Strong Lens Finding Simulations to train Neural Networks

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Strong lensing systems







Strong lensing systems







- ~ hundreds of lenses confirmed
- ~ thousand of lenses candidates

We need much more to train the Neural Network

Lens simulation in the literature

Fully Simulated



Simulated source + Real lens galaxy



Jacobs+2017





Real source galaxy

Lensed source





Real lens galaxy



Simulated Lens





Real source galaxy

Lensed source





Simulated Lens

Looking for lenses in CFIS & DES

- Canada-France Imaging Survey (CFIS):
 - The Canada-France-Hawaii Telescope (CFHT), Hawaii, USA.
 - MegaCam.
 - ~5000 square degrees.
 - **r-band** & u-band.
 - pixel size of 0.187"/pixel
- Dark Energy Survey (DES):
 - The Blanco Telescope, La Serena, Chile.
 - DeCam.
 - ~5000 square degrees.
 - **g, r, i,** z, Y bands.
 - pixel size of 0.265"/pixel



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

Looking for lenses in CFIS & DES

24

+90

+60

+30

CFHT latitud (0000) +0

-30

-60

-90

360

Dec

B semester

21^H

18"

- Canada-France Imaging Survey (CFIS):
 - The Canada-France-Hawaii Telescope Ο (CFHT), Hawaii, USA.
 - MegaCam. Ο
 - ~5000 square degrees. Ο
 - r-band & u-band. 0
 - pixel size of 0.187"/pixel Ο
- Dark Energy Survey (DES):
 - The Blanco Telescope, La Serena, Chile. Ο
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 - ~5000 square degrees. Ο
 - **g**, **r**, **i**, z, Y bands. Ο
 - pixel size of 0.265"/pixel 0

We plan to look for lenses in HST F814W. See **Benjamin Clement** talk tomorrow!

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



B semester

3^H

Galactic dust Ecliptic lat.l < 15deg

SDSS CFIS-LUAU 10k deg2

PS1 3P

Euclid Wide Dark Energy Survey

CFIS-WIQD 5k deg2

CEIS_WIOD/SDSS

LSST main survey

+90

+60

+30

CEHT Intitude

64

A semester (LST midnight)

12"

9^H

15^H

CFIS & DES lens selection

CFIS : 100000 LRG with SDSS spectra randomly selected to match redshift and velocity dispersion distributions in Oguri & Marshall 2010



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

Similar to Jacobs+2019







DES DR1 galaxies

Velocity dispersion & Redshifts SDSS catalogue

K-Neighbors Regression







CFIS-r







DES-dr1





Real source galaxy

Lensed source





Real lens galaxy

Real source galaxies

HST+HSC combined images









galaxy

Lensed source







Minimum Einstein radio



select one randomly







Minimum Einstein radio select one randomly









LRG

Singular Isothermal Ellipsoid (SIE) lens model:

 $\Theta_{\rm E}, {\rm q}, \Theta_{\rm q}, {\rm x}_{\rm L}, {\rm y}_{\rm L}$







Real source galaxy

Lensed source





LRG

• The image is rescaled to final image pixel size.



 Then is Convolved with the LRG PSF image.







Real source galaxy

Lensed source







Simulated Lens

Simulations of lens systems for CFIS and DES

r-band simulations for CFIS



Simulation with Glee

gri simulations for DES



Simulation with Lenstronomy

Conclusions & Future Work

We are **successfully** simulating CFIS and DES galaxy-galaxy systems using **real data**.

TO DO LIST:

- 1. Increase the **source sample** at higher redshift and with a depth according to each survey.
- 2. Investigate the **best distribution** of Einstein radio to optimize the search.
- 3. Simulate thousands of lens systems and train the CNN.
- 4. Find a bunch of new lenses!

CNN Architecture



CFIS candidates

DES candidates



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