LSST:UK Consortium

LSST:UK Science Centre

Software Management Plan

Work Package 3.7

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1 What software will you develop?

- We will develop an alternative sky subtraction algorithm for LSST, tailored to preserve low surface brightness flux.

- This software will, with permission from the LSST Data Management team, replace the current full-focal-plane sky subtraction algorithm in the LSST pipeline itself.

- We will build this software in two stages:

  1. We will adjust the existing sky subtraction routine to use more rigorous masking of astrophysical flux and lower-order fits to unmasked pixels, to produce a first-order image coadd in which many of the pipeline's problems that we have already identified will be mitigated.

  2. We will then develop a secondary sky subtraction routine, using the first-order image coadd, to further improve the sky models. This will be added into the pipeline on top of our modifications to the existing sky-subtraction algorithm as described above, and should improve the survey's final surface brightness depth.

2 Who are the intended users of your software?

- We intend to integrate the software into the LSST data reduction pipeline, so it will be accessible alongside the rest of the pipeline via the Rubin Science Platform (RSP).

- While the LSST Data Management team will likely be the primary users of the software, anyone with access to the RSP will be able to import it and its component pieces from within the RSP Notebook Aspect.

- Additionally, we will keep a copy of the software in a separate repository in the LSST:UK GitHub.

3 How will you make your software available to your users?

- Because we intend to incorporate the software into the LSST pipeline, ultimately the source code will be available alongside the rest of the pipeline source code (i.e., at https://pipelines.lsst.io/).

- During development, prior to pipeline integration, we will maintain a GitHub repository at: https://github.com/lsst-uk/sky-estimation-WP3.7/

- In either location, our software will be open source, using Apache License 2.0.

4 How will you support those who use your software?

- We will include extensive documentation at the above-mentioned GitHub repository, to be migrated to the LSST pipelines documentation pages upon integration into the pipeline.

- For any further inquiries, we will make the primary developer's (Aaron Watkins) e-mail and Slack contact information available in this documentation.

5 How will your software contribute to research?

- By improving the LSST sky subtraction algorithm, we will open the scope of LSST science beyond what it was primarily designed for.

- Our software should improve photometry and shape measurements of LSST's primary targets of interest (lensed galaxies at cosmological distances), improve photometry of sources in crowded fields such as the Galactic bulge, improve photometry of secondary science targets such as local Universe galaxies, and open up LSST to the mostly unexplored low surface brightness regime, where a large portion of the survey's discovery space is expected to lie.

- Finally, by reducing the amount of over-subtraction of low surface brightness flux, our software will increase the detectability of faint objects, which should mollify any systematic statistical biases the survey would otherwise incur.

6 How will your software relate to other research objects?

- In making the source code of our sky subtraction algorithm publicly available, anyone will be able to reproduce our methodology for use in their own external data reduction pipelines.

- We will also produce an accompanying paper discussing the applicability and limits of our novel sky subtraction algorithm, in comparison to existing algorithms, which will serve as a resource for anyone involved in low surface brightness research.

7 How will you measure your software's contribution to research?

- Our software will have two quantifiable effects that the LSST community can measure and track:
    1. It will improve the survey's limiting surface brightness limit, with a goal of reaching the theoretical 10-year depth of 31 magnitudes/arcsec^2.
    2. It will prevent over-subtraction of low surface brightness flux around astrophysical objects, which we are currently tracking and will continue to track using a suite of synthetic galaxies injected into the images during data reduction.
- Additionally, LSST users, as well as those external to LSST who make use of our sky-subtraction algorithm in their own pipelines, will be able to cite the accompanying paper in their own work.

8 Where will you deposit your software to guarantee its long-term availability?

- We will deposit the software both on GitHub, which we expect will be maintained in the long-term given its current wide usage, and on the LSST pipelines webpage, which we expect will be maintained during and well beyond the survey's lifetime.