Minimal Boundary Estimate for Irregularly Shaped X-ray Sources

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Astronomers are interested in delineating boundaries of extended sources in noisy images. Analyzing the morphology of these objects is particularly challenging for X-ray images of high redshift sources where there are a limited number of high-energy photon counts. Low-counts Image Reconstruction and Analysis (LIRA), a Bayesian multi-scale image reconstruction, has been tremendously successful in analyzing low count images and extracting noisy structure. However, we do not always have supplementary information to predetermine the region of interest, and the size and shape can significantly affect flux/luminosity estimates. To group similar pixels, we impose a multi-phase model using the output of LIRA to build a distribution for the minimal boundary, the point at which the source is no longer distinguishable from the background noise. We adopt the Ising model as a prior on assigning the pixels to either the background or the ROI. This Bayesian post-process step informs the final boundary. This method is applied to observed data as well as simulations to show it is capable of picking out meaningful ROIs.