ASQ CRE Prep course

Lesson II. A. 4. d.

Poisson Process Models

Mann Reverse Arrangement Test


Looking for trends in time to failure data
MANN REVERSE
ARRANGEMENT TEST

What is a Reversal?

- **A reversal is an interarrival time that is less then a time that occurs later.**

- **An example 50, 145, 232, 120, 150**
  50 is less then all 4, thus is 4 reversals
  145 is less then 232 and 150, for 2
  232 is greater than remaining, thus 0
  120 is less than 150, for 1
  7 total reversals in this data set

Step 1: Setup Hypothesis

- **The null hypothesis:**
  Times are independent and identically distributed

- **The alternative hypothesis (pick one):**
  H_{11} decreasing interarrival times
  H_{12} increasing interarrival times
  H_{13} non-constant interarrival times

Step 2: Form sequence of inter-arrival times

- **Let's use the example of:**

  36, 63, 86, 128, 165, 324

  are days on which repairs occur
  repairs take about an hour, this is days from start of operation, not interarrivals

Step 3: Count Reversals

- **Given the data count reversals of interarrival time (days)**
  Convert data to interarrivals

  36, 27, 23, 42, 37, 159

- **Counting reversals, I get**

  R = 3 + 3 + 3 + 1 + 1 = 11

Step 4: Compute Mean and Std

- **Mean**

$$\text{Mean } \mu_R = \frac{n(n-1)}{4} = \frac{11(11-1)}{4} = 27.5$$

- **Standard Deviation**

$$\text{Stdev } \sigma_R = \frac{\sqrt{n(n-1)(n+2.5)}}{6} = \frac{\sqrt{11(11-1)(11+2.5)}}{6} = 6.42$$

Step 5: Set critical value

- **For a 0.05 significance level the z-value is**

$$Z_{0.05} = 1.645, \text{ and } Z_{0.025} = 1.96$$

- **H_{11} decreasing interarrival times**

$$\text{Conclude } H_{11} \text{ if } R \le r_{1-\alpha} \approx \text{Ceiling } \left[\mu_r - z_\alpha \sigma_R - c_\alpha\right] = \frac{n(n-1)}{2} - r_\alpha$$

- **H_{12} increasing interarrival times**

$$\text{Conclude } H_{12} \text{ if } R \ge r_\alpha \approx \text{Floor } \left[\mu_r + z_\alpha \sigma_R + c_\alpha\right] = \frac{n(n-1)}{2} - r_{\alpha-1}$$

- **H_{13} non-constant interarrival times**

$$\text{Conclude } H_{13} \text{ if } R \le r_{1-\alpha/2} \text{ or } R \ge r_{\alpha/2}$$

Z and c values

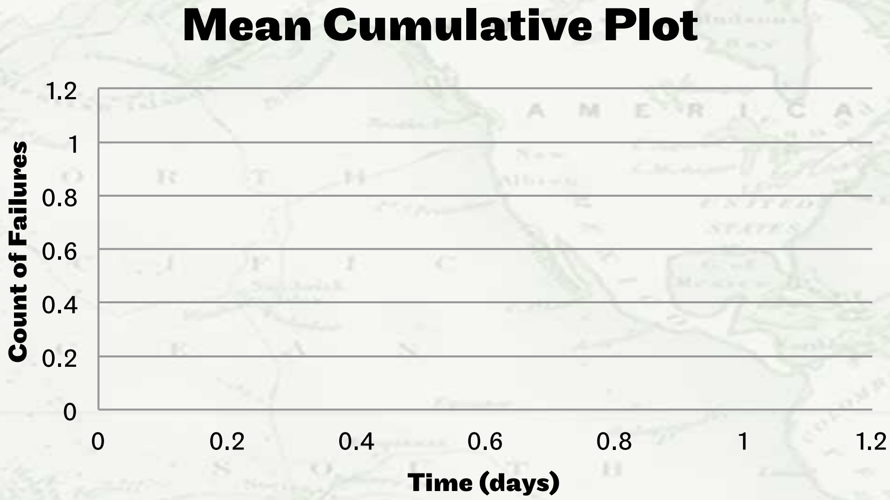
α	0.1	0.05	0.025	0.01
z_α	1.28155	1.64485	1.95996	2.32635
c_α	1.62	1.48	1.34	1.09

z_α is from the standard normal table

c_α is a correction to the calculation when n is less than 30

Step 6: Compare Count to Critical

- **Is the process getting more reliable?**



$$\text{Conclude } H_{12} \text{ if } R \geq r_\alpha$$

$$r_\alpha \approx \text{Floor}\left[\mu_r + z_\alpha \sigma_R + c_\alpha\right]$$

$$r_\alpha \approx \text{Floor}\left[27.5 + 1.645(6.42) + 1.48\right]$$

$$r_\alpha \approx 39$$

$$R = 11$$

$$R \leq r_\alpha \text{, therefore no evidence to say it's improving}$$

Do you remember Hypothesis Testing?

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Lesson II. A. 4. e.

Poisson Process Models

Laplace's Trend Test