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A comparative study of tests for poisson mean

V.V. PATIL AND H.V. KULKARNI

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ABSTRACT

The Poisson distribution has found extensive and varied applications in modeling a wide variety of phenomena dealing with counts of events. In these situations construction of confidence intervals and tests for the Poisson mean μ are important inferential aspects. the problem of interval estimation of μ is widely addressed in the literature. Each interval estimation procedure leads to a corresponding test procedure for μ. In this study, we carry out power comparison among nineteen test procedures each arising out of a corresponding interval estimation procedure. The study leads to recommendations regarding the use of particular methods depending on the type of alternative hypothesis.

Key words : Poisson, Sticky plate, Tests

The observed number of events in a specified time or area can be modeled using Poisson distribution. Such situations occur in a wide range of phenomenon in a variety of disciplines, for example the number of pollen grains collected in regions of a sticky plate exposed to the open air, the number of white blood cells found in a cubic centimeter of blood, number of accidents taking place at a spot in a specified duration, number of defects observed during a specified period in a production process etc. to name a few. In these situations construction of confidence intervals and tests for the Poisson mean μ are important inferential aspects.

A large number of methods are available for obtaining confidence interval for the parameter μ of the Poisson distribution. It is commonly accepted that confidence sets and tests are two sides of a coin. A confidence set consists of those parameter values that are not rejected by a test at the corresponding level. There are many places one can find confidence regions described in terms of hypothesis testing (cf. Lehmann (1986), Cox and Hinkley (1974)).

In this article we attempt power comparison among the ninteen test procedures arising from different interval estimation procedures for the poisson parameter μ that are availlable in the literature.

Section 2 reports the methods for interval estimation of μ. Section 3 discusses power comparisons among the allied test procedures. Section 4 gives concluding remarks.

Correspondence to:
V.V. PATIL, Department Statistics, Tuljaram Chaturchand College, BARAMATI (M.S.) INDIA
Authors' affiliations:
H.V. KULKARNI, Department of Statistics, Shivaji University, KOLHAPUR (M.S.) INDIA

Interval estimation procedures for the Poisson Mean:

A large number of interval estimation procedures exist in the literature for the Poisson Mean. The exact interval based on the Poisson distribution of observed total number of counts (X) is too conservative and the most popular Wald interval based on the asymptotic normality of X suffers from serious drawbacks as shown by Brown, Cai and DasGupta (2003) among others. This motivated the use of other intervals. Most of the alternative procedures rely on the asymptotic normality of the variance stabilising square-root transformations coupled with various types of continuity corrections to account for the bias due to discreteness. An exhaustive comparative study of these intervals based on many criteria including expected coverages and lengths, balace of non-coverage probabilities on both sides of the interval, P-bias and P-confidence etc. is attempted in Kulkarni and Patil (2010). Table 1 presented below lists the nineteen two sided confidence interval procedures for the Poisson mean. A Detail review and motivation behind each procedure is given in Kulkarni and Patil (2010).

The next section attempts a power comparison among the allied test procedures.

Power comparison of tests :

In this Section test procedures associated with the nineteen CI reported in Table 1 below are compared with respect to powers and type I errors. From first principles, the powers corresponding to alternative hypothesis $H_1 : \mu \neq \mu_0$, $H_1 : \mu < \mu_0$ and $H_1 : \mu > \mu_0$ evaluated at m are P(μ), PL(μ) and PR(μ), respectively given by

$$\mathbf{P}(\mu) = \sum_{x=0}^{\infty} \mathbf{I}((\mu_0 < \mathbf{l}(\mathbf{x})) \cup (\mu_0 > \mathbf{u}(\mathbf{x}))(\mathbf{e}^{-\mu}(\mu)^{\mathbf{x}} / \mathbf{x}!$$