive correlation**
- Top right
- Bottom left

**Negative correlation**
- Top left
- Bottom right

$$\text{cov}(h, w) = \frac{1}{n} \sum_i (h_i - \bar{h})(w_i - \bar{w})$$

$$(68 - 66)(72 - 70) = 2 * 2 = 4$$
$$(62 - 66)(58 - 70) = (-4) * (-12) = 48$$
$$(64 - 66)(67 - 70) = (-2) * (-3) = 6$$
$$(61 - 66)(72 - 70) = (-5)(2) = -10$$
$$\vdots$$
$$(72 - 66)(80 - 70) = (6)(10) = 60$$

Covariance is the average of all these numbers

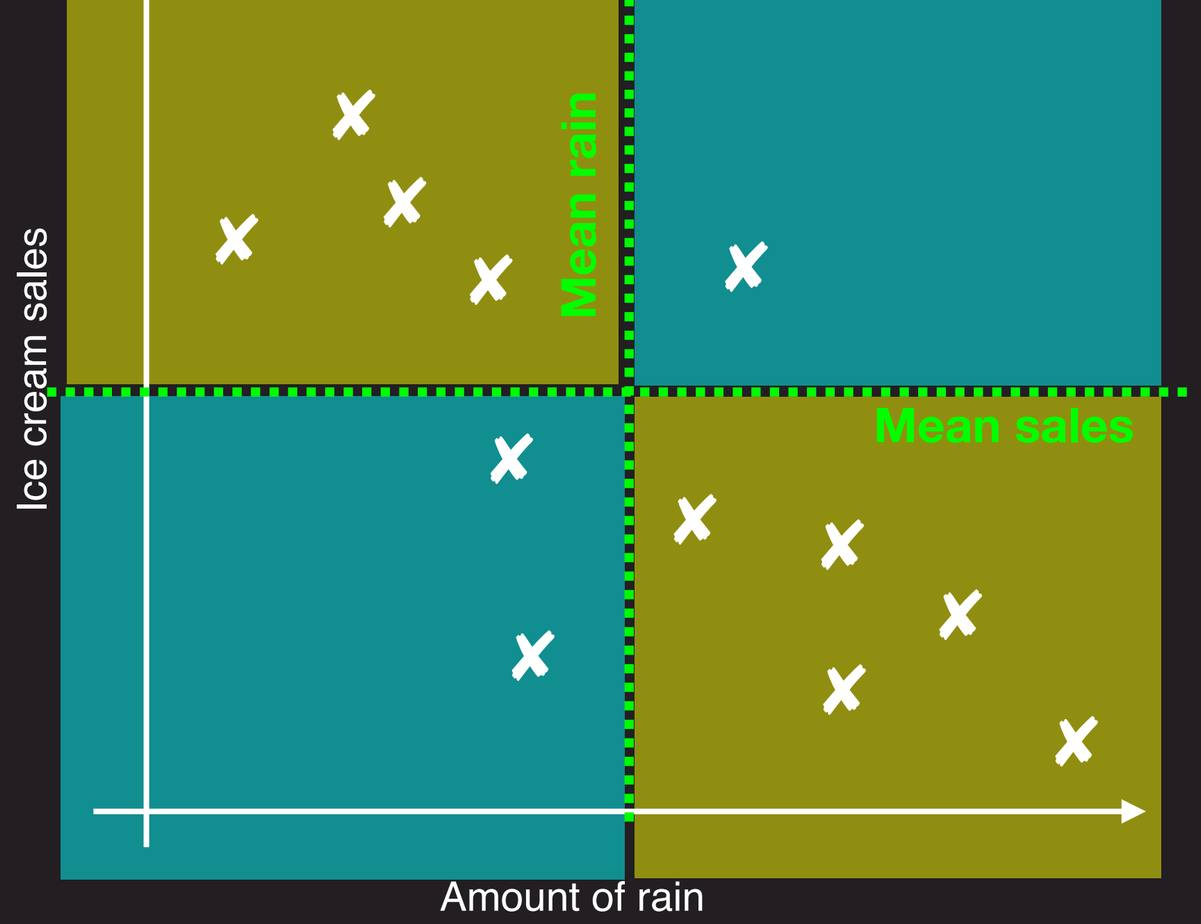
$$\frac{1}{10}(4 + 48 + 6 - 10 + \cdots + 60)$$

Which has more influence? Positive or negative

Positive has more influence

We say that these two features are positively correlated

## Ice cream Vs Rain




**Positive correlation**
- Top right
- Bottom left

**Negative correlation**
- Top left
- Bottom right

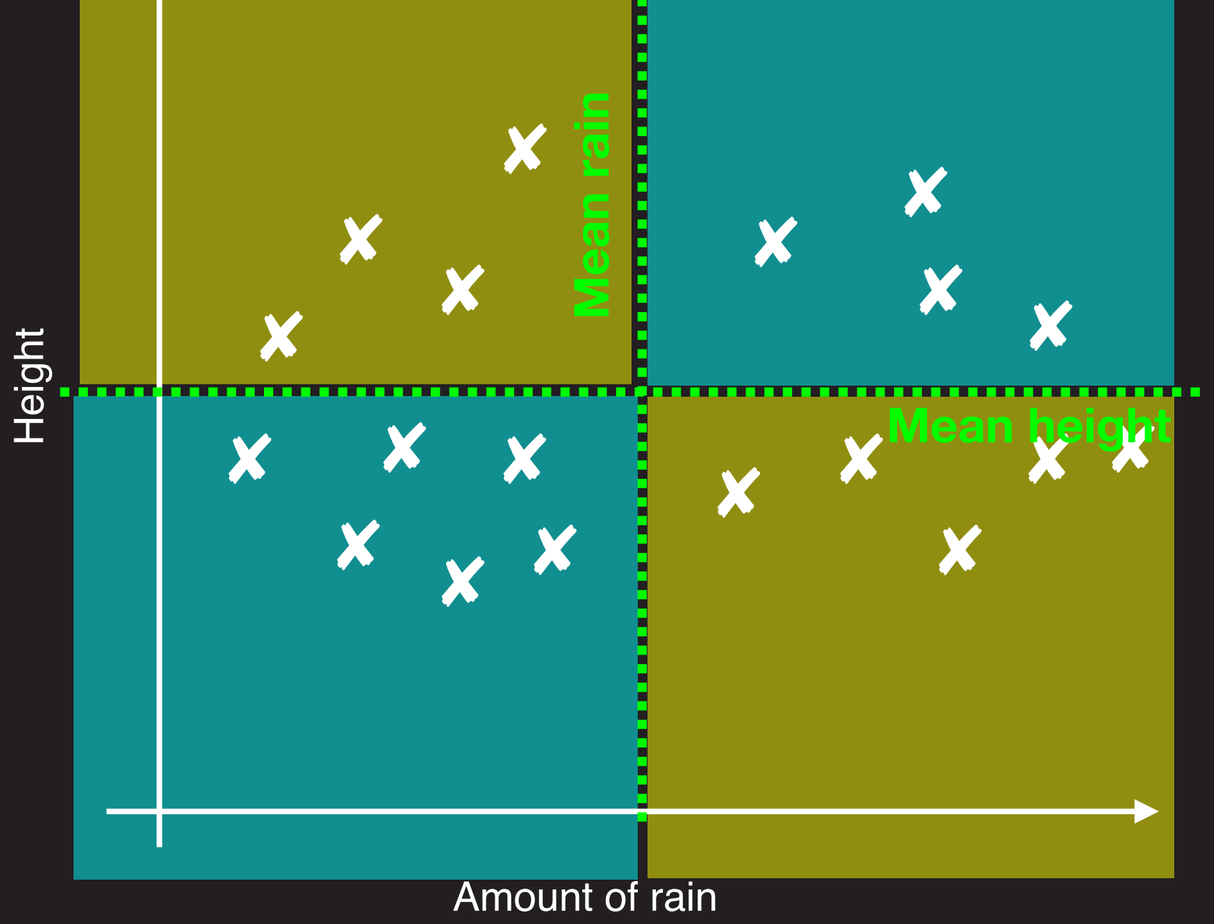
$$\text{cov}(x, y) = \frac{1}{n} \sum_i (x_i - \bar{x})(y_i - \bar{y})$$

Which has more influence? Positive or negative

Negative has more influence

We say that these two features are negatively correlated

## Height Vs Rain




**Positive correlation**
- Top right
- Bottom left

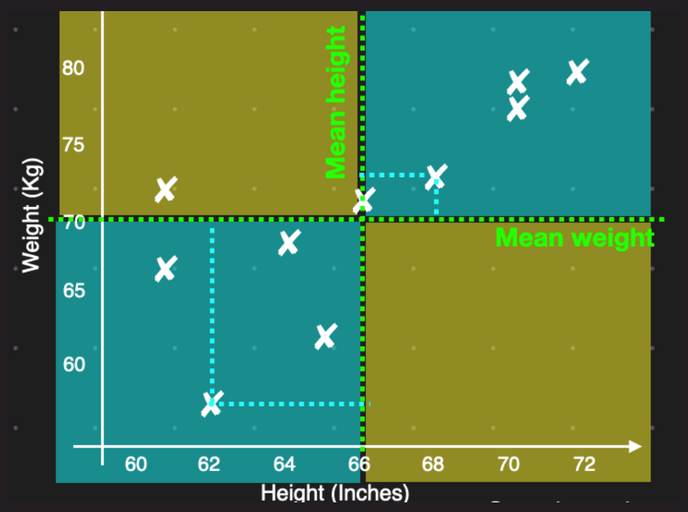
**Negative correlation**
- Top left
- Bottom right

$$\text{cov}(x, y) = \frac{1}{n} \sum_i (x_i - \bar{x})(y_i - \bar{y})$$

Which has more influence? Positive or negative

Both have (approximately) equal influence

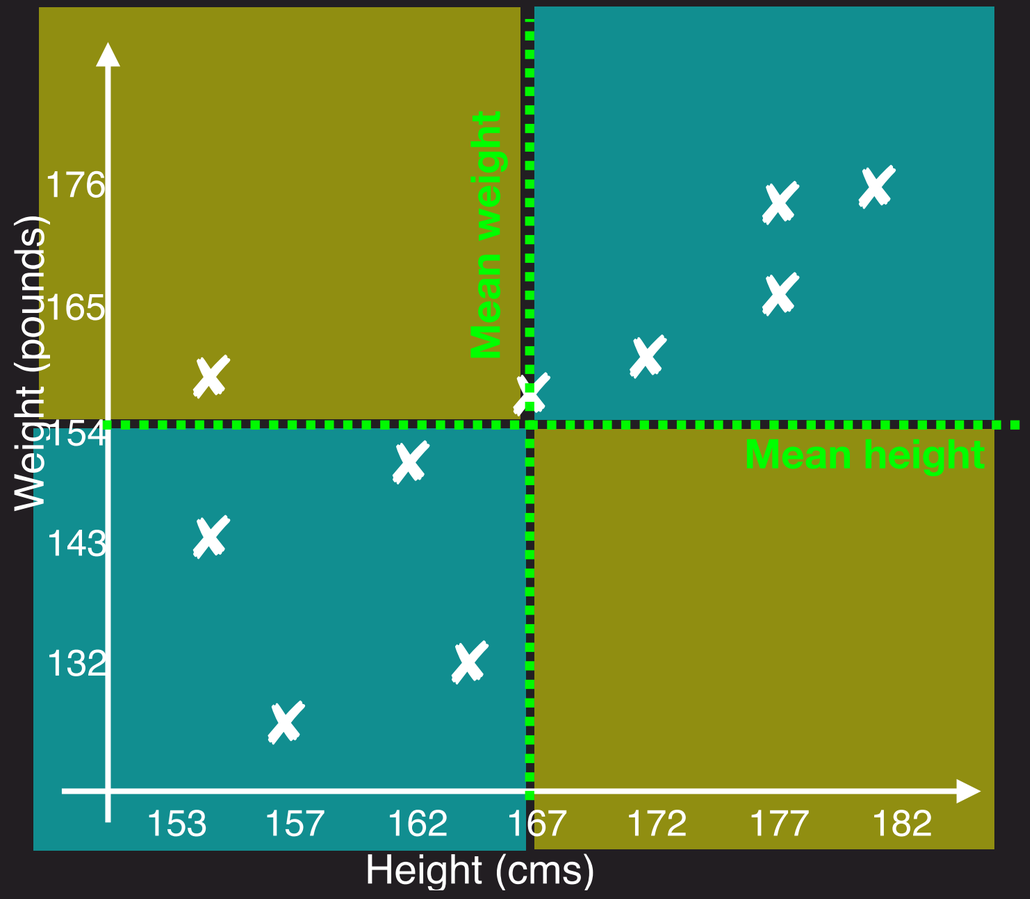
We say that these two features are uncorrelated




Suppose we express height in centimetres and weight in pounds

Simply stretching the axis should not have much influence on how we quantify correlation

The definition of “correlation” does a standardisation of “covariance”




If we apply the formula of correlation, we get the same number whether we use the inch/Kg axis or cms/pounds axis

**Positive correlation**

- Top right
- Bottom left

**Negative correlation**

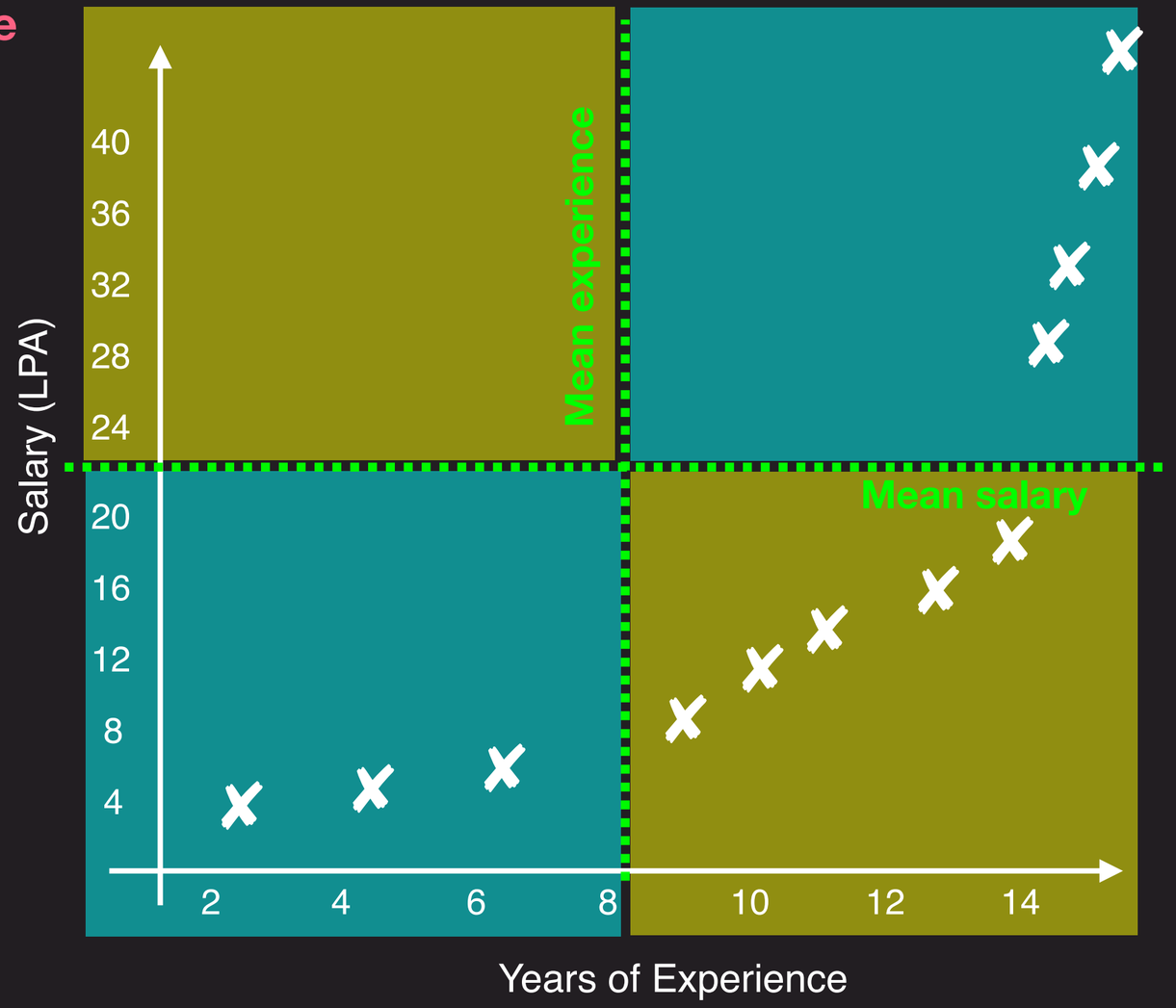
- Top left
- Bottom right

$$\text{cov}(x, y) = \frac{1}{n} \sum_i (x_i - \bar{x})(y_i - \bar{y})$$

$$\rho_{xy} = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y}$$

$$-1 \leq \rho_{xy} \leq 1$$

# Salary Vs Experience




**Positive correlation**

- Top right
- Bottom left

**Negative correlation**

- Top left
- Bottom right

$$\text{cov}(x, y) = \frac{1}{n} \sum_i (x_i - \bar{x})(y_i - \bar{y})$$

$$\rho_{xy} = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y}$$

$$-1 \leq \rho_{xy} \leq 1$$

Strange phenomenon: Even though we know that the two features are related, the correlation turns out to be very low

Spearman to the rescue!!!

Instead of taking the correlation of X and Y, we take correlation of rank(X) and rank(Y)

**Pearson Correlation**

$$\text{cov}(x, y) = \frac{1}{n} \sum_i (x_i - \bar{x})(y_i - \bar{y})$$

$$\rho_{xy} = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y}$$

**Spearman Correlation** Pearson correlation of rank(X) and rank(Y)