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A Bayesian Approach to Locating the Red Giant Branch Tip Magnitude (Part I)

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We present a new approach for identifying the Tip of the Red Giant Branch (TRGB) which, as we show, works robustly even on sparsely populated targets. Moreover, the approach is highly adaptable to the available data for the stellar population under study, with prior information readily incorporable into the algorithm. The uncertainty in the derived distances is also made tangible and easily calculable from posterior probability distributions. We provide an outline of the development of the algorithm and present the results of tests designed to characterize its capabilities and limitations. We then apply the new algorithm to three M31 satellites: Andromeda I, Andromeda II and the fainter Andromeda XXIII, using data from the Pan-Andromeda Archaeological Survey (PAndAS), and derive their distances as $731^{(+ 5) + 18}_{(- 4) - 17}$ kpc, $634^{(+ 2) + 15}_{(- 2) - 14}$ kpc and $733^{(+ 13)+ 23}_{(- 11) - 22}$ kpc respectively, where the errors appearing in parentheses are the components intrinsic to the method, while the larger values give the errors after accounting for additional sources of error. These results agree well with the best distance determinations in the literature and provide the smallest uncertainties to date. This paper is an introduction to the workings and capabilities of our new approach in its basic form, while a follow-up paper shall make full use of the method's ability to incorporate priors and use the resulting algorithm to systematically obtain distances to all of M31's satellites identifiable in the PAndAS survey area.

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