Poisson variability test

The Poisson variability test tests the null hypothesis H_0

$$H_0 : m_1, m_2, ..., m_n \text{ are independent Poisson random variables.} \qquad (1)$$

While $m_1, m_2, ..., m_n$ are required to be independent Poisson random variables, they need not be *identically-distributed*: the means of the Poisson random variables may differ. Since the counts of inhomogeneous Poisson processes are themselves Poisson random variables the test thus provides a hypothesis test for independent, inhomogeneous Poisson processes as a special case (allowing, again, that each such process could have a different rate function).

In the context of neural data analysis, $m_1, m_2, ..., m_n$ are expected to be the spike counts from n trials. The test uses the statistic (n, N, S) to determine whether a data set is to be rejected for a fixed confidence level, where N is the total number of spikes across all n trials, and S is the sum across all trials of the square of the number of spikes in each trial:

$$N = \sum_{i=1}^{n} m_i \qquad S = \sum_{i=1}^{n} m_i^2 \qquad (2)$$

In practice, one just reports the p-value which a statistical test assigns to data. The MATLAB code **pvt_alpha.m** provided on this web page outputs this p-value as a function of (n, N, S). Thus, for example, if one collects spike count data of $\{5, 4, 3, 2, 4, 5, 6\}$ (i.e, with 5 spikes on the 1st trial, 4 spikes on the second trial, ..., and 6 spikes on the last trial), then we have $n = 7, N = \sum_{i=1}^{n} m_i = 29$, and $S = \sum_{i=1}^{n} m_i^2 = 131$. So that entering

```
>> pvt_alpha(7,29,131)
ans =
  0.1705
```

we find that 0.1705 is the $p-$value of the test for this data set.

The MATLAB code is capable of computing the test in two ways, by dynamic programming or by Monte Carlo sampling. The former is exact but can be time-consuming; the latter is fast but is approximate. These settings are discussed in the code's own instructions (type `help pvt_alpha` at the MATLAB prompt), and everything here is explained in full detail in Chapter 2 of A. Amarasingham's dissertation, also provided on this web page.

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