perplexity

Machine Learning Question.

The regression coefficients are independent of the change of origin but they are not independent of change of scale?
First of all explain the meaning of this question and then give me the answer of this question in very very simple way

Regression coefficients in linear models remain unchanged when you shift the data (change of origin) but adjust when you rescale the data (change of scale). Here's a simple breakdown:

What does "change of origin" and "change of scale" mean?

- **Change of origin**: Adding/subtracting a constant to all values of a variable.
  Example: Converting temperature from Celsius (°C) to Kelvin (K = °C + 273.15).
- **Change of scale**: Multiplying/dividing all values by a constant.
  Example: Converting meters (m) to kilometers (km = m / 1000).

Why are coefficients unaffected by origin changes?

- Shifting the data (e.g., adding 10 to all X-values) **does not alter the relationship** between X and Y.Example: If the original equation is
  $$Y = 2X + 5$$
  , shifting X to
  $$X' = X + 10$$
  updates the intercept (to
  $$Y = 2X' - 15$$
) but keeps the slope (2) unchanged.

Why are coefficients affected by scale changes?

- Rescaling the data (e.g., converting meters to kilometers) **changes the units** of X.Example: If the original slope is 2 (for X in meters), rescaling X to kilometers divides the slope by 1000 (since 1 km = 1000 m). The new slope becomes
  $$2/1000 = 0.002$$
  .

Simple Analogy:

- Imagine measuring a road's slope.
  - Shifting the starting point (origin) doesn't change the steepness (regression coefficient).

- Switching from meters to centimeters (scale) changes how you describe the steepness (e.g., 1% slope per meter vs. 1% slope per 100 centimeters).

In short: **Shifting data is like moving a ruler, while scaling changes the ruler's markings** – coefficients adjust only when the ruler's markings change.