Regression

Regression in Biostatistics

Introduction

- Regression analysis is a statistical method used to study the relationship between:
  - one **dependent variable**, and
  - one or more **independent variables**.
- In **biostatistics**, regression is very important because it helps researchers:
  - understand medical and biological data,
  - study the effect of risk factors on health,
  - predict health outcomes, and
  - make better decisions in medicine and public health.

Properties (Assumptions) of Regression

For regression results to be valid, the following conditions should usually be satisfied:

- **Linearity:** The relationship between the variables should be linear.
- **Additivity:** The combined effect of more than one independent variable is added together.
- **Independence:** Each observation should be independent of the others.
- **Homoscedasticity:** The spread (variance) of errors should be the same for all values of the independent variables.
- **Normality:** The errors (residuals) should be approximately normally distributed.

Methods to Study Regression

Regression models can be estimated using different methods:

- **Least Squares Method:** Finds the line that minimizes the total squared errors.
- **Maximum Likelihood Estimation (MLE):** Finds the values of the parameters that make the observed data most likely.
- **Bayesian Methods:** Use previous knowledge (prior information) and update it with data.
- **Robust Regression:** Works better when there are outliers or when assumptions are not fully satisfied.

Types of Regression

Different regression models are used in biostatistics depending on the type of data:

- **Simple Linear Regression:** One independent variable and one dependent variable.
- **Multiple Linear Regression:** Two or more independent variables and one dependent variable.

- **Logistic Regression:** Used when the outcome is binary (for example: disease / no disease).
- **Poisson Regression:** Used for count data.
- **Cox Proportional Hazards Regression:** Used in survival or time-to-event analysis.
- **Non-linear Regression:** Used when the relationship is not linear.
- **Polynomial Regression:** Uses polynomial terms (square, cube, etc.).
- **Ridge and Lasso Regression:** Used to prevent overfitting by shrinking large coefficients.

Regression Equations

For X on Y:

$$X = a + bY$$

- where:
  - a is the intercept (value of X when Y = 0),
  - b is the slope (rate of change of X for each unit change in Y).

For Y on X:

$$Y = a + bX$$

- where:
  - a is the intercept (value of Y when X = 0),
  - b is the slope (rate of change of Y for each unit change in X).

Regression Line

- A regression line is a straight line that best fits the data points.
- It shows the relationship between the independent and dependent variables.
- It is used to predict the value of the dependent variable.

Applications in Biostatistics

- Regression analysis is widely used in:
  - epidemiology,
  - pharmacology, and
  - clinical trials.
- It is mainly used for:
  - **Prediction**: Estimating outcomes based on input variables (e.g., predicting blood pressure from body weight).
  - **Understanding Relationships**: Evaluating how variables are associated (positive or negative relationship).

- **Assessing Model Fit**: Metrics like R-squared and Adjusted R-squared help assess how well the model explains the variability in the outcome.

Example 1: Educational Context

Dataset

Hours Studied (X)	Exam Score (Y)
1	50
2	55
3	65
4	70
5	80
6	85

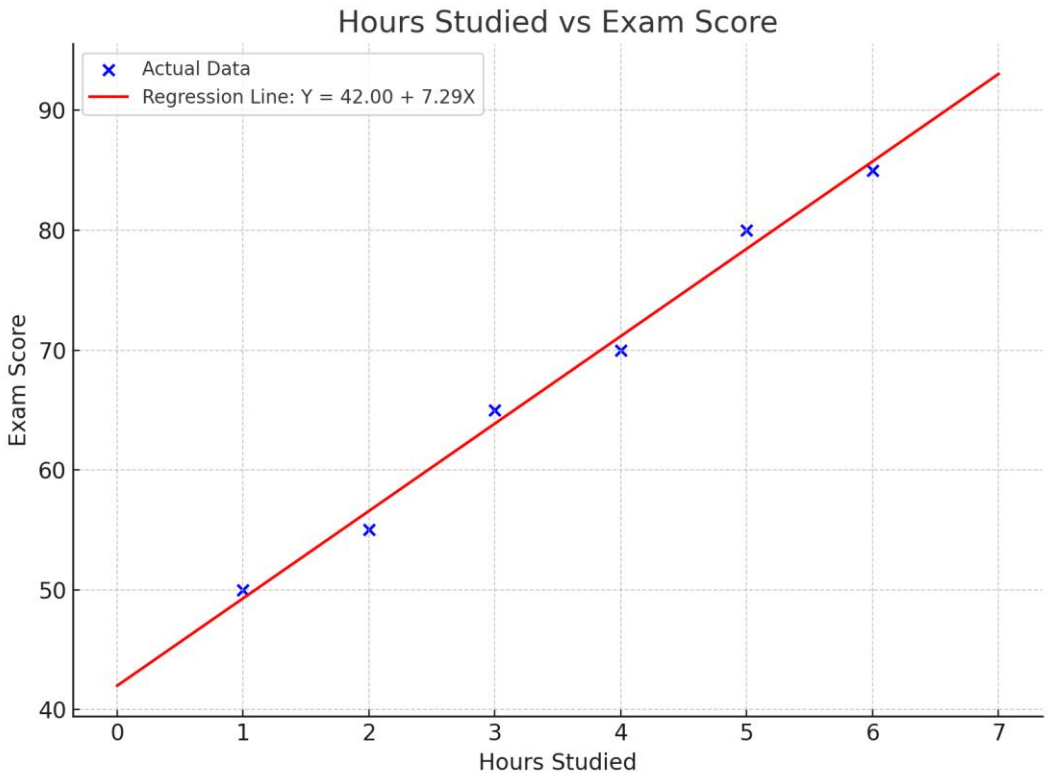
Regression Equation

- After applying the least squares method:

$$Y = 42.00 + 7.29X$$

Interpretation:

- **Intercept (42.00)**: The baseline score without studying is 42.
- **Slope (7.29)**: Each additional hour of study increases the score by ~7.29 points.



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