Automating the detection of strong gravitational lenses in large-scale surveys using deep learning

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Propositions

accompanying the dissertation

Automating the Detection of Strong Gravitational Lenses in Large-Scale Surveys Using Deep Learning

by

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1. The rapid growth in astronomical survey data, particularly from missions like Euclid surveying up to 2 billion galaxies, necessitates automated methods that complement traditional human inspection for identifying rare objects (this Thesis).
2. DenseNet can achieve comparable performance to ResNet architectures in gravitational lens detection while requiring fewer parameters and achieves lower training error in comparably less training steps.(Chapter 2).
3. The Information Content metric provides a more reliable method for ranking lens candidates than classification probability alone (Chapter 2).
4. Segmentation algorithms, when combined with classification scores, can significantly reduce false positives while maintaining high detection efficiency for strong gravitational lenses (Chapter 3).
5. Denoising Diffusion Generative Adversarial Networks can generate realistic mock-images, providing an additional tool for expanding training datasets (Chapter 4).
6. Based on the discovery rate of strong lenses in Euclid ERO data, at least 5,500 strong lenses could be readily discovered in the complete Euclid survey without human intervention (Chapter 5).
7. The automation of astronomical discovery processes must balance efficiency with reliability, as false positives remain a significant challenge even in state-of-the-art automatic classification systems.
8. The future of large-scale astronomical surveys depends on our ability to develop robust automated classification systems that can process data faster and more reliably than human inspection allows.
9. Machine learning in astronomy represents a paradigm shift from traditional visual inspection to accelerate discovery of strong lenses.
10. Technical excellence combined with clear communication drives successful scientific collaboration.