

## Title: Poisson Regression Analysis on Case Counts

### 1. Introduction

- This script analyzes a dataset containing the number of cases recorded over different quarters across a span of five years (1984-1988).
- The goal is to fit a Poisson regression model to understand the trend of case counts over time.

### 2. Library Loading

- The `tidyverse` library is loaded for data manipulation and visualization.

### 3. Data Preparation

- A data frame is created with three columns: `year`, `quarter`, and `cases`.
- A new column `time_period` is generated representing the time order of the observations.
- Log transformations are performed on `cases` and `time_period` to linearize the relationships, resulting in `ln_cases` and `ln_time_period`.

### 4. Data Visualization

- A scatter plot of `ln_cases` against `ln_time_period` is created to visualize the relationship between the log-transformed variables.

### 5. Parameter Initialization

- Beta coefficients (`beta`) are initialized to zeros.
- Constants for the maximum number of iterations (`max_iter`) and convergence threshold (`epsilon`) are defined for the iterative optimization process.

### 6. Fisher's Scoring Method

- An iterative process (Fisher's scoring method) is performed to estimate the beta coefficients of the Poisson regression model.
- In each iteration:
  - Expected values (`mu`) and variance (`V`) are calculated based on the current beta coefficients.
  - Working response (`z`) and working weights (`W`) are computed.
  - The design matrix (`X`) is formulated.
  - Beta coefficients (`beta`) are updated.
  - Convergence is checked based on the difference between the new and old beta coefficients. If the change is less than the defined threshold (`epsilon`), the process stops.

### 7. Beta Coefficient Output

- The estimated beta coefficients are printed to the console.

### 8. GLM Fitting

- The `glm` function is used to fit a generalized linear model (GLM) assuming a Poisson distribution with a log link function.
- A summary of the model is printed, providing various statistics including the estimated coefficients, standard errors, z-values, and p-values, among others.

## 9. Conclusion

- This script demonstrates a manual implementation of Poisson regression via Fisher's scoring method and also utilizes the `glm` function to fit a Poisson regression model.
- The resulting beta coefficients and model summary provide insights into the relationship between the time period and the number of cases.