A New Homogeneous Pure Birth Process based Software Reliability Model

Néstor Ruben Barraza

Universidad Nacional de Tres de Febrero, Caseros, Argentina
nbarraza@untref.edu.ar

1 Introduction

Software Reliability models has been developed for decades. The majority of them are based on non homogeneous Poisson processes, where the failure rate is a non linear function of time. They are also well described by pure birth processes what leads to non homogeneous continuous time Markov chains (NHCTMC), as it is usually used in the simulation of the stochastic software failure process.

Pure birth processes are described by the following general equation:

$$P_r'(t) = -\lambda_r(t)P_r(t) + \lambda_{r-1}(t)P_{r-1}(t) \tag{1}$$

where $P_r(t)$ is the probability of having r individuals in the population at time t. The process (1) is also a Markov process where the number of individuals corresponds to the state of the system. Several particular cases arise following $\lambda_r(t)$ depends just on r, t or none. The Poisson process arises when $\lambda_r(t)$ is constant in time $\lambda_r(t) = \lambda$.

As it is usually considered in the literature, the stochastic failure processes involve cases were the failure rate depends non linearly only on time $\lambda_r(t) = \lambda(t)$ leading to non homogeneous continuous time Markov chains.

We propose in this work a different and novel approach. We consider a failure rate that does not depend on time but depends non linearly on the number of failures $\lambda_r(t) = \lambda_r$. We use the parametric Empirical Bayes framework in order to estimate λ_r.

The mean time between failures can be estimated as $mtbf(r,t) = \frac{1}{\lambda_r(t)}$. It can be shown that the model fits well several reported failure dataset.

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