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Selection functions of strong lens finding neural networks

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Convolutional neural networks (CNNs) are now the standard tool for finding strong gravitational lenses in imaging surveys. Upcoming surveys like Euclid will rely completely on CNNs for strong lens finding but the selection function of these CNNs has not yet been studied. This is representative of the large gap in the literature in the field of machine learning applied to astronomy. Biases in CNN lens finders have the potential to influence the next generation of strong lens science unless properly accounted for. In our work we have quantified, for the first time, this selection function. We also explore the implications of these biases for various strong lens science goals.

We find that CNNs with similar architecture and training data as is commonly found in the lens finding literature are biased classifiers. We use three training datasets, representative of those used to train galaxy-galaxy and galaxy-quasar lens finding neural networks. The networks preferentially select systems with larger Einstein radii, as in this case the source and lens light is most easily disentangled. Similarly, the CNNs prefer large sources with more concentrated source-light distributions, as they are more distinct from the extended lens light.

The model trained to find lensed quasars shows a stronger preference for higher lens ellipticities than those trained to find lensed galaxies. The selection function is independent of the slope of the power-law of the mass profiles, hence measurements of this quantity will be unaffected. We find that the lens finder selection function reinforces the lensing cross-section. In general, we expect our findings to be a universal result for all galaxy-galaxy and galaxy-quasar lens finding neural networks.

Based on work in Herle A., O'Riordan C. M., Vegetti, S., arXiv:2307.10355, submitted to MNRAS. arXiv submission

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