The Evaluation of Evidence for Autocorrelated Data: with an Example Relating to Traces of Cocaine on Banknotes

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Much research in recent years for evidence evaluation in forensic science has focussed on methods for determining the likelihood ratio in various scenarios. The likelihood of the evidence is calculated under each of two propositions, that proposed by the prosecution and that proposed by the defence. The value of the evidence is given by the ratio of the likelihoods associated with these two propositions. The aim of this research is to evaluate this likelihood ratio under two scenarios. The first is when the evidence consists of continuous autocorrelated data. The second, an extension to this, is when the observed data are also believed to be driven by an underlying latent Markov chain. Four models have been developed to take these attributes into account: an autoregressive model of order one, a hidden Markov model with autocorrelation between adjacent data points and a nonparametric model with two different bandwidth selection methods. Application of these methods will be illustrated with an example where the data relate to traces of cocaine on banknotes as measured by the log peak area for the ion count for cocaine product ion m/z 105 in a mass spectrometer. The likelihood ratios using these four models will be calculated for these data, and the results compared.

Keywords: Evidence evaluation, likelihood ratio, hidden Markov models, autoregressive models