The Euclid Strong Lensing Pipeline

Benjamin Clément - Hubert Degaudenzi - Frédéric Courbin
Karina Rojas - Elodie Savary
EPFL / Unige

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Galaxy and group/cluster scales

- GGL : Galaxy-Galaxy Lens Re ~ 1” - 3”
- GrGL : Group-Galaxy Lens Re ~ 3” - 10”
- CL : Cluster Lens Re ~ 20” - 50”
The Full Picture
Data

- OU-MER Tiles FOV is 32’ x 32’ or 1024 arcmin$^2$ or 0.2844 deg$^2$
- How many tiles in total?
  
  15000 deg$^2$ ~ 50000 tiles

- 12 bands: VIS, NIR (YJH), EXT DECAM (griz), EXT OMEGACAM (ugri)
- How many objects to inspect?
  
  naive magnitude cut in VIS < 22 : ~1000 objects per tile

- How many lenses per tile to expect?
  
  ~170 000 lenses in the full survey (Collett 2015)
  ~ 1-10 / deg$^2$
  ~ 3 lenses / tile
  ~ 60 lenses / day
Expected properties of the lens sample

from Collett (2015)
GGL branch

MER Tile

Selection
- all
- color cuts, flux, size, ...

MER Final Catalog
- id, ra, dec, mag, ...

Clusters ? Groups ?

Cutouts

MER images
- bkg sub VIS + NIR
- PSF ?

CNN

GGL ?

Pre-launch
Simulated data

Training set

yes

no

GGL candidate catalog
- id, ra, dec, tile, score/p ...

Cutouts

Modeling

PHZ ?

Visual Inspection

GGL candidate Final Catalog
- id, ra, dec, tile, score/p, Re, ...

Cutouts

DB SHE

Calibration
Input
Task
Tmp product
Output

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GGL branch

MER images
- bkg sub VIS + NIR
- PSF ?

MER Tile

Selection
- all
- color cuts, flux, size, …

MER Final Catalog
- id, ra, dec, tile, mag, …

Clusters ? Groups ?

Cutouts

CNN GGL ?

Outputs
- GGL candidate catalog
  - id, ra, dec, tile, score/p …

Pre-launch
Simulated data

Training set

Inputs

PHZ ?

Modeling

Cutouts

Task

Calibration

Inputs

Tmp product

Outputs

reuse ?
1. Catalog filtering

A sample of objects is selected based on various criteria (e.g. magnitude, color cuts, size, etc.)
2. Cutout production

10”x10” for galaxy scale lenses
2’ x 2’ for cluster cores
3. Classification

score or probability of being a lens using a convolutional neural network
3. Classification

score or probability of being a lens using a convolutional neural network
3. Classification

score or probability of being a lens using a convolutional neural network
4. Modelling
basic physical properties:
Einstein radius \( R_e \), mass enclosed in \( R_e \),
number of images, type of lens, ...
5. Visual inspection
lens candidates with probability above a certain threshold are reviewed by human eye and given a grade (e.g. citizen science)
Main data product

Pre-lab
Simulated data

GGL branch

MER Tile

Training set

GGL ?

no

Cutouts

Modeling

Visual Inspection

GGL candidate Final Catalog
- id, ra, dec, tile, score/p

Cutouts

GGL candidate Final Catalog
- id, ra, dec, tile, score/p, Re

DB

SHE

Reuse ?

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Cutouts

MER Final Catalog
- id, ra, dec, mag, …

Clustering? Groups?

MER Tile

Selection
- all
- color cuts, flux, size, …

MER images
- bkg sub VIS + NIR
- PSF?

Cutouts

GGL candidate catalog
- id, ra, dec, tile, score/p …

Cutouts

Modeling

PHZ?

Visual Inspection

GGL candidate Final Catalog
- id, ra, dec, tile, score/p, Re,…

Cutouts

DB SHE

Pre-launch
Simulated data

Training set

CNN
GGL?

yes

no

Calibration
Input
Task
Tmp product
Output

GGL branch

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Training set branch

MER Tile

MER images
- bkg sub VIS + NIR
- PSF ?

Selection
- all
- color cuts, flux, size, …

Cutouts

Classifier

source

lens

others

PHZ ?

Lensing

simulated GGL

non GGL

Training set

DB SHE

Clustering ? Groups ?

Input

Task

Tmp product

Output

Training set branch

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Simulating the lens sample

- GLAMER software
- Field and lens galaxy drawn from flagship mock
- Source from HST UDF
- Realistic PSF and noise properties
- Challenge 1.0 (Metcalf+2018)
  Challenge 2.0 (on-going, see E. Savary’s talk)
- Add strong lenses in SC8 images
- Test the pipeline
Testing the simulation with HST data

- Hubble Source Catalog (V3) and Hubble Legacy Archive
- ~158000 objects selected (F814W < 22 AB)
- 5886 ACS images in F814W (~15-18 deg$^2$)
- Extend the search to other ACS filters, WFPC2, WFC3-UVIS/IR
Summary and future actions

• Lens finding pipeline based on CNN

• Improve simulation of the training set and be prepared to make use of real Euclid data after launch

• Test the procedure on “large scale” high-resolution dataset (e.g. HST)

• Citizen science

• Spectroscopic follow-up (e.g. DESI, 4MOST, WEAVE)

• Be ready for Quick Release 1 and the first ~500 lenses