Simulation Exercise: Exponential Survival Data with Censoring

Objective

Simulate data from a hypothetical clinical trial with two treatment arms (Control and Treatment). The survival times should follow an exponential distribution, with non-informative right censoring.

Scenario

You're designing a simulation study to evaluate the impact of a new treatment on patient survival. You need to:

- Simulate 500 patients randomized equally to two arms.
- Generate exponentially distributed survival times with different hazard rates for each arm.
- Apply non-informative censoring using a separate exponential distribution.
- Create Kaplan-Meier survival curves and estimate hazard ratios.

Step 1: Define Simulation Parameters

- Total patients: n <- 500
- Proportion in treatment arm: 0.5
- Hazard rates:
  - Control: lambda_control = 0.1
  - Treatment: lambda_treatment = 0.07
  - Censoring: lambda_censor = 0.05

Tip: Use rbinom() to randomly assign groups.

Step 2: Generate Survival and Censoring Times

Use rexp(n, rate) to simulate:

- true_survival
- censoring_time

Observed time = pmin(true_survival, censoring_time)

Event indicator = as.integer(true_survival <= censoring_time)

Repeat for both treatment groups.

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Step 3: Combine the Data

Combine control and treatment data using rbind().

Ensure the dataset has: id, group, time, status, true_survival, censor_time.

Make group a factor: Control vs Treatment.

Step 4: Kaplan-Meier Curves

Use Surv(time, status) and survfit() to estimate curves.

Use base R plot() or ggsurvplot() (from survminer) to visualize survival.

Step 5: Cox Proportional Hazards Model

Use coxph(Surv(time, status) ~ group, data).

This will estimate hazard ratios and test for treatment effect.

Bonus Challenge

Add a covariate (e.g., age using rnorm()).

Include it in the Cox model and observe how the HR changes.

Expected Output

- Simulated dataset with 500 rows

- Kaplan-Meier plot showing separation

- Hazard ratio < 1 if treatment is effective