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Likelihood-free forward modeling for optimal survey design

As with any lab experiment, every astronomical survey requires numerous design decisions, from the instrument itself all the way through to the analysis pipelines, ultimately impacting the degree to which its resulting data can answer the most pressing questions about the universe. By collecting vast quantities of uncertainty-dominated data, the upcoming Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) poses special challenges to making such decisions, particularly in light of the diverse scientific goals of its users. Likelihood-free modeling can be used to optimize these design choices by bridging the gap between simulated or precursor data in hand and the inherently unknown regime of the potential data that could be collected under each set of choices. I present an approach to optimizing survey design decisions for LSST using a fully probabilistic forward model of realistically complex galaxy redshifts and broad-band photometry. In addition to presenting a few case studies showing its application to the optimization of observing strategy and photometric redshift estimation algorithms, I also outline how to generalize this procedure to other surveys and science use cases.

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