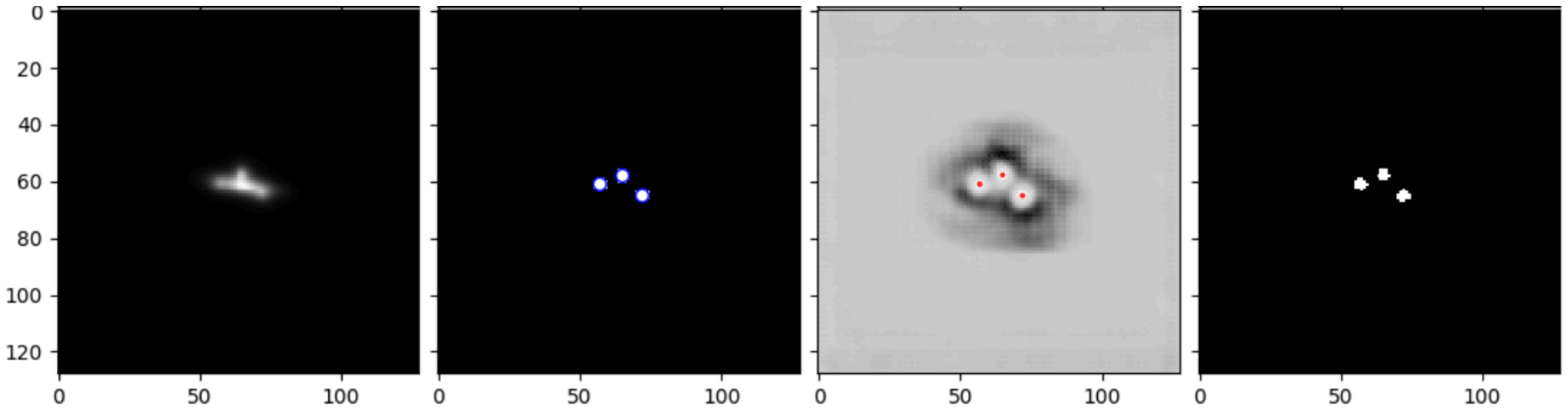
SIMULATED GALAXY

CLUMP MASK

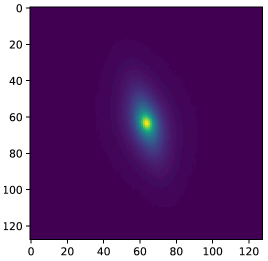
NETWORK PROBA MAP

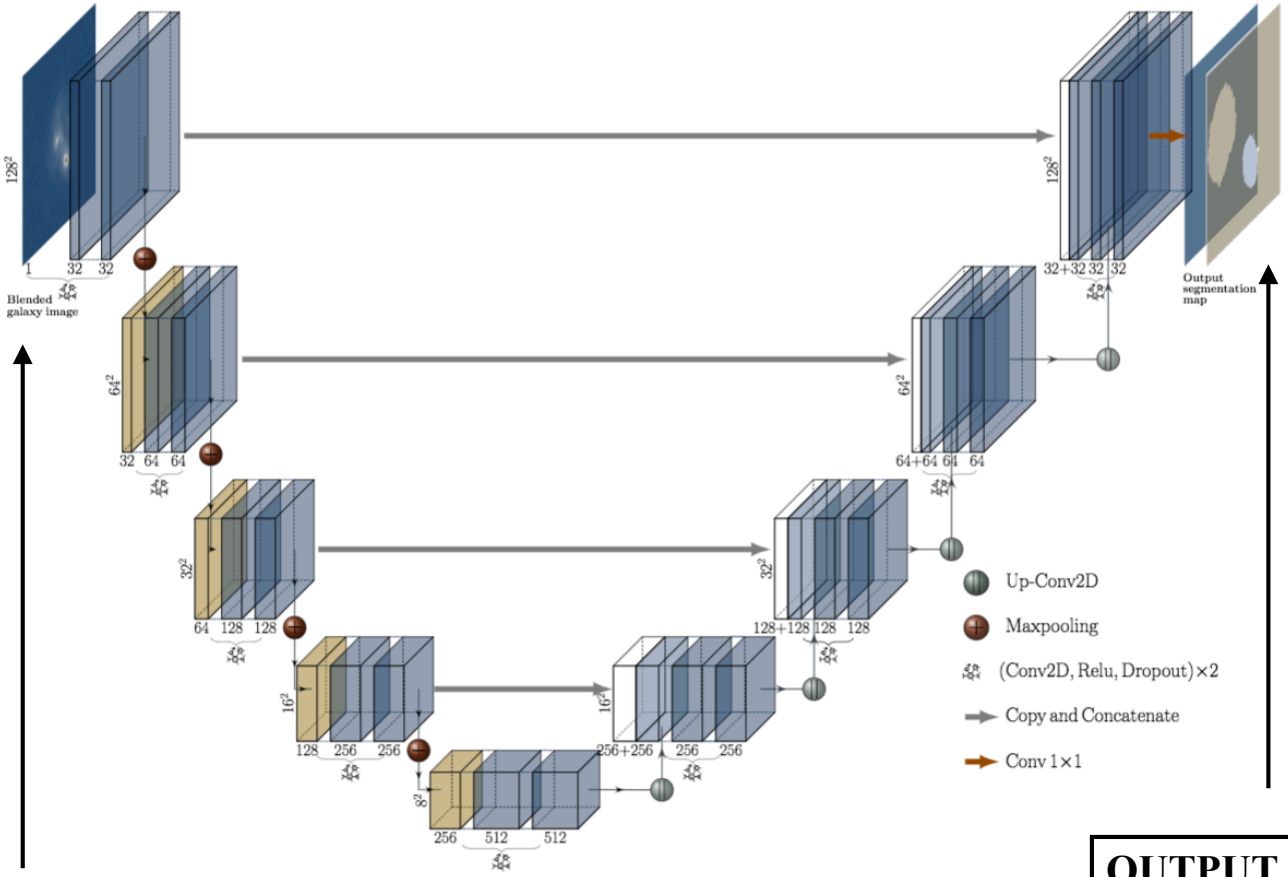
NETWORK OUTPUT THRESHOLDED (SEXTRACTOR)



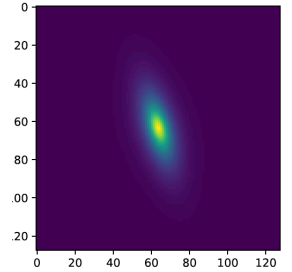
LEE, MHC, PRIMACK+ 19

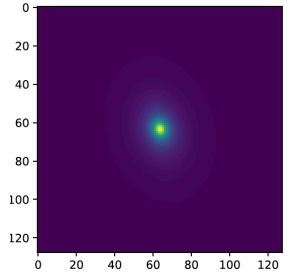
ALSO REGRESSION…





DISK





BULGE

GALAXY STAMP

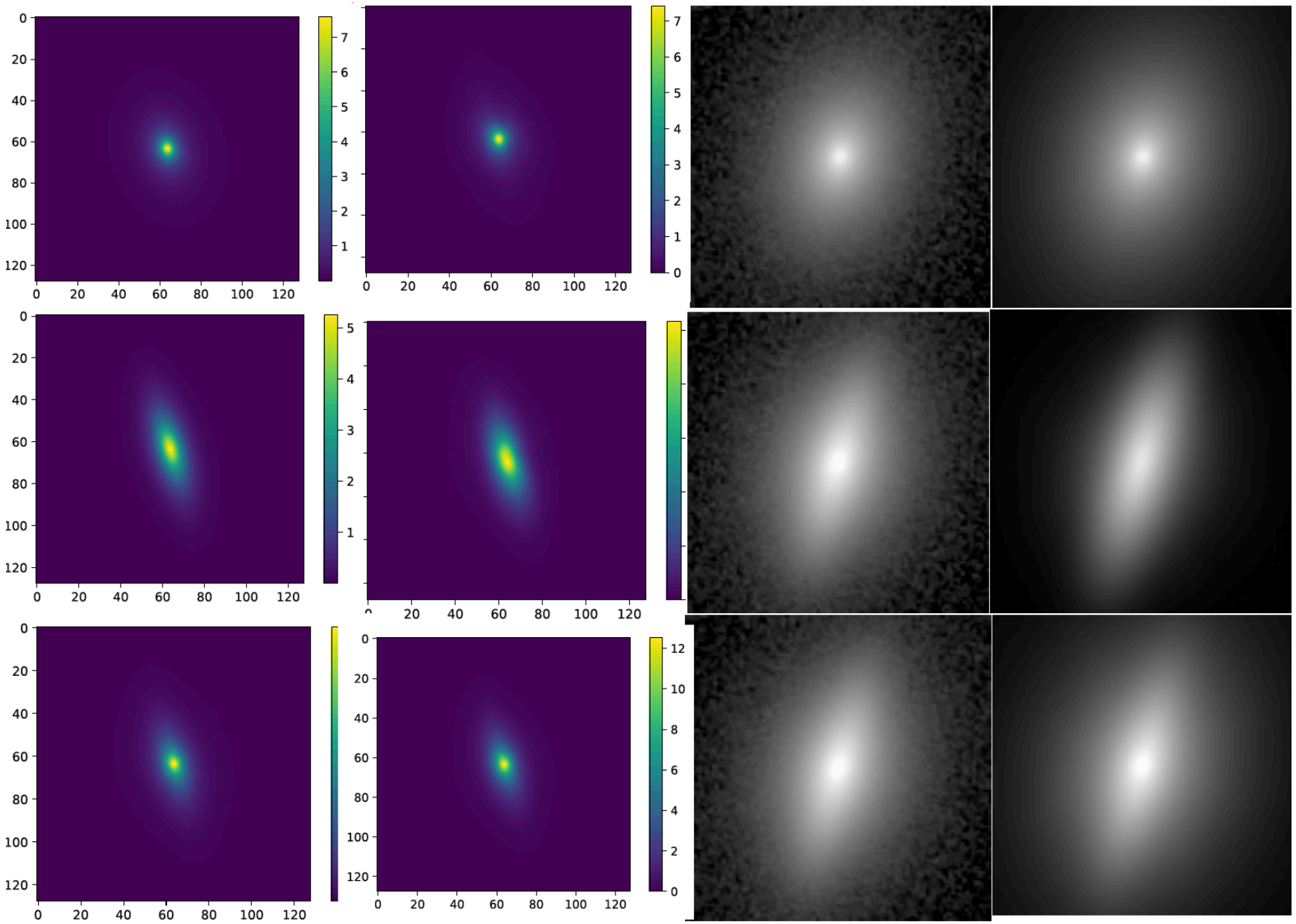
BULGE AND DISK PARAMETERS (SIZE, INCLINATION ETC)

OUTPUT IMAGE OF BULGE AND DISK COMPONENTS

Tuccillo, MHC+18,19

DEEP LEARNING

GALFIT

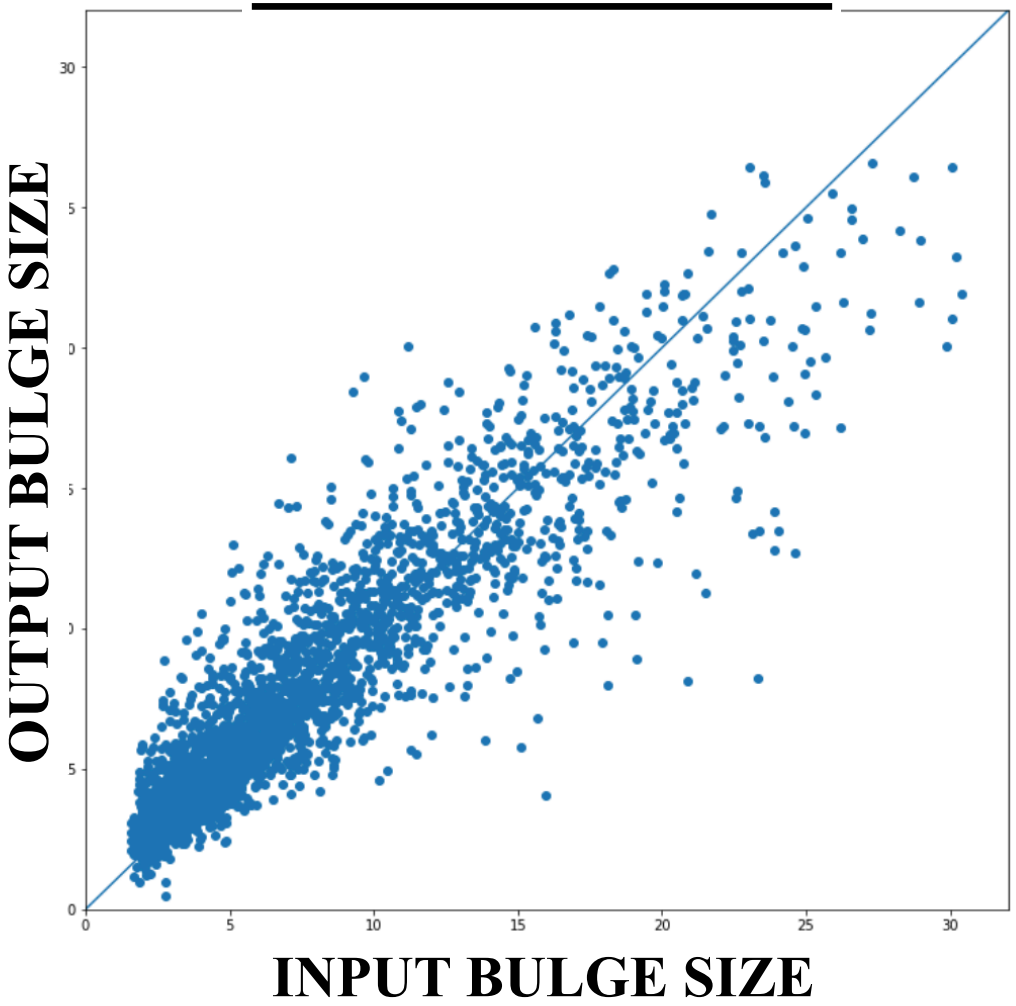


ORIGINAL RECONSTRUCTION ORIGINAL RECONSTRUCTION

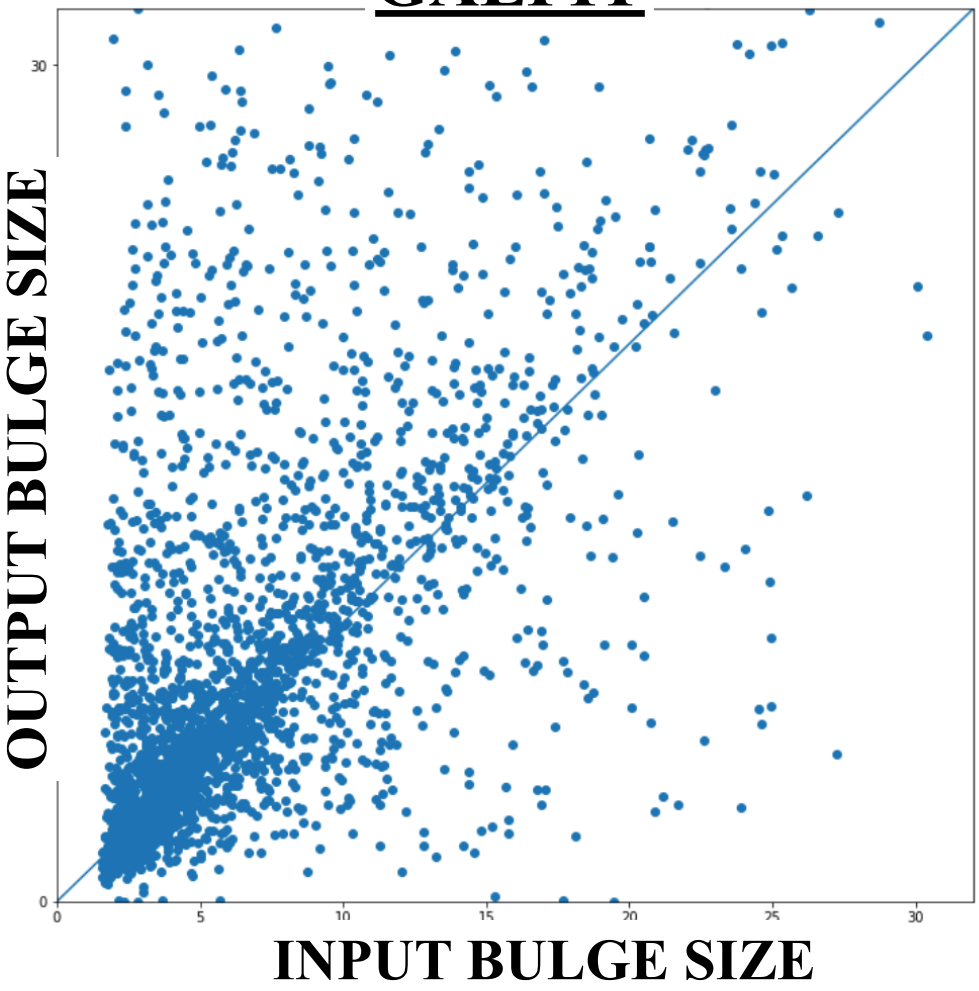
Tuccillo, MHC+18,19

PRELIMINARY!!

DEEP LEARNING



GALFIT

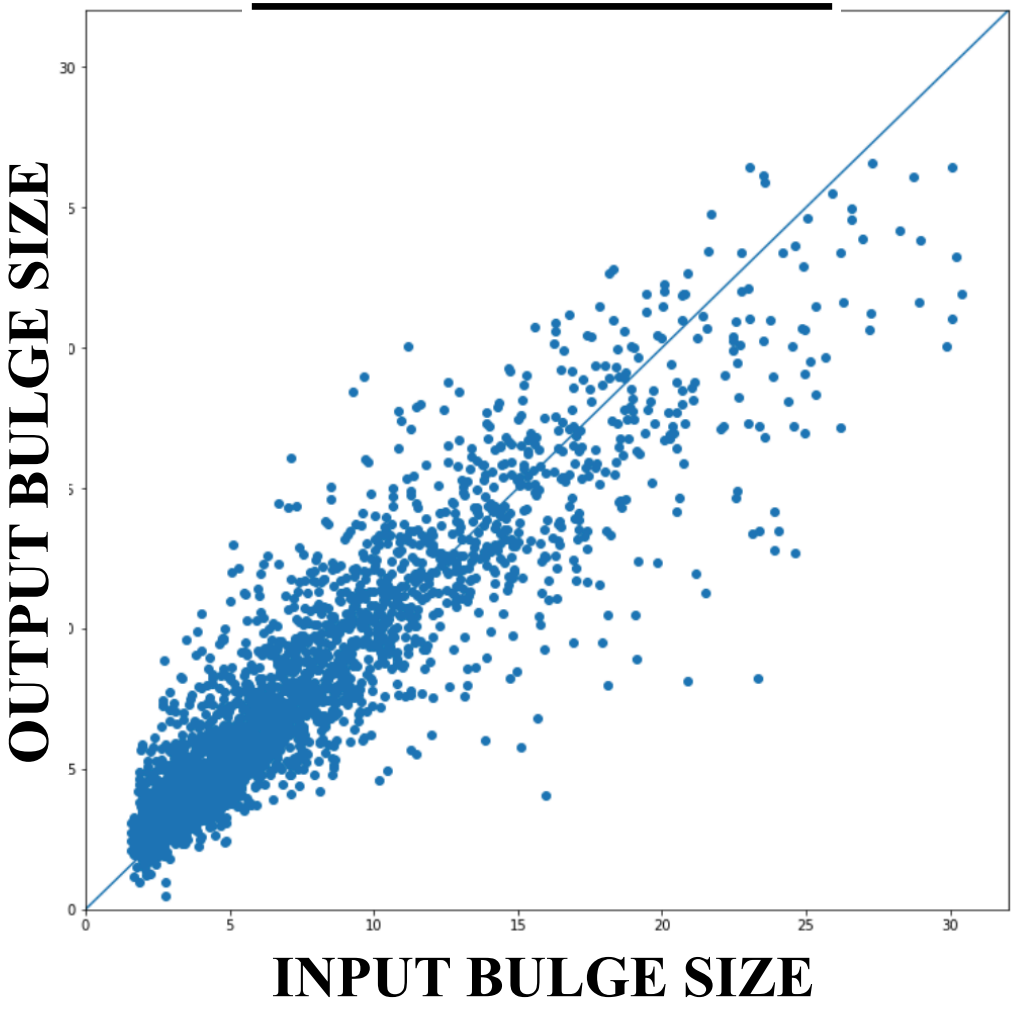


Tuccillo, MHC+18,19

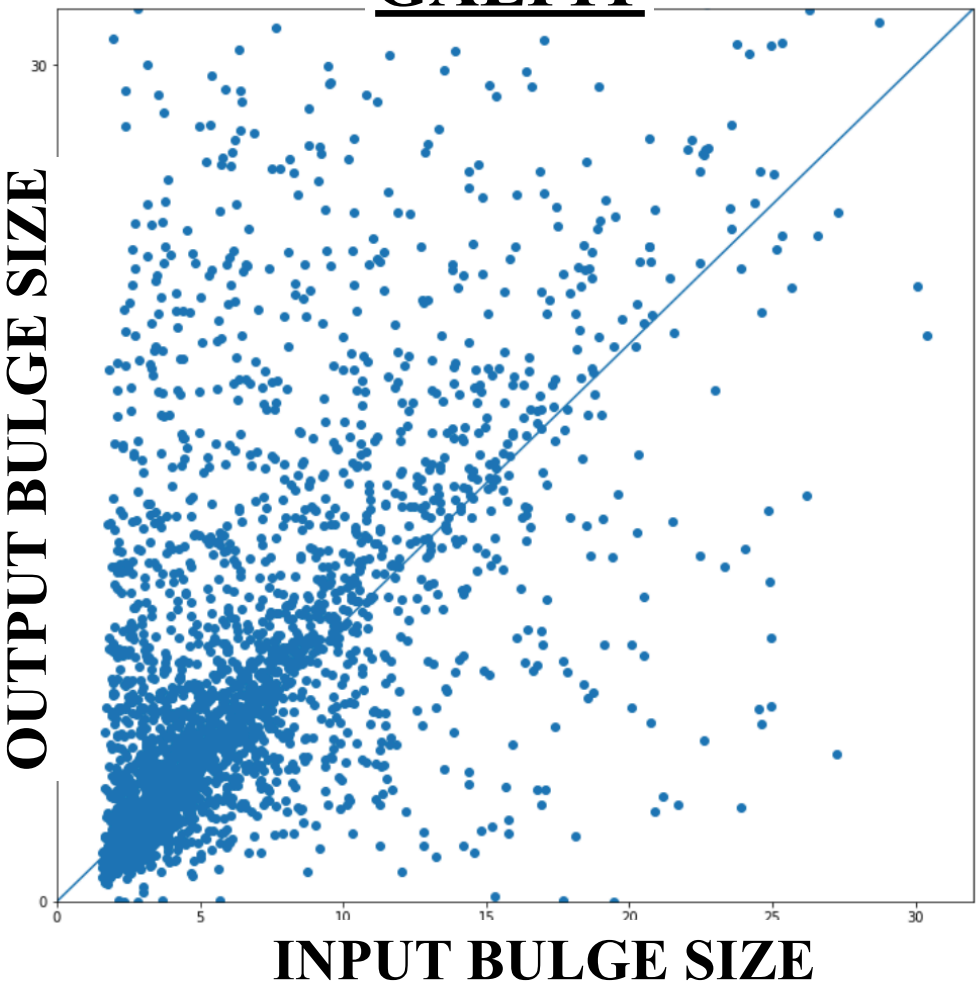
4s [ONCE TRAINED]

4hrs

DEEP LEARNING

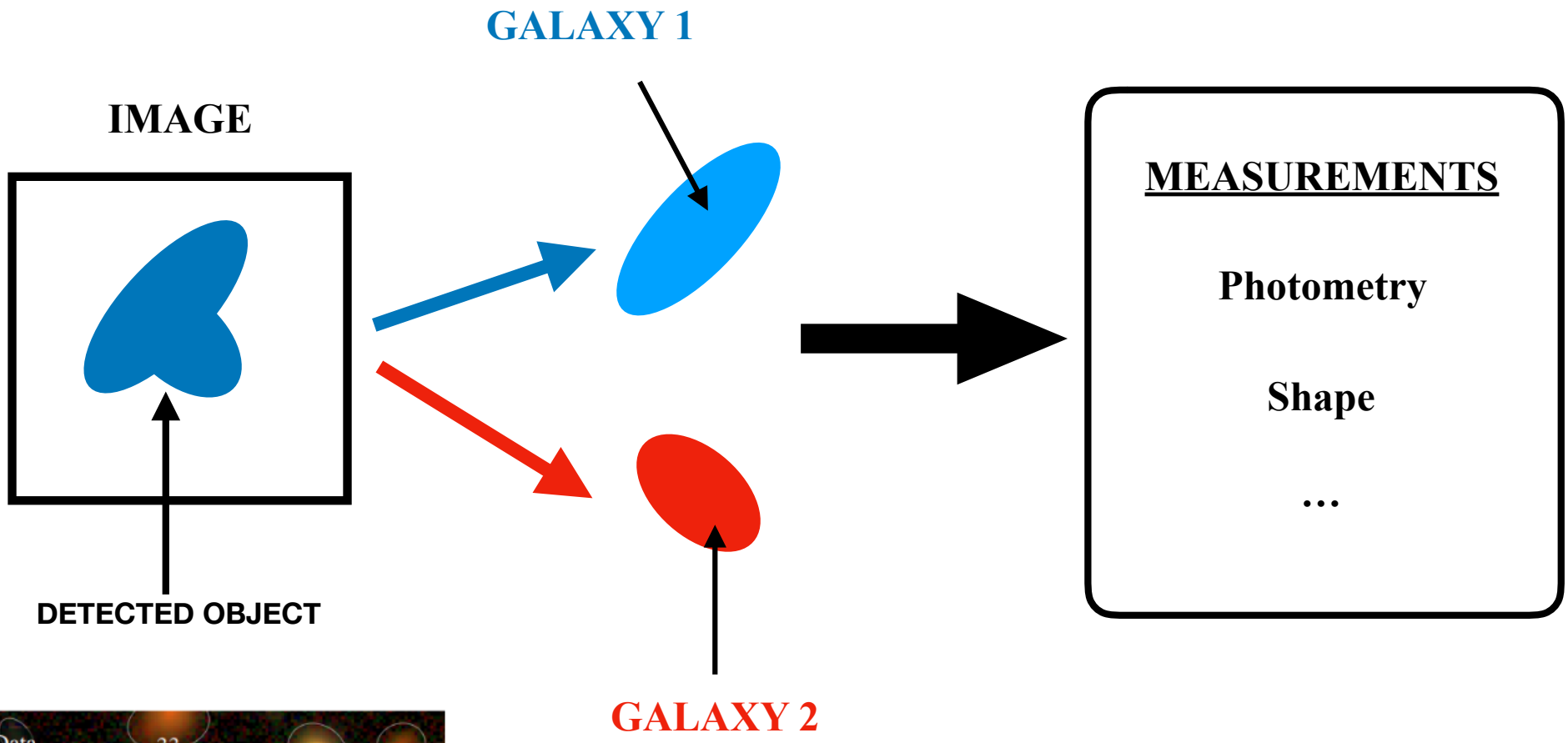


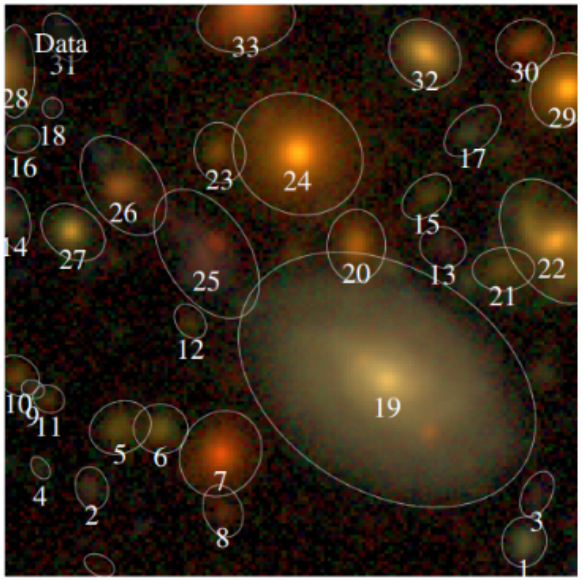
GALFIT



PRELIMINARY!!

Tuccillo, MHC+18,19





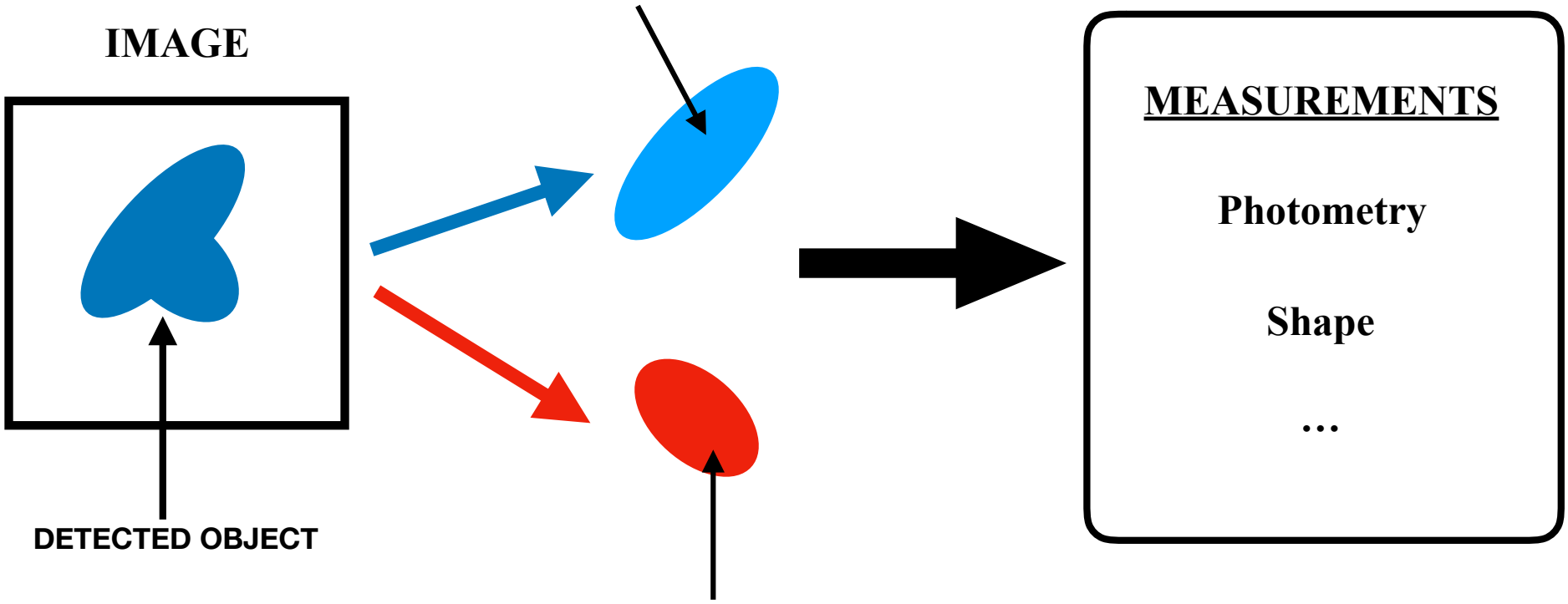
Bosch+17

>50% of objects will be affected by blending in future deep surveys such as LSST

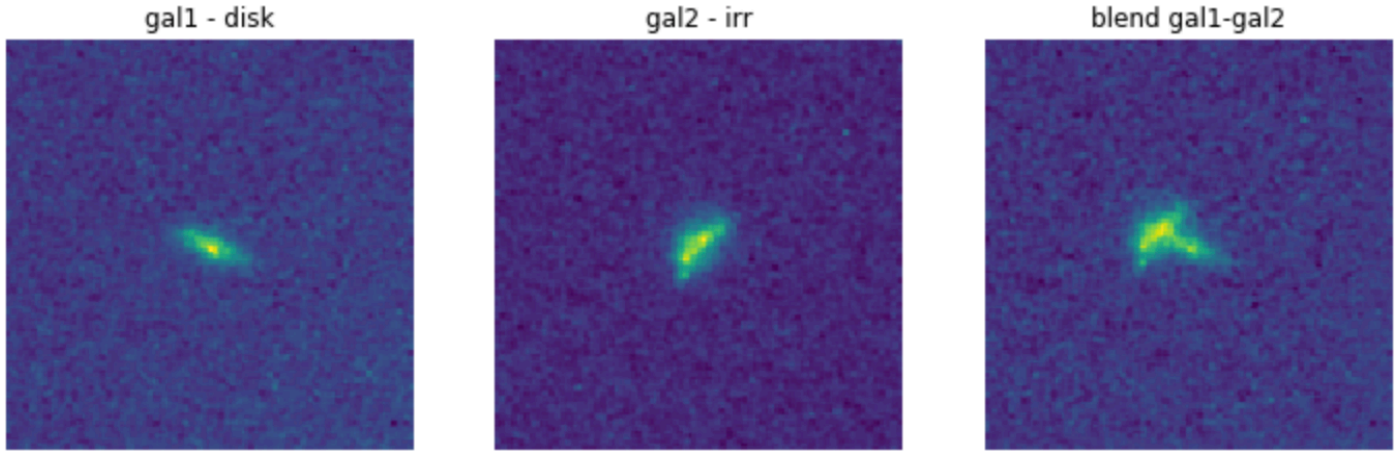
Boucaud+19

GALAXY 1

IMAGE

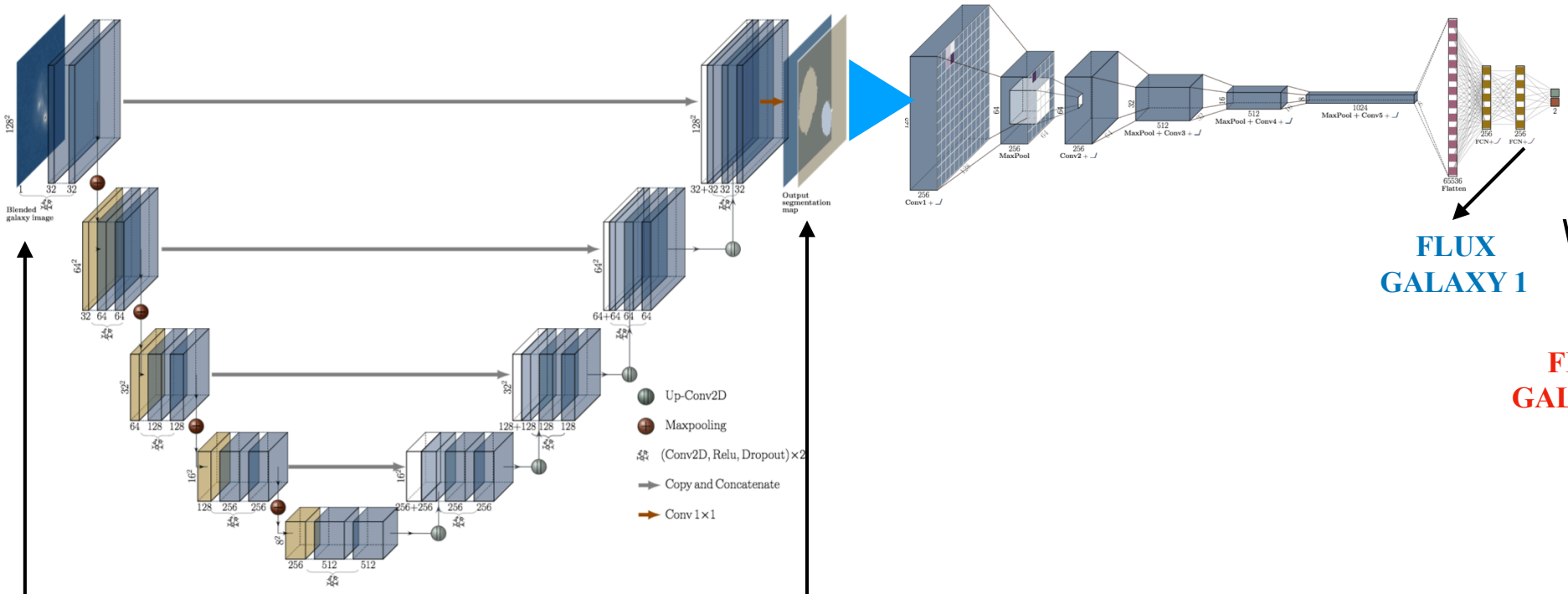


ISOLATED GALAXIES ARTIFICALLY BLENDED



U-NET (ENCODER DECODER)

VANILLA CNN



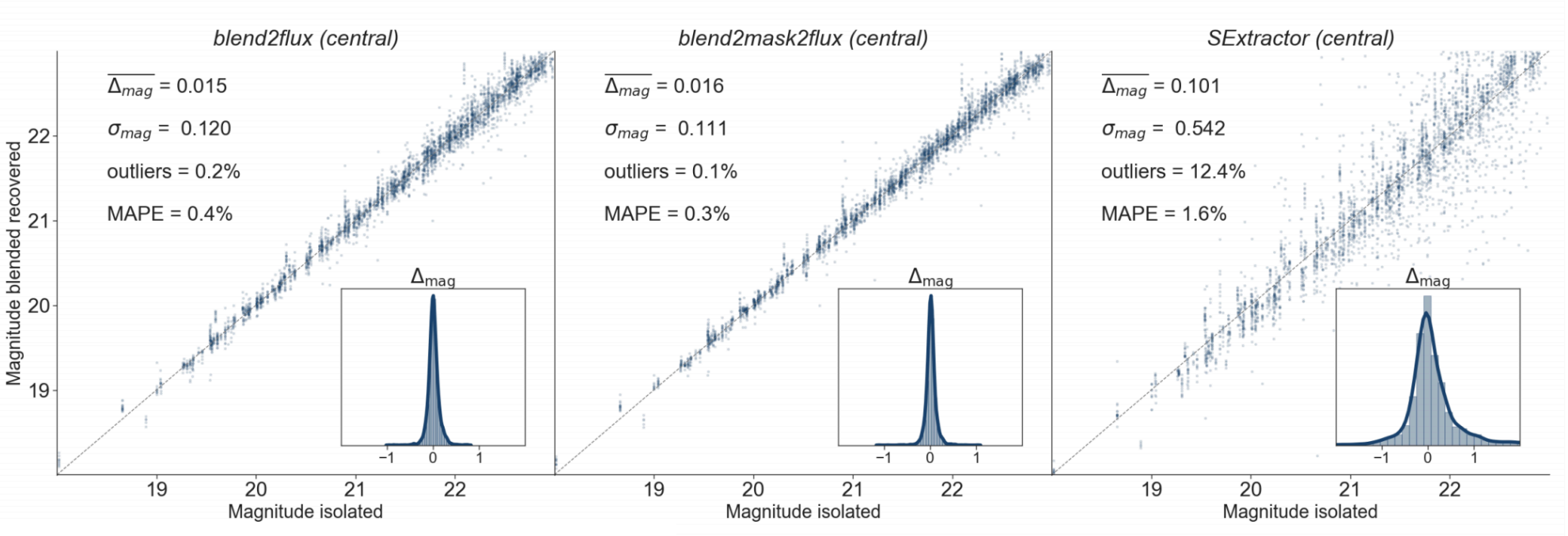
FLUX GALAXY 1

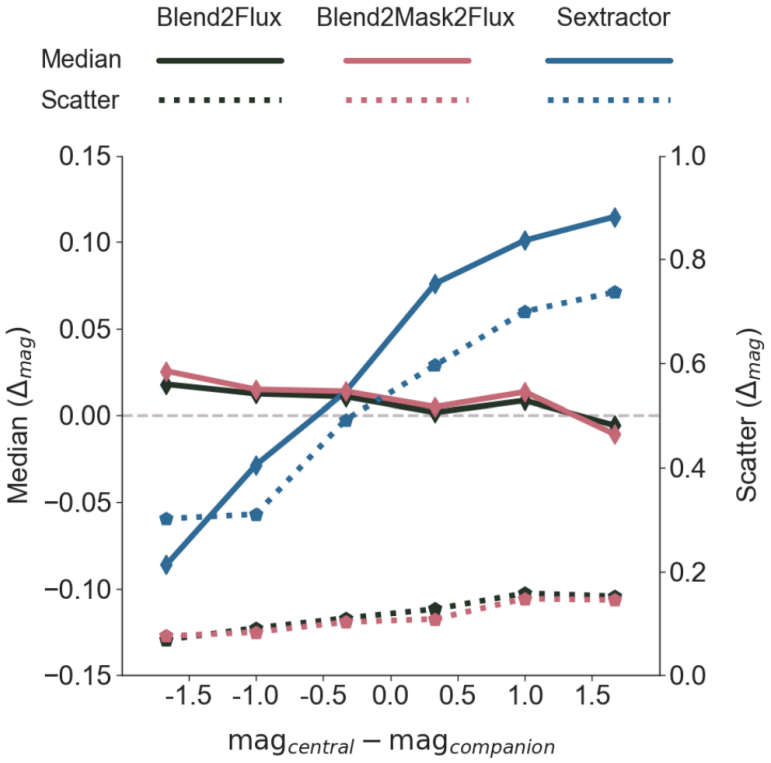
FLUX GALAXY 2

IMAGE OF BLENDED OBJECTS

OUTPUT SEGMENTATION MAP (BINARY 2 CHANNELS)

Boucaud, MHC+19

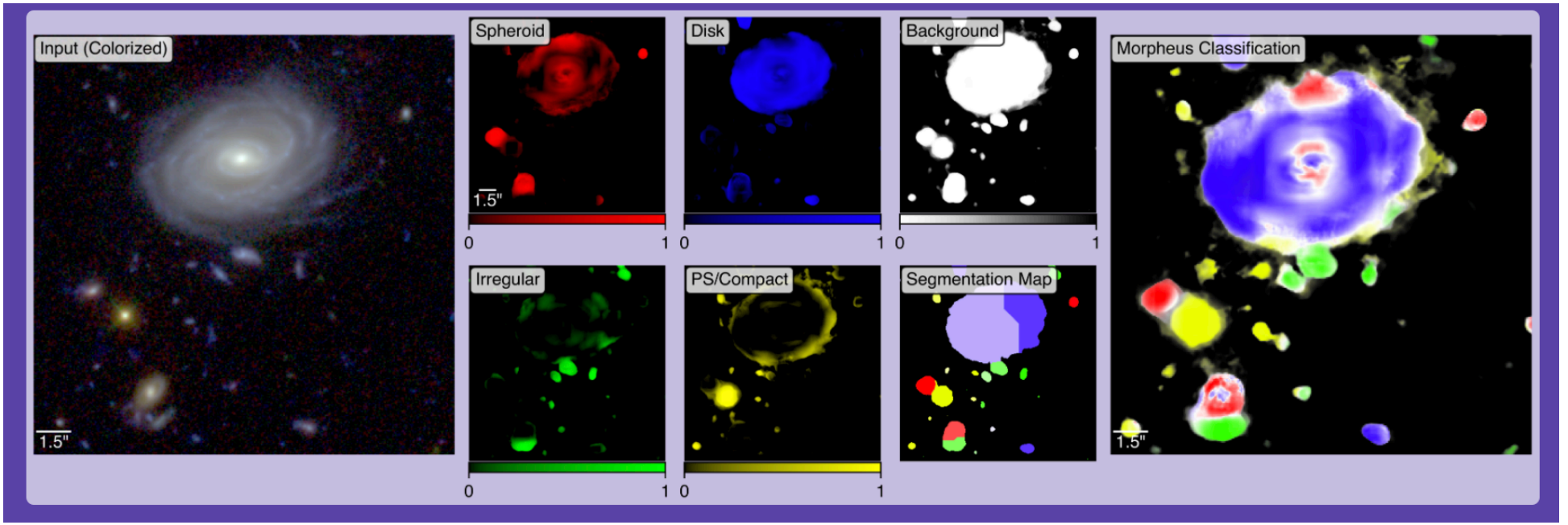




LESSONS LEARNED:

- **It is easy to do better than Sextractor**

- **Masks do not provide additional information**

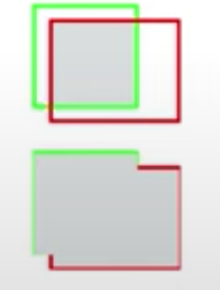


https://www.youtube.com/watch?v=hEL1h_dODkU#action=share

Hausen+20

EVALUATION METRICS FOR IMAGE SEGMENTATION

WE TYPICALLY USE THE INTERSECTION OVER UNION LOSS

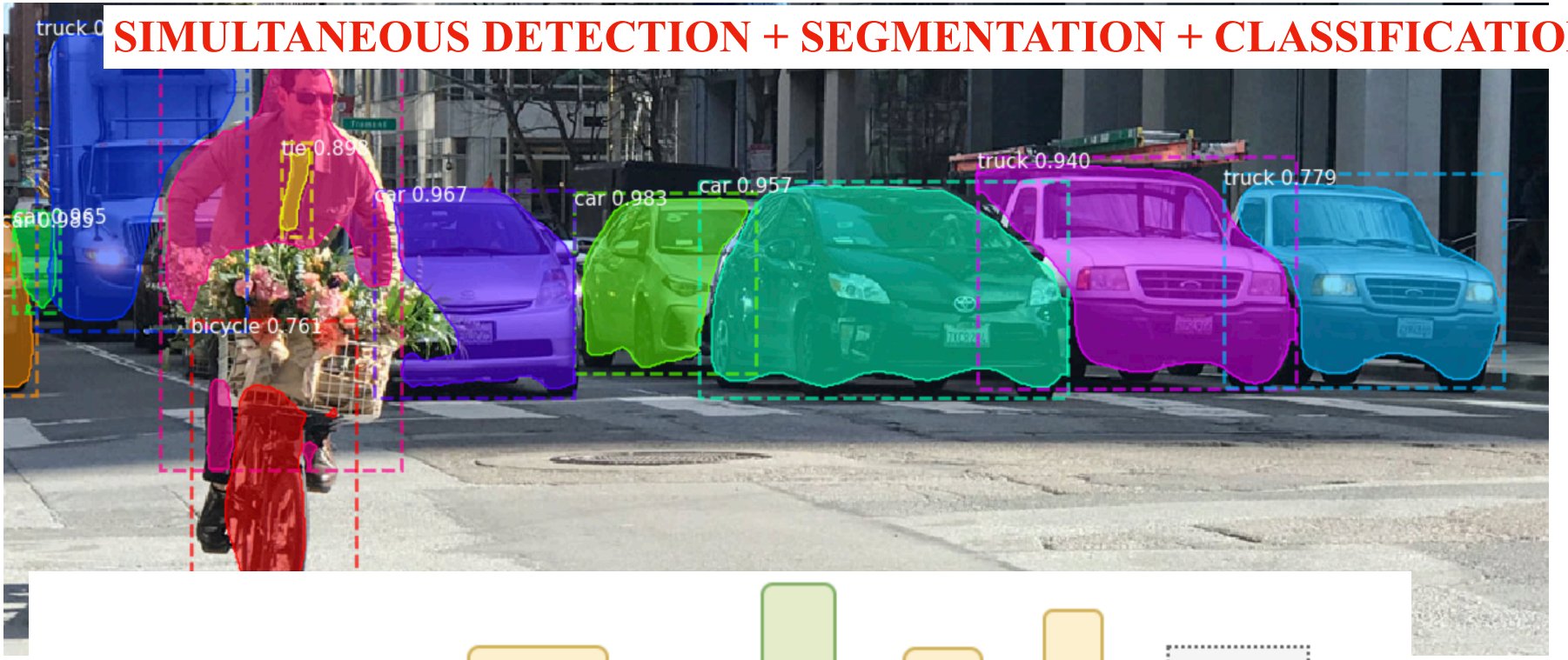


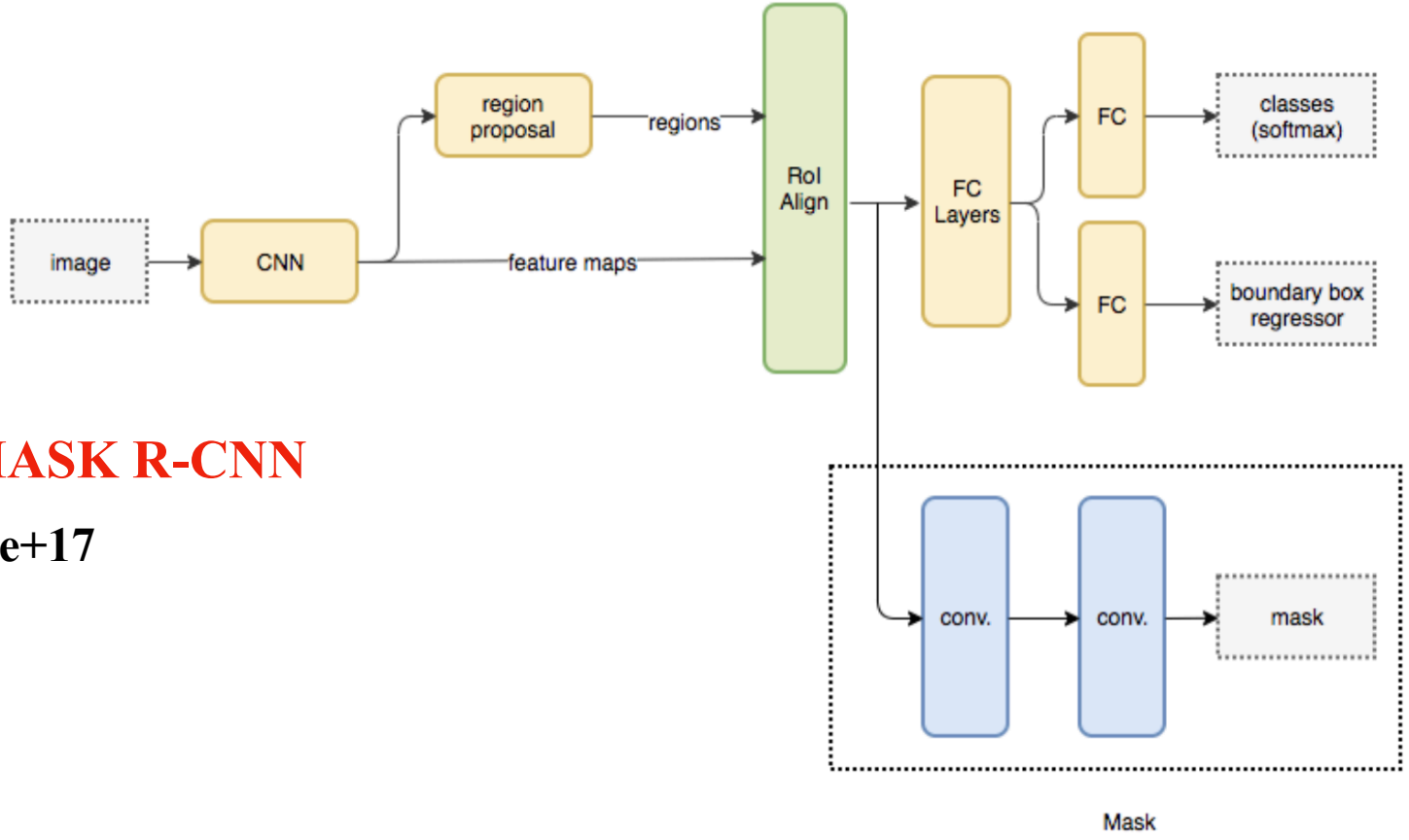
$$\mathcal{J}(\mathbf{P},\mathbf{T}) = \frac{\mathbf{P} \bigcap \mathbf{T}}{\mathbf{P} \bigcup \mathbf{T}}$$

HOWEVER, THIS IS NOT DIFFERENTIABLE, CANNOT BE USED FOR TRAINING

He+18 Mask R-CNN

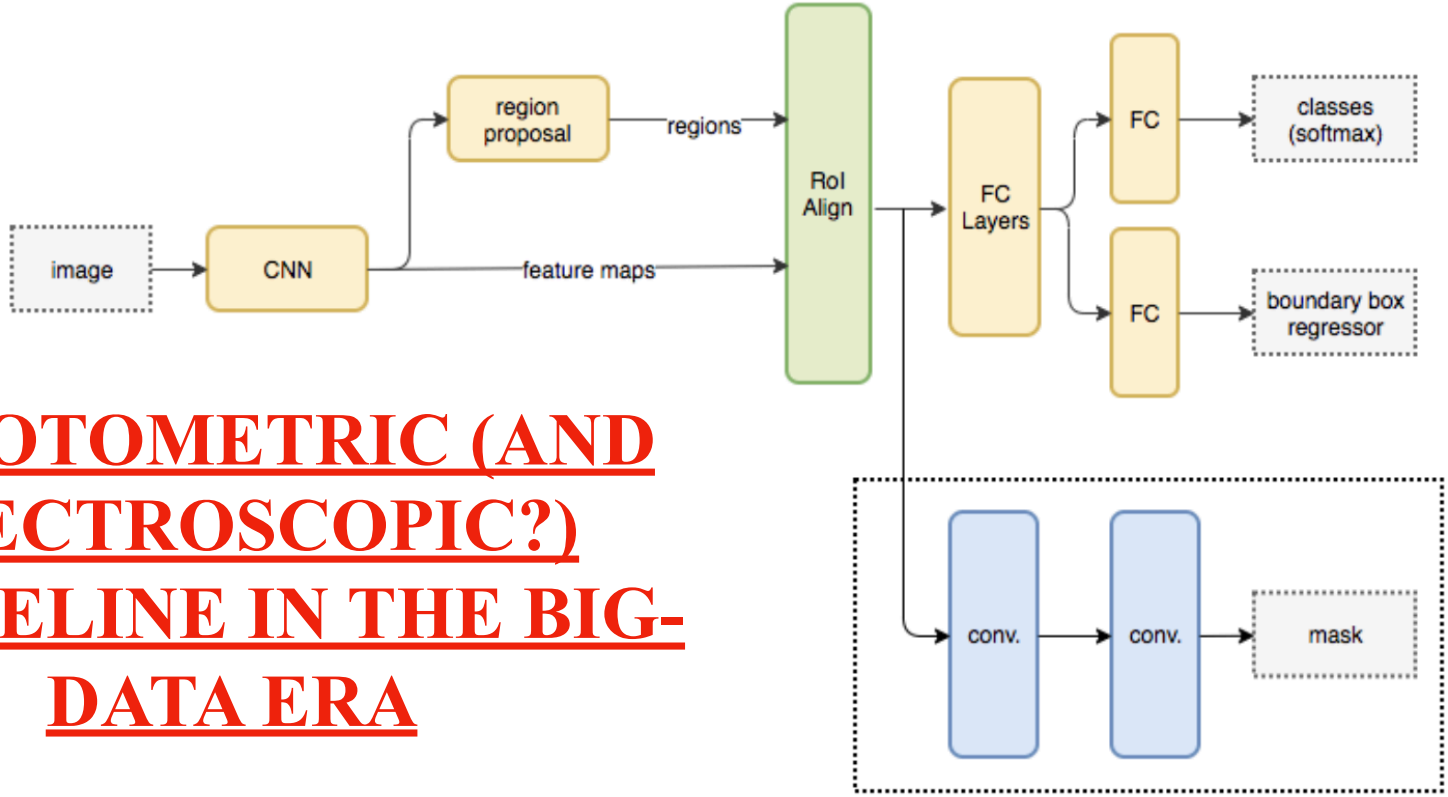
SIMULTANEOUS DETECTION + SEGMENTATION + CLASSIFICATION





MASK R-CNN

He+17

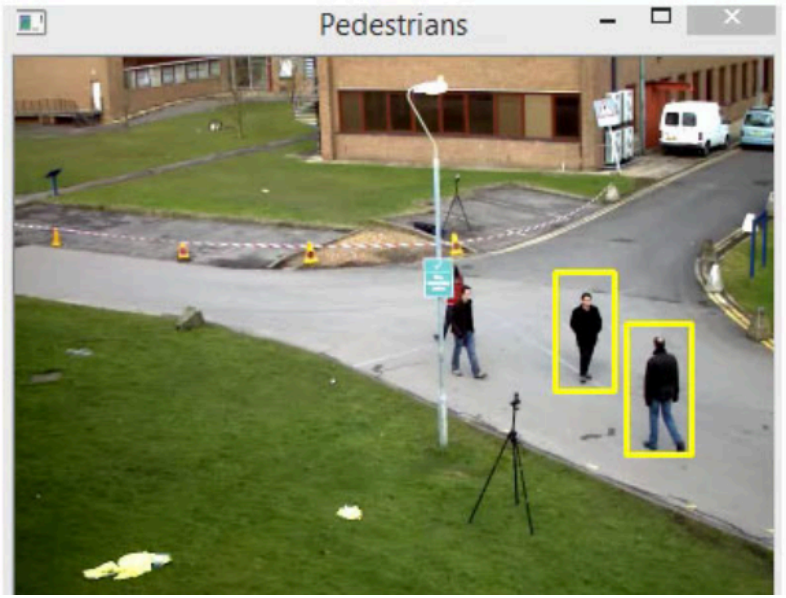


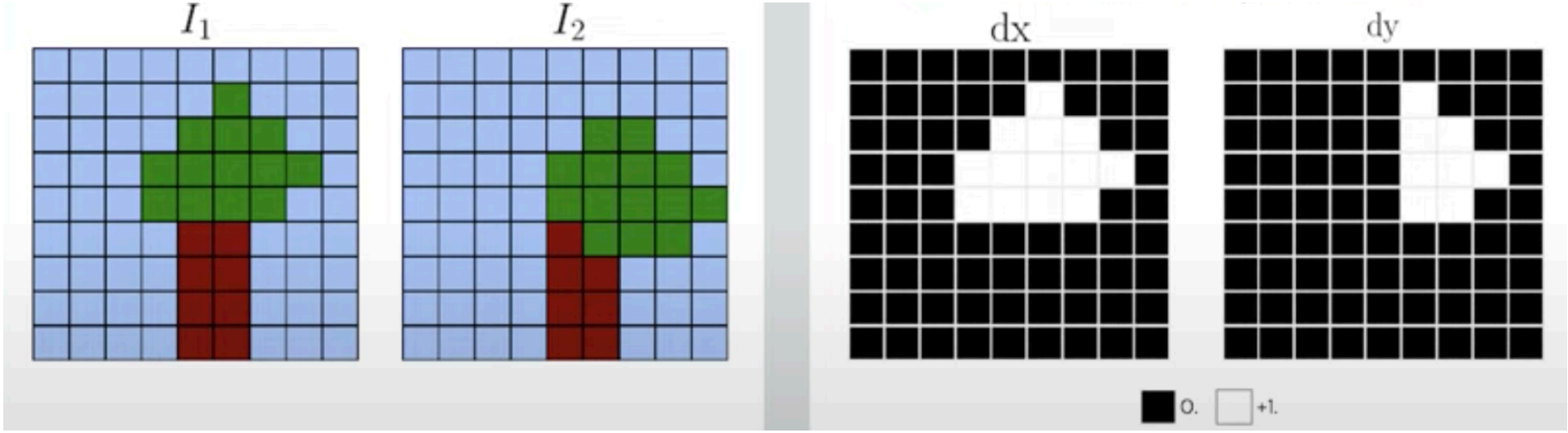
A PHOTOMETRIC (AND SPECTROSCOPIC?) PIPELELINE IN THE BIG-DATA ERA

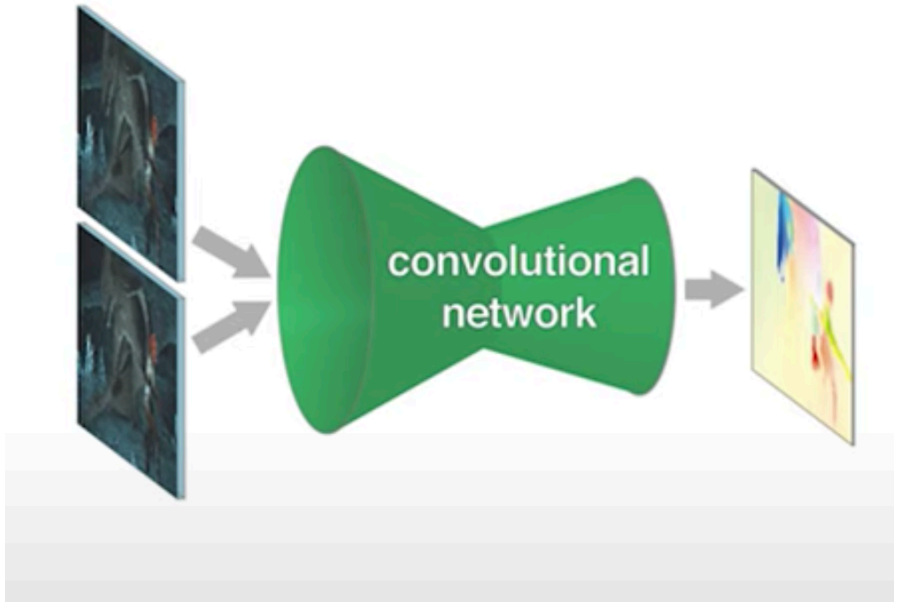
He+17

BEYOND SINGLE IMAGE INPUT…

Inputs	Task definitions	Models	Challenges
Pairs of images	Optical flow estimation	Image-based models	Obtaining labels
Videos	Action recognition	3D convnets	A note on efficiency
		Recurrent (not covered)	







FLOW NET

ENCODER-DECODER

EUCLIDIAN DISTANCE LOSS

DOMAIN ADAPTATION
(or transfer learning)

THE CONVOLUTIONAL PART OF A CNN IS
A FEATURE EXTRACTOR ….

DOMAIN ADAPTATION
(or transfer learning)

THE CONVOLUTIONAL PART OF A CNN IS
A FEATURE EXTRACTOR

IN THAT RESPECT, THEY ARE VERY FLEXIBLE …

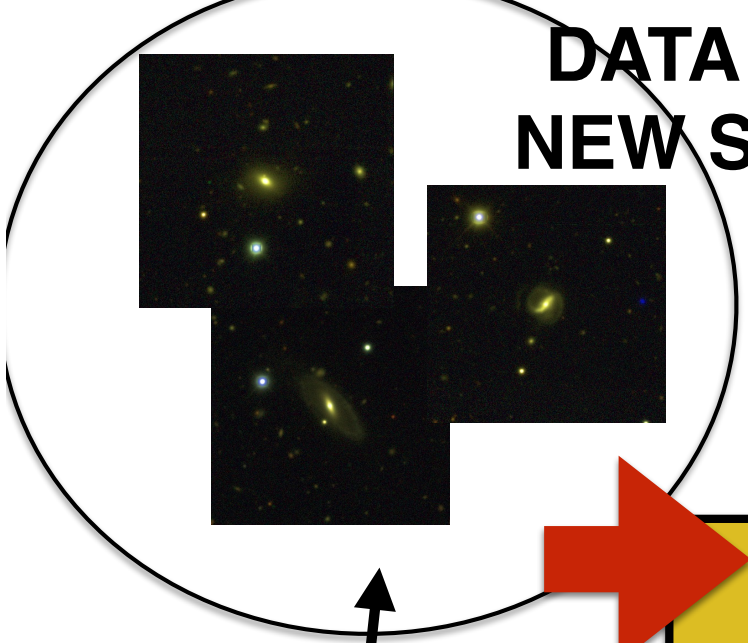
DOMAIN ADAPTATION
(or knowledge transfer)

EVEN IF OUR TRAINING SET IS NOT SO LARGE …

WE CAN USE A CNN PRE-TRAINED ON A LARGER SAMPLE

DEPENDING ON HOW SIMILAR BOTH DATASETS ARE, WE CAN:

- RECYCLE THE SAME FEATURES
- FINE-TUNING THE WEIGHTS



DATA FROM NEW SURVEY

How robust to different datasets? Do we always need a big training set?

DEEP-LEARNING BASED MACHINE

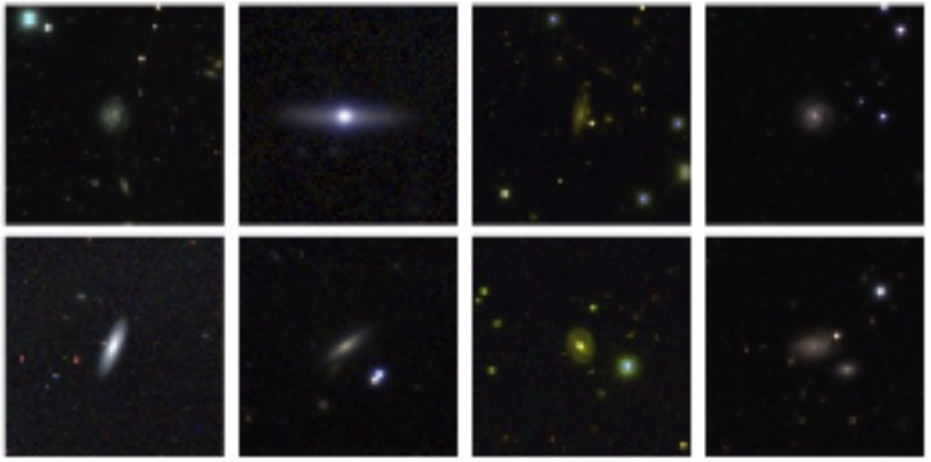
"Improved" Galaxy ZOO like classifications for for the entire sample

Transfer knowledge?

Human classifications from existing survey

Dominguez-Sanchez+18b

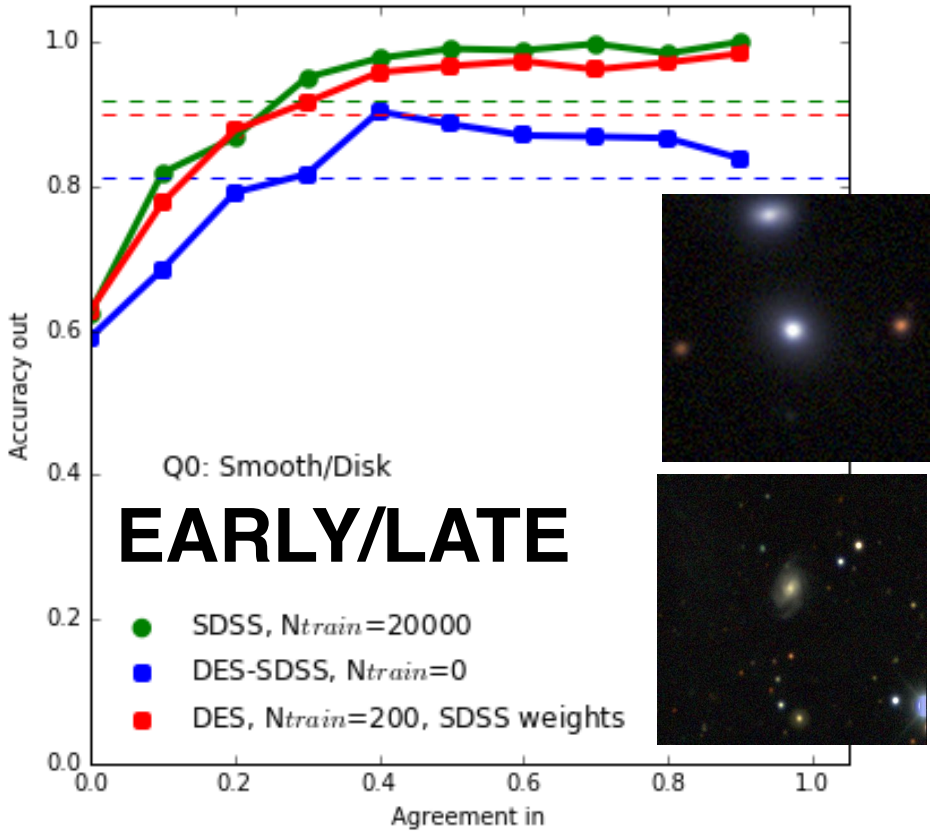
SDSS

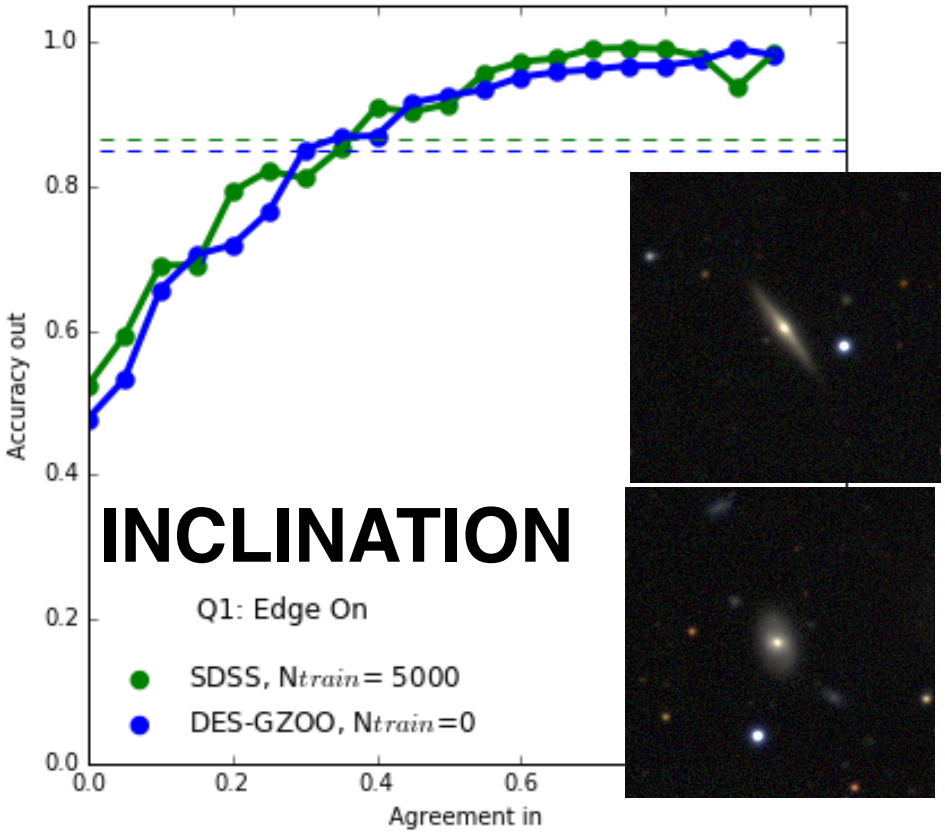


DES

Dominguez-Sanchez+18b

Knowledge Transfer from SDSS to DES





Only 200 (**1%!**) objects classified in DES are needed to reach an accuracy >90% if a machine trained on the SDSS is used

For some properties, i.e. EDGE-ON galaxies. No training at all is needed to go from SDSS to DES

PART IV: A VERY BRIEF INTRODUCTION TO DEEP UNSUPERVISED LEARNING

*elements taken from D. Kirkby lectures at KSPA19

WHAT DOES MACHINE LEARNING DO?

the machine is told what to look for

SUPERVISED

LEARNS A MAP FROM X [FEATURES] TO Y [LABELS]

$$P(X|Y)$$

the machine is NOT told what to look for

UN-SUPERVISED

NO LABELS - DISCOVER PATTERNS

$$P(X)$$