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Biostatistics
BT2023

Lecture 11
Correlation and regression

Himanshu Joshi
12 September 2023

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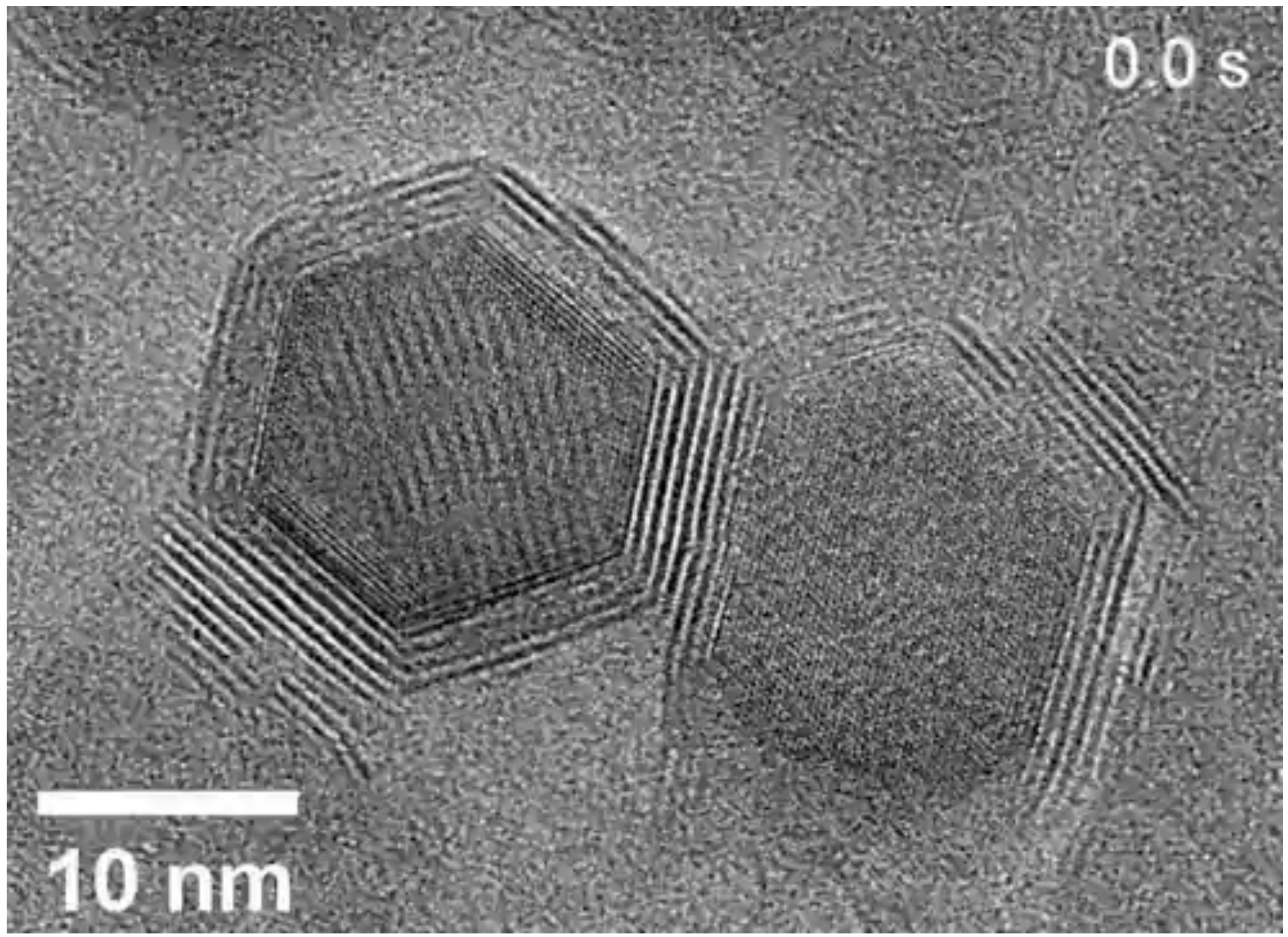

Reference Nature Communications
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Biostatistical Analysis
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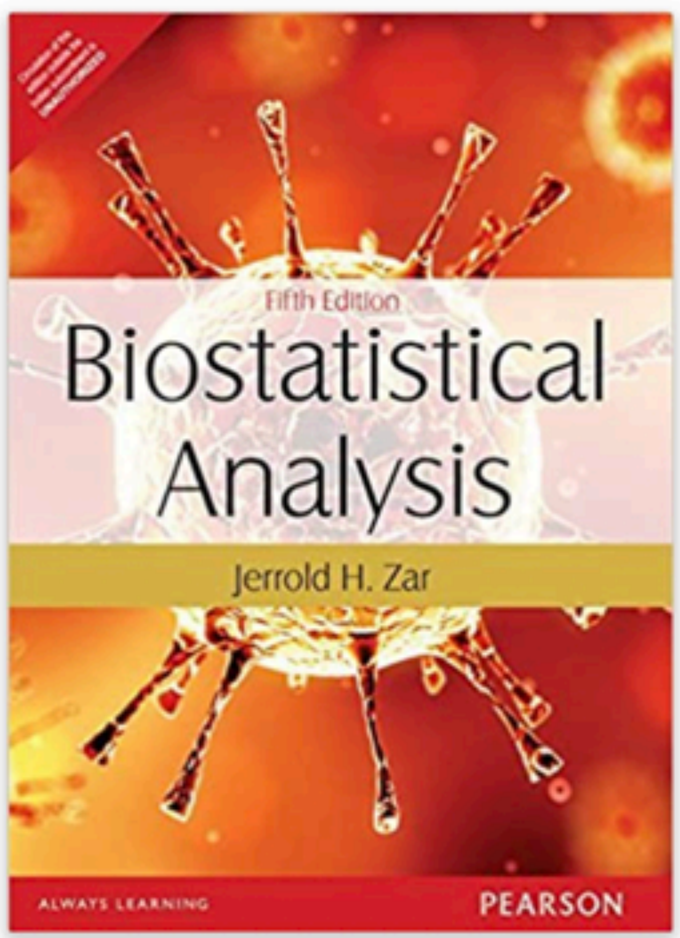

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Covariance

Covariance in two quantities variable X and Y on a given set is given by

$$Cov.\,(X,Y) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$$

$$= \frac{1}{n}\sum_{i=1}^{n} x_i y_i - \frac{1}{n}\sum_{i=1}^{n}(x_i)\frac{1}{n}\sum_{i=1}^{n}(y_i)$$

$$Cov(X,Y) = E(XY) - E(X)E(Y)$$

Correlation coefficient

$$r = \frac{\sum_{i=1}^{n} \frac{(x_i - \bar{x})}{\sigma_x} \frac{(y_i - \bar{y})}{\sigma_y}}{n}$$

$$\implies r = \frac{\sigma_{xy}}{\sigma_x \sigma_y}$$

$$where\ \sigma_{xy} = Cov(X, Y)$$

Properties of the correlation coefficient

1. It will range from -1 to +1
2. Measures the closeness of the fit

$$dx = x - \bar{x}$$

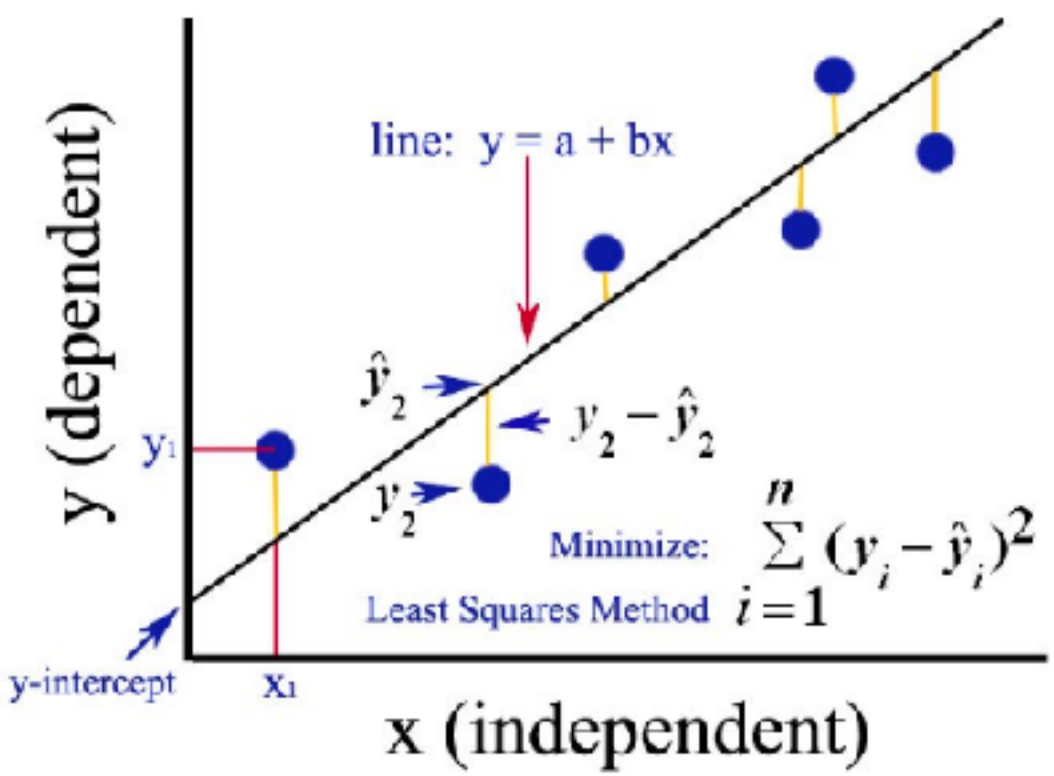
$$dy = y - \bar{y}$$

$$r_{xy} = \frac{\sum_{i=1}^{n} dxdy - \left(\sum dx \sum dy\right)}{\sqrt{\sum dx^2 - \frac{\left(\sum dx\right)^2}{n}} \times \sqrt{\sum dy^2 - \frac{\left(\sum dy\right)^2}{n}}}$$

Linear regression by least square method

In least square method, two conditions needs to be satisfied,

$$\sum_{i=0}^{n}(y_i - \hat{y}) = 0$$



Normal equations

$$\sum y = na + b\sum x$$

$$\sum xy = a\sum x + b\sum x^2$$

$$b_{yx} = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

Correlation and Regression

$$b_{yx} = \frac{n\sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$$

$$= \frac{Cov(X,Y)}{\sigma_x}$$

$$= r\frac{\sigma_y}{\sigma_x}$$

$$r = \frac{\sum_{i=1}^{n} \frac{(x_i - \bar{x})}{\sigma_x}\frac{(y_i - \bar{y})}{\sigma_y}}{n}$$

$$\implies r = \frac{\sigma_{xy}}{\sigma_x \sigma_y}$$

$$where\ \sigma_{xy} = Cov(X,Y)$$

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The regressor and response

When there is a possibility of functional dependence of one variable to another, such relationship is called regression. The variables are called independent and dependent variables but it doesn’t a cause and effect relationships between two variable.

Consider the following examples;

1. Blood pressure and the age of the patient
2. Length of arm vs length of legs

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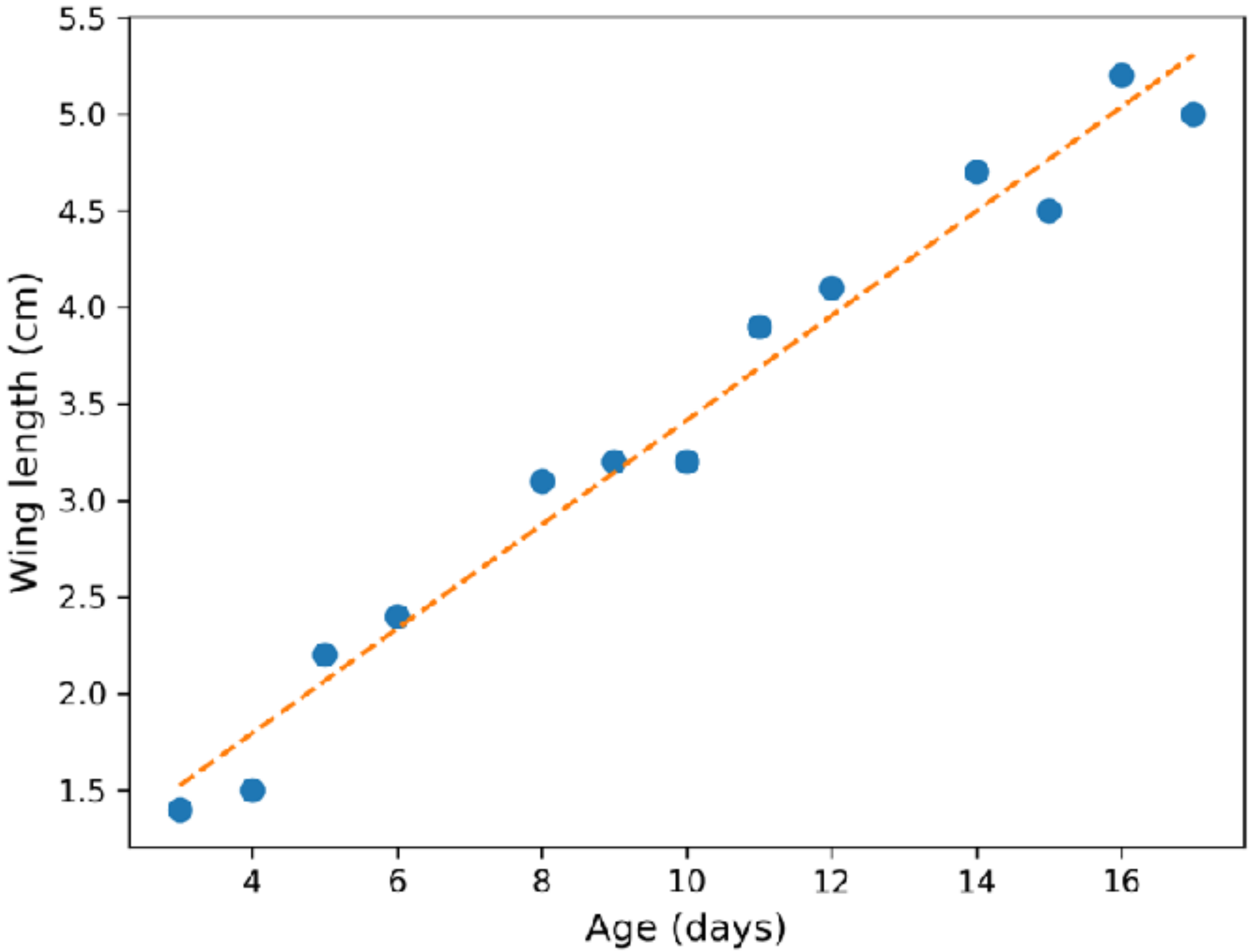
Caution with regression



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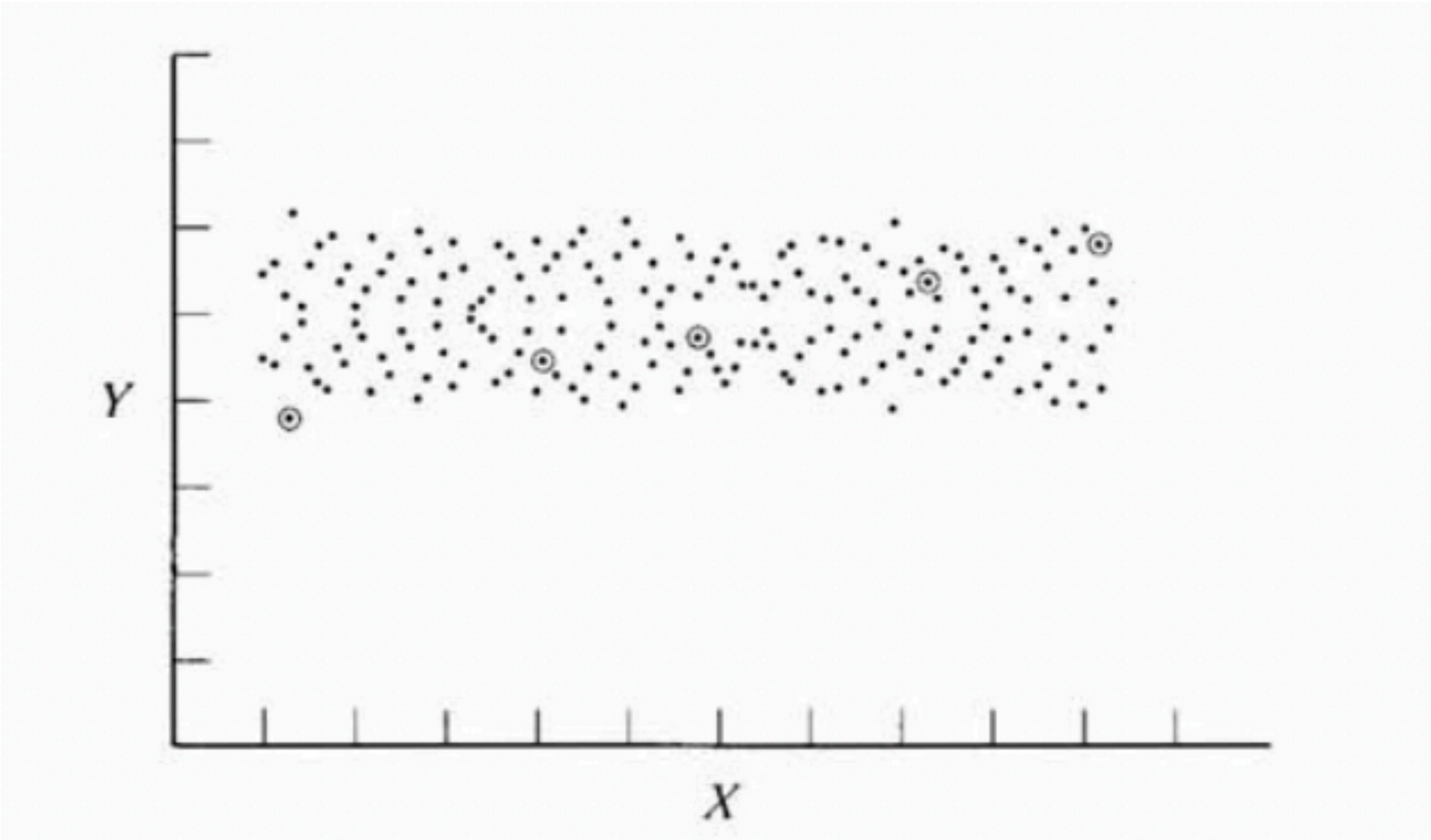

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