

A PHYSICS-INSPIRED FRAMEWORK FOR AGN CLASSIFICATION IN TIME-DOMAIN SURVEYS

S. J. Shamsi^{1,2}

¹*Faculty of Mathematics - University of Belgrade, Department of Astronomy,
Studentski trg 16, 11000 Belgrade, Serbia*

²*Department of Physics, University of Rome Tor Vergata,
Via Cracovia, 50, 00133 Rome, Italy*

E-mail: shoaibjamal.shamsi@students.uniroma2.eu

The classification of active galactic nuclei (AGNs) in large-scale optical time-domain surveys is challenged by irregular sampling and diverse variability behavior. Traditional methods often focus on direct time-series statistics and/or spectral features, overlooking the dynamical structure of lightcurves. We propose a novel deep learning pipeline that employs physically inspired representations of variability: the first derivative, characterizing the rate of flux variation, and the second derivative, describing the temporal acceleration of variability.

Using high-quality light curves from a highly imbalanced dataset of $\sim 40,000$ AGNs from the Zwicky Transient Facility (ZTF) Data Release 6 (DR6), we construct 2D maps of these variability derivatives—encoding both smooth modulations and rapid transitions in observed magnitudes. These dynamic feature maps are used as input to a ResNet-based convolutional neural network (CNN) trained to classify AGN sources as core-dominated Type-1 AGNs ($Q \sim 20,000$), Type-1 AGNs with X-ray emission ($QX \sim 4,000$), and Type-1 AGNs with radio emission ($QR \sim 2,000$). The pilot results from this master’s thesis show that this dual-derivative approach improves classification accuracy of AGN subclasses, providing a scalable, physically motivated basis for light curve classification in current (ZTF) and upcoming Vera C. Rubin Observatory Legacy Survey of Space and Time.

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