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Automated detection of gravitational lensing events using neural networks.

Content

Gravitational lenses are rare not only because of their intrinsic rarity, but also because they are difficult to locate in the extensive astronomical catalogs. Recently, a number of techniques have been devised to search for gravitational lenses in a systematic way, among which supervised machine learning approaches stand out. In this work we generate a convolutional neural network model for the automated detection of gravitational lensing events.

5500 artificial images of galaxies were generated with the open-source software GalSim, of which 2000 have no gravitational lensing effect and the remaining 3500 do. They are divided into 4400 images for training and 1100 for evaluation. The model was designed and trained using the machine learning libraries TensorFlow and Keras. Due to the nature of the problem, the use of TPUs was necessary to accelerate the training process, for which the Kaggle platform was used.

It was possible to train a convolutional neural network for the detection of gravitational lensing events with an accuracy of 74%. It is possible to improve the accuracy of the network, as this is a first approach to the problem, but it demonstrates the potential for the application of neural networks in gravitational lensing, specifically convolutional neural networks.

In addition, the network demonstrated higher detection accuracy for strong gravitational lensing than for weak gravitational lensing events, demonstrating that the reason the network does not achieve higher accuracy is because it encounters more difficulties in the spectrum of images that do not exhibit such drastic lensing effects. Consequently, the network can obtain better accuracy by focusing only on strong gravitational lensing events.

On the contrary, if a study focused on weak gravitational lensing events is desired, further development of a different neural network model is required to achieve greater accuracy because, although the margin of error in this category is greater, the level of accuracy achieved is indicative that convolutional neural networks can be a useful tool for the study of weak gravitational lensing as well.

In summary, this study highlights the great potential of convolutional neural networks for the automated detection of gravitational lensing events, in particular for those with strong lensing. The accuracy achieved in these cases suggests that this approach can be a valuable tool for identifying these phenomena in large astronomical catalogs, which would speed up and optimize their search. Although weak lensing events present greater challenges, the results obtained indicate that further refinement of the models could extend the applicability of these networks to a broader spectrum of events, opening the door to future developments in this field.

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