Using machine learning to find gravitationally-lensed quasars and supernovae

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**Description:** The Large Synoptic Survey Telescope (LSST) will play a main role in revolutionising strong gravitational lensing in the 2020s. LSST will be able to detect many tens of thousands of new strong gravitational lens events (e.g. Collett 2015), thanks to its expected image quality (0.6'' FWHM including telescope, atmosphere and wind). These lenses will be complementary to those detected by Euclid and other surveys, with LSST probing a much fainter source population and benefitting both from multicolour data and a cadence well-suited to lensed quasar and SNe discovery. These gravitational lenses will enable a diverse range of important legacy science goals, e.g.

- Cosmography / $H_0$, through Shapiro time delay of lensed QSOs and SNe, through the discovery of high-redshift SNe, and through galaxy-galaxy lens population statistics such as rare "jackpot" double lens systems
- Dark matter halo profiles, through lens population statistics (the lensing optical depth is strongly dependent on halo density profiles), through the combining of strong and weak lensing constraints, and through the detection of rare central images in the cores of groups and clusters (e.g. Collett et al. 2017)
- Determination of the dust extinction in foreground galaxies, through comparison of lensed QSO and SNe multiple images
- Statistically resolving the structure in AGN accretion discs, through the millilensing variability of lensed quasars as a function of colour
- Detection of ultra-faint rare background populations, including ultra-high-redshift galaxies

We currently have a PhD student designing 'deep learning' convolutional neural networks for the discovery of strong gravitational lenses in the forthcoming Euclid mission, and a Gaussian Mixture Model for colour-based component separation. The aim of this project will be to extend and deepen this work into LSST and the time-domain, to create machine learning software for the discovery and analysis of strongly gravitationally lensed quasars and supernovae.

**References:**


**Qualifications required:** First class honours in a first degree or a Merit at MSc preferred, or 2:1 combined with relevant skills sets