Identifying Changing-State AGN in LSST Data Using Simulation-Based Inference

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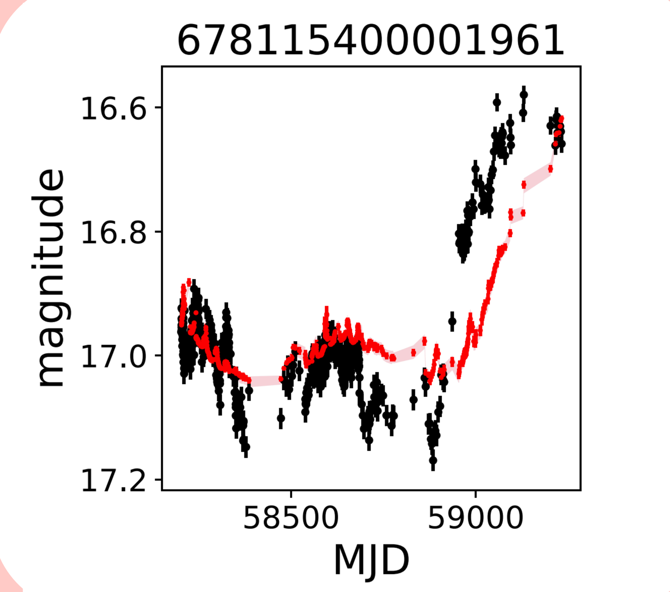
Active galactic nuclei (AGN) typically exhibit some level of stochastic but statistically predictable variability.

Changing-state AGN undergo much more dramatic variability, including **large changes in luminosity** and the **appearance or disappearance of optical broad emission lines.**

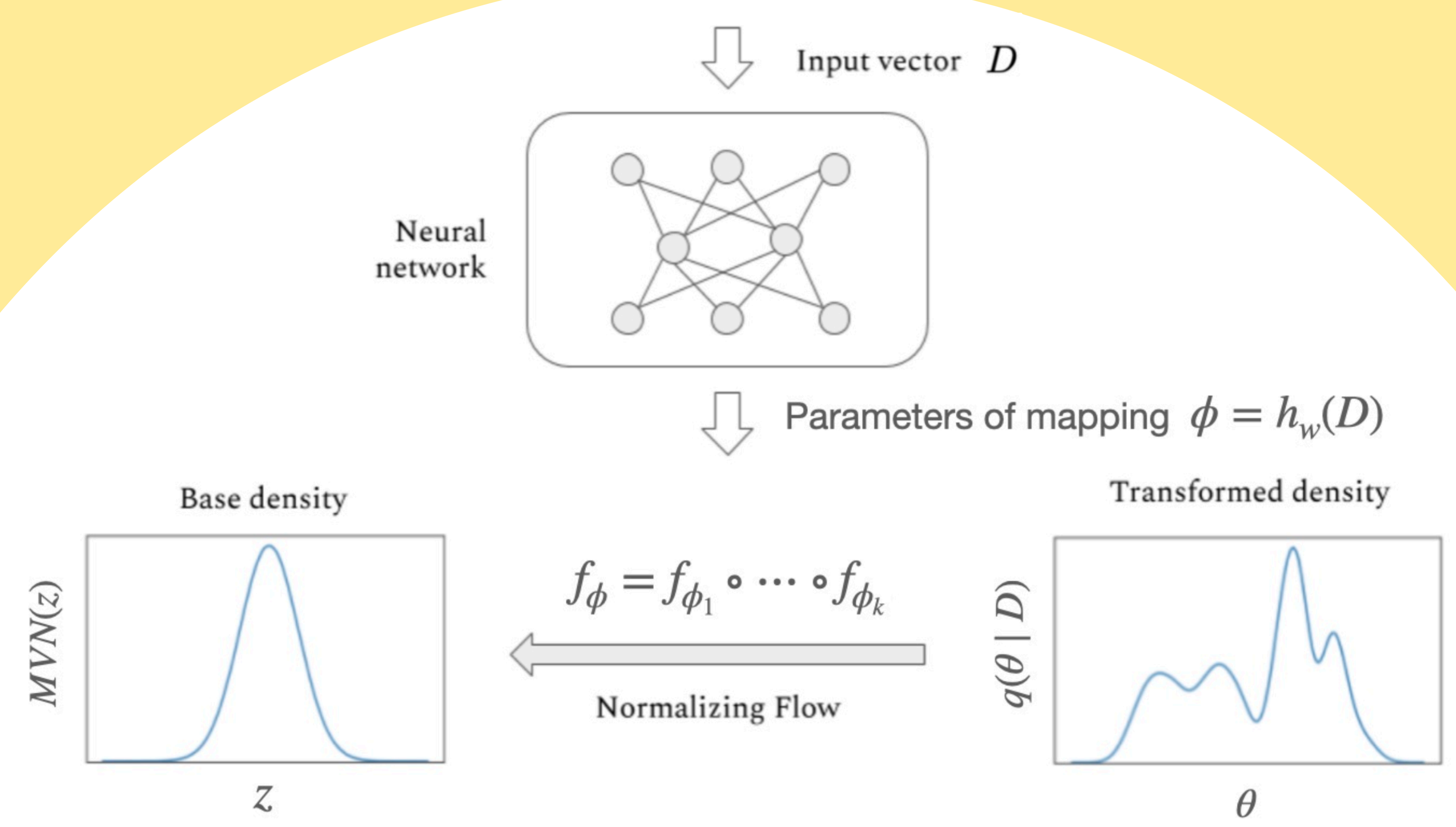
Most changing-state AGN have been identified through spectroscopic surveys, but **changes in optical light curves** may also be used.



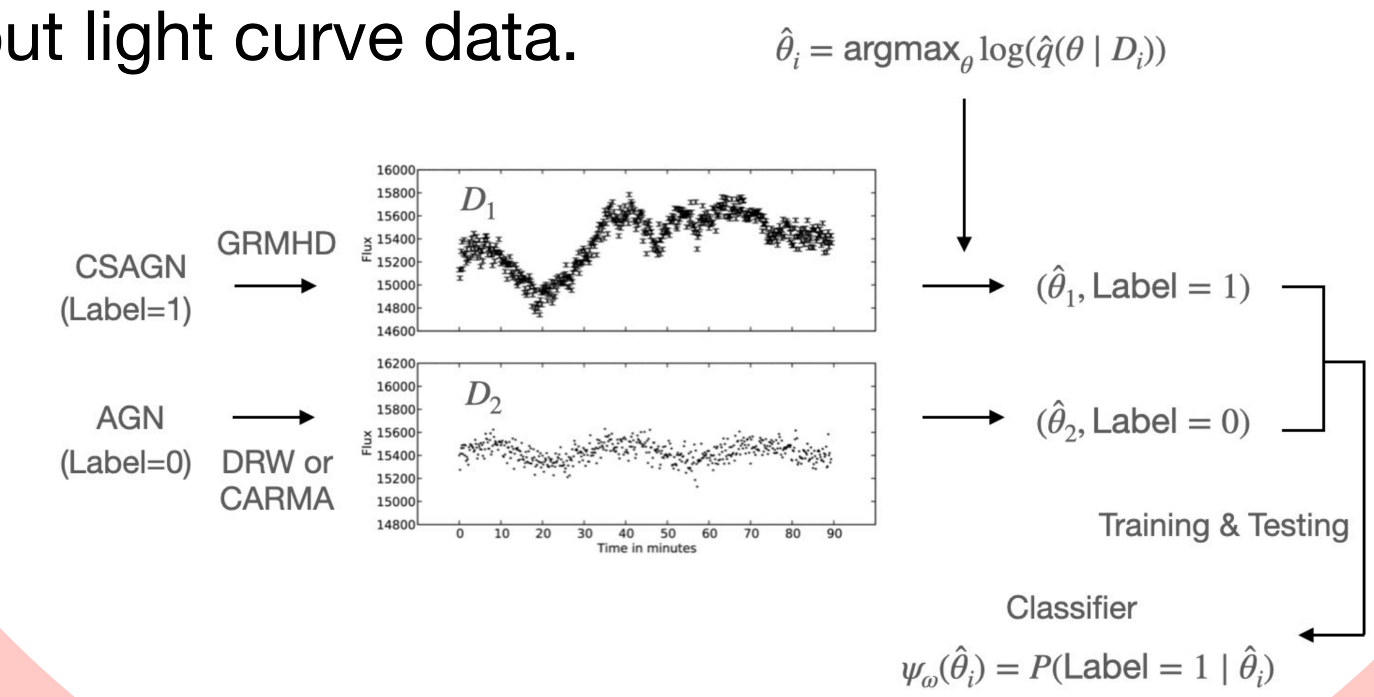
Light curve of of changing-state AGN candidate [1].

Past studies have used different **statistical tests of variability** [2,3] and **neural networks** [1] **to select changing-state AGN** based on their light curves.

Task 1: **Train a neural network** using simulation-based inference (SBI) [5, 6] to learn relationship between light curves and **underlying model parameters**.



Once trained, the SBI framework will estimate a posterior distribution of parameters that best explains input light curve data.

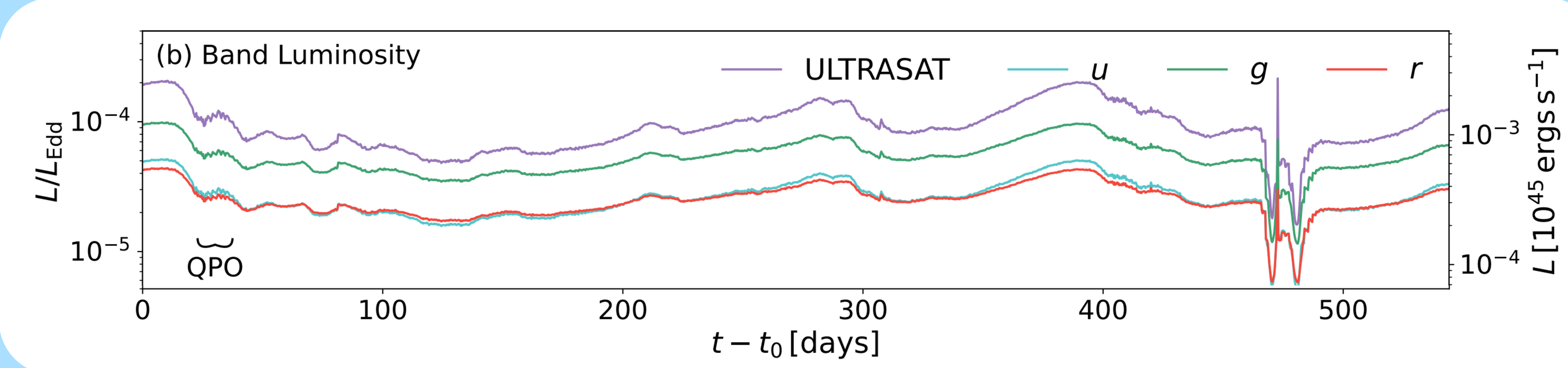


Task 2: **Build a classifier** to differentiate between a changing-state AGN and a normal AGN **based on the model parameters estimated** from the light curve by the SBI framework.

We aim not just to identify but to **attribute variability to a physical model** of a changing-state event.

General relativistic magnetohydrodynamic (GRMHD) simulations **connect different physical scenarios, like disk tearing, to observable signatures**.

We can construct **fake light curves, informed by GRMHD simulations**, and use them to train a framework for **inferring physical properties**. For disk tearing, this includes black hole mass and spin, inclination angle, and the disk's temperature distribution.



Simulated light curves from GRMHD simulations of disk tearing [4].

This pipeline will allow us to **test the validity of different physical models** and **better understand changing-look events**.

We plan to expand this work into a **real-time detection system for changing-state AGN in LSST data**, which will allow for rapid multi-wavelength and/or spectroscopic follow-up of the events.

References:

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