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Subject : Observational astronomy and machine learning

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Title : Enabling identification of Early Supernova Ia in Rubin data

Summary: Astronomy has been going through a data revolution in the last decade. Bigger telescopes, coupled with even more powerful cameras give us insights into regions of the Universe that were hidden from us until not so long ago. However, getting data is only the first stage of a very long process which will eventually result in a scientific discovery. Since we are getting more data than ever before, we need to use automatic machine learning algorithms and other similar tools to help us identify a few interesting needles in a haystack of astronomical observations.

The goal of this project is to evaluate performance efficiency of machine learning algorithms in identifying early type Ia supernovae in the first batch of alerts from the Vera C. Rubin Observatory Legacy Survey of Space and Time.

Type Ia Supernovae are explosions marking the death of binary star systems involving at least one white dwarf. They have become one of the main cosmological probes since it was proven that their brightness evolution can be standardised and thus enable distance measurements in large cosmological scales.

The Vera Rubin Observatory Legacy Survey of Space and Time[1] (LSST), is an 8.4m telescope located in Chile, with streaming data expected at maximum in early 2026. At each night, the LSST is expected to detect 10 million transient candidates which need to be classified before they can be used to produce scientific results. These candidates will be distributed via community brokers. Software systems capable of dealing with large data sets, which are already in operation.

Fink[2] is one of such brokers, born in LPC in 2018, it is able to receive and process and classify large volumes of complex astronomical data. This is done via the construction of science modules which are specialised in a given type of astronomical transient.

One of the science modules currently available focuses on the detection of early supernova Ia. It has been widely tested in data from the Zwicky Transient Facility (ZTF) and simulations. However, the efficiency of the mode in processing Rubin data is still to be determined. This project aims at identifying crucial differences and implementing necessary modifications to the current Early SNIa module[3] in order to ensure scientific output from Rubin data.

The successful candidate should be willing to work in an interdisciplinary team; willing to learn new things in an active research environment; comfortable with programming in Python and with basic statistics tools. Familiarity with collaborative code development, e.g., github is welcome. All the activities and discussions related to the work will happen in English. An interest in stellar astrophysics, curiosity for the subject and commitment to keeping deadlines are also important.

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[1] https://www.lsst.org/lsst/
[2] https://fink-broker.org/
[3] https://arxiv.org/pdf/2111.11438