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Using cGANs for Anomaly Detection: Hunting for Gravitational Lensing Systems in Euclid

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We present a proof of concept for an alternative method of strong gravitational lens finding using a conditional Generative Adversarial Network (*cGAN*). We use Early Release Observation (*ERO*) images of the Perseus Cluster from Euclid, covering 0. 57sq.degrees on the sky, and the network is based on the *pix2pix* architecture with an adapted *U-Net* generator. We train our model to predict Euclid's *NISP-H* band flux ($1.54-2.00m$) from a combination of the filters *NISP-J*, *NISP-Y* and *VIS* band ($0.55 - 1.54m$) in 40,000 cut-outs from the Perseus Cluster which are 20×20 arcseconds in size. We test the *cGAN* on 5,000 cut-outs from the Perseus cluster, 10% of which contain a simulated strong gravitational lens painted into the cut-out based on SIE/Singular Isothermal Ellipsoid and PEMD/Power Law Ellipse Mass Density mass profiles. Candidate gravitational lenses and cut-outs with a gravitational lens painted in were deliberated excluded from the model's training data set such that gravitational lensing systems remain unknown to the network. We find that the *cGAN* can accurately predict the *NISP-H* band flux of the cut-outs from the Perseus cluster. However, the model fails to predict the *NISP-H* band flux of the cut-outs containing the simulated gravitational lenses, with a larger difference between the prediction of the model and ground truth for lenses with extended arcs and Einstein rings, suggesting that the *cGAN* can be used as an anomaly detector for an alternative method of lens finding.

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Session Classification: Cosmic Insights from Big Data: How Machine Learning is Decoding the Universe

Track Classification: Artificial Intelligence Methods (AI): Machine learning in astronomy: AGN, transient events, cosmology and others