af1ak: Advanced Framework for Learning Astrophysical Knowledge

— A visual programming approach to analyze multi-spectral astronomical data—

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Thesis Abstract

This thesis describes an extendable graphical framework, aflak (Advanced Framework for Learning Astronomical Knowledge) – A visual programming approach to analyze multi-spectral astronomical data –

This thesis describes an extendable graphical framework, aflak (Advanced Framework for Learning Astronomical Knowledge), which provides a collaborative visualization environment for the exploratory analysis of multi-spectral astronomical datasets. aflak allows the astronomer to share and define analytics pipelines though a node editing interface, in which the user can compose together a set of built-in transforms (e.g. dataset import, integration, Gaussian fit) over astronomical datasets. aflak supports the loading and exporting of Flexible Image Transport System (FITS) files, the de facto data interchange format used in astronomy, allowing interoperability with existing astronomy software.

The contribution of this thesis lies in that we leverage visual programming techniques to conduct fine-grained astronomical transformations, filtering and visual analyses on multi-spectral datasets, with the possibility for astronomers to interactively fine-tune all the interacting parameters. As the visual program is gradually designed, the computed results can be visualized in real time, thus aflak puts the astronomer in the loop.

Moreover, aflak can query and load datasets from public astronomical data repositories, by implementing standard query protocols used in astronomy, such as Simple Image Access (SIA). aflak extends the FITS standard in a manner such that the full provenance of the output data created by aflak be preserved and reviewable, and that the exported file be usable by other common astronomical analysis software. By embedding aflak’s provenance data into FITS files, we both achieve interoperability with existing software and full end-to-end reproducibility of the process by which astronomers make discoveries.

Not only is aflak fast and responsive, but the macro it supports can be conveniently exported, imported and shared among researchers using a purposefully built data interchange format and protocol. A user can implement some common analytical procedure either by combining several nodes and creating a macro with aflak’s user interface, or by programmatically implementing new nodes in the Rust programming language.

During the development of aflak, we worked together with astronomers to provide a universal tool that suits their analytic needs as close as possible. aflak joins ease of use, responsiveness, shareability and reproducibility of the analytical process by which astronomers make discoveries.