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Automatic Estimation of Flux Distributions of Astrophysical Source Populations

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In astrophysics a common goal is to infer the flux distribution of populations of scientifically interesting objects such as pulsars or supernovae. In practice, inference for the flux distribution is often conducted using the cumulative distribution of the number of sources detected at a given sensitivity. The resulting "log(N>S)-log(S)" relationship can be used to compare and evaluate theoretical models for source populations and their evolution. Under restrictive assumptions the relationship should be linear. In practice, however, when simple theoretical models fail, it is common for astrophysicists to use pre-specified piecewise linear models. This paper proposes a methodology for estimating both the number and locations of "breakpoints" in astrophysical source populations that extends beyond existing work in this field.
An important component of the proposed methodology is a new Interwoven EM Algorithm that computes parameter estimates. It is shown that in simple settings such estimates are asymptotically consistent despite the complex nature of the parameter space. Through simulation studies it is demonstrated that the proposed methodology is capable of accurately detecting structural breaks in a variety of parameter configurations. This paper concludes with an application of our methodology to the Chandra Deep Field North (CDFN) dataset.

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