Lens Finding using Neural Networks

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Gravitational strong lensing









We have :

~ hundreds of lenses **confirmed**

~ thousand of lenses candidates

We want to find more Gravitational Lens Systems

but why??



Gravitational lenses are very useful ...

... to see far far away galaxies

Distant Galaxy Lensed by Cluster MACS J0647 Hubble Space Telescope = ACS = WFC3

... help to solve HO tension

... to study dark matter and ...

... structures in galaxies ...





Among others...

Looking for lenses in ground base surveys



Dark Energy Survey (DES):
Blanco Telescope, La Serena, Chile
DeCam.
g, r, i, z, Y bands.
0.265"/pixel

Credit: http://www.cfht.hawaii.edu/Science/CFIS/cfissurvey.html

DES LRG color-magnitude selection

DES DR1: 1.8 < (g - i) < 5.0 18 < r < 23 0.6 < (g - r) < 3 20 < g 18 < i

Similar to Jacobs+2019



This sample contains a total of 18'745'029 galaxies

Artificial Neural Networks



Convolutional Neural Networks



Building our training set using simulations







Lenstronomy Birrer & Amara (2018)



CNN Characteristics & evaluation

- ★ Training/validation set:○ 100'000 simulations
 - $\circ~$ 100'000 non lenses

	Training	Validation	Test
Accuracy	1.0	0.998	0.896
Loss	0.009	0.016	0.437

CNN results

98.6% of the sample



CNN results

133'322 objects above 0.5



CNN results

133'322 objects above 0.5



Visual inspection tools





https://github.com/esavary/Visualisation-tool

~ 80 Lens candidates



Rojas et al. In prep

~ 300 Maybe Lenses

Rings, mergers & spirals

Rojas et al. In prep







Getting ready for the future ...



Euclid Telescope



Vera C. Rubin Observatory

more than 100'000 lenses are discoverable

Conclusions

- → We simulated gravitational lens system using Lenstronomy.
- → We trained a CNN for finding lenses
- \rightarrow We successfully found ~80 sure lenses and ~300 maybe lenses.

To do :

- \star Model the candidates (In progress).
- \star Follow up campaigns to confirm candidates.
- \star Use the false positives to investigate a way to obtain more pure candidates samples.
- \star Use the ring galaxies catalog to do science!

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