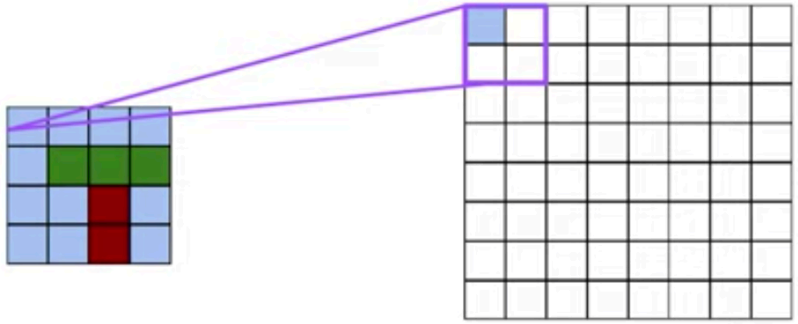
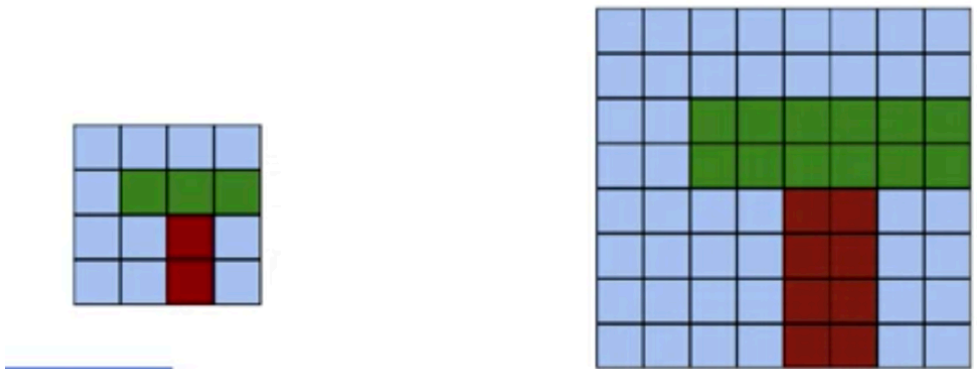
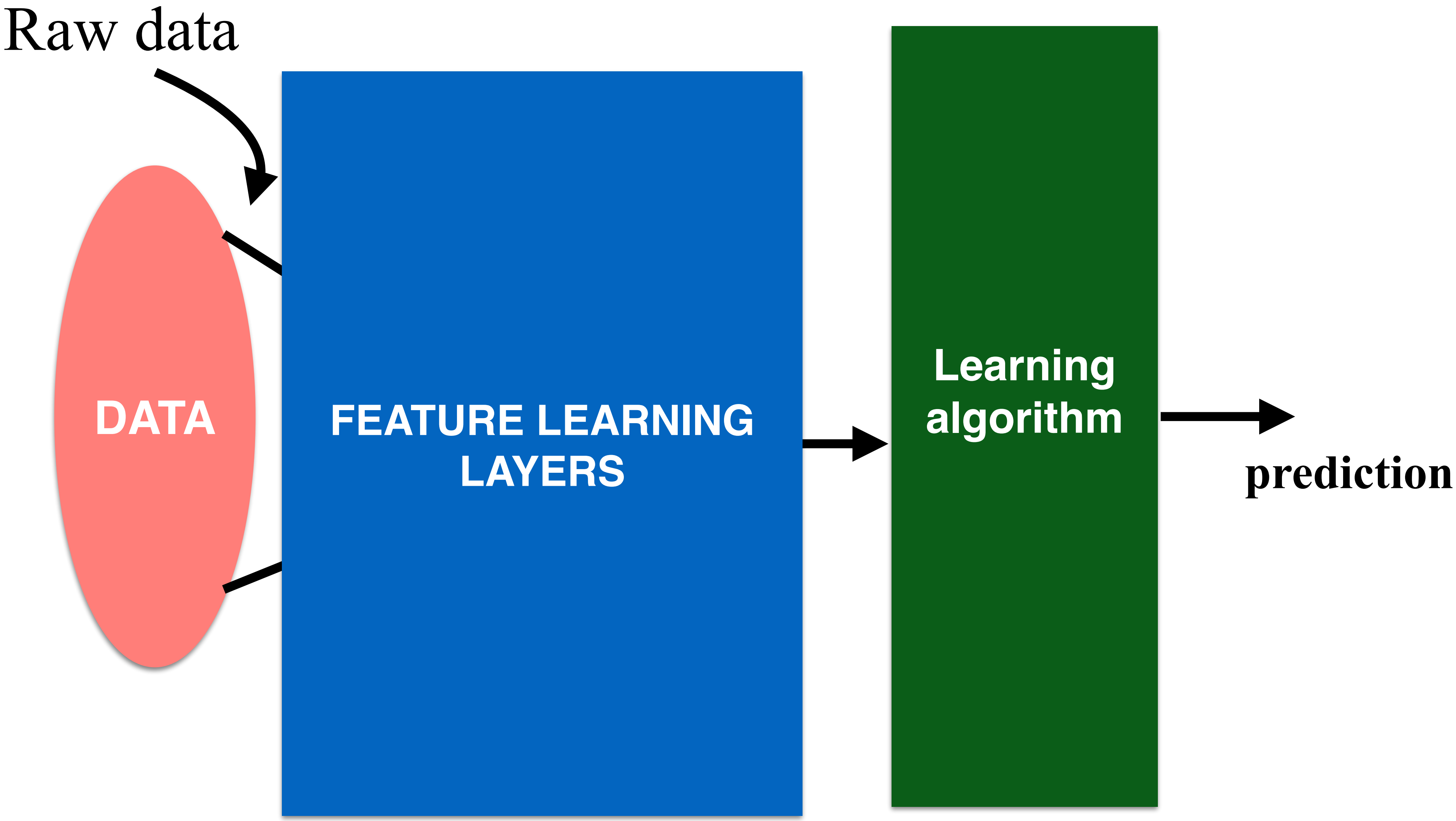
UNPOOLING OPERATION (INVERSE OF POOLING)



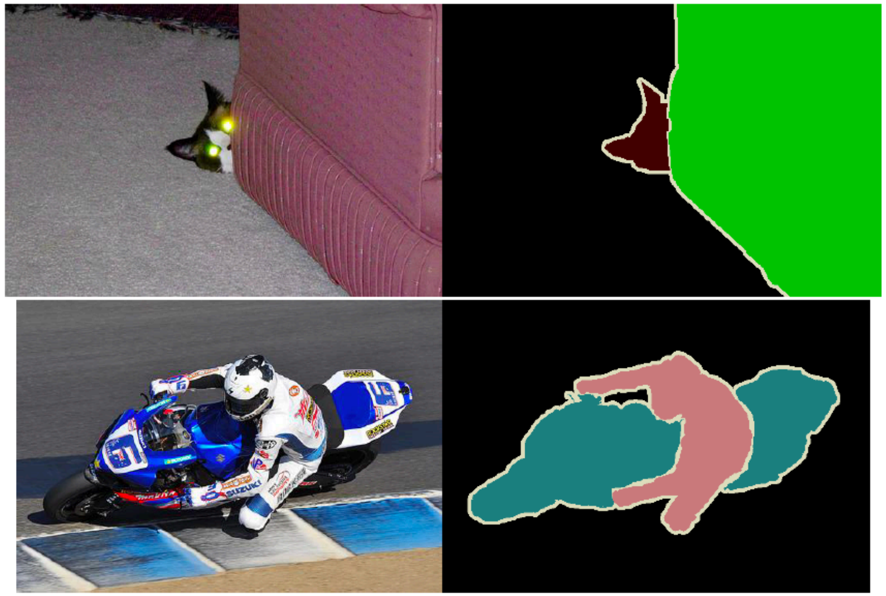
COPY PIXELS IN A GIVEN WINDOW



GENERATES LARGER IMAGES FROM SMALLER ONES

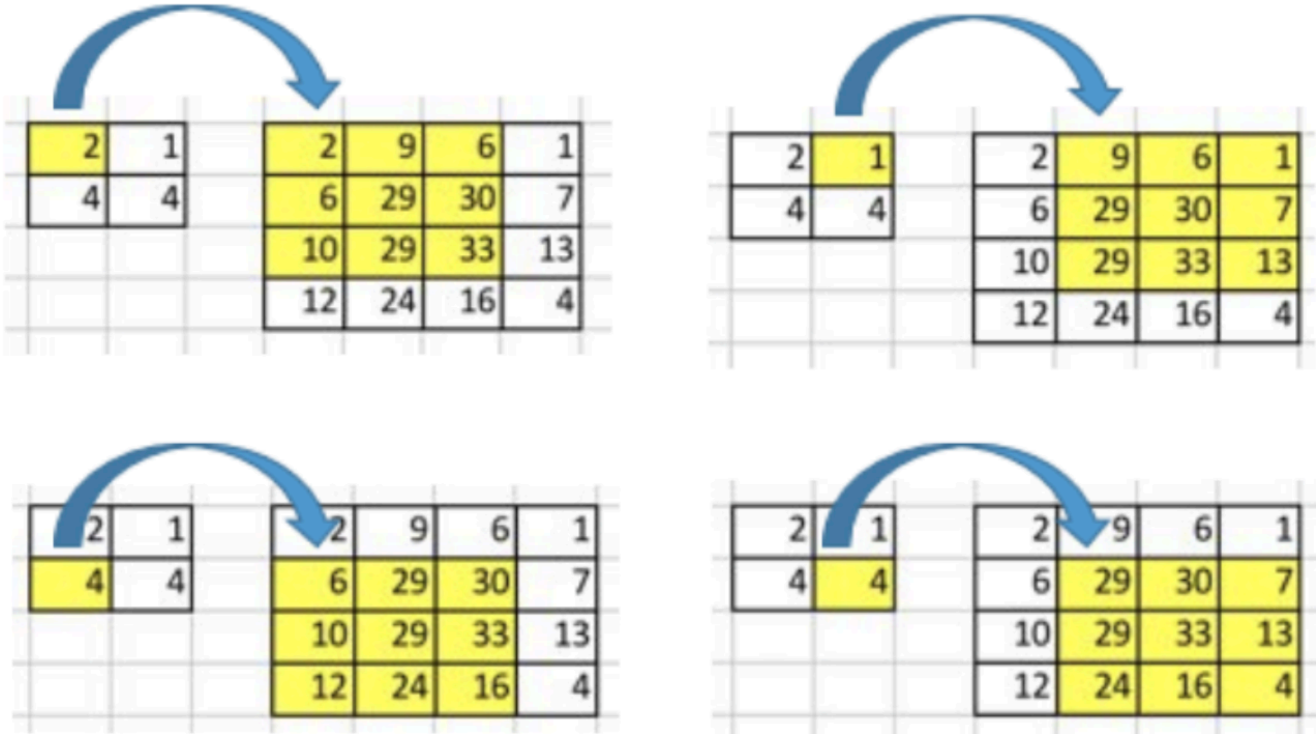

Raw data
DATA
FEATURE LEARNING
LAYERS
Learning
algorithm
prediction

FIRST: IMAGE SEGMENTATION WITH ENCODERS-DECODERS



TRANSPOSED CONVOLUTION

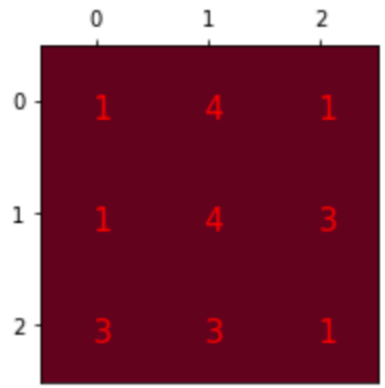
ALLOWS TO INCREASE THE SIZE



Going Backward of Convolution

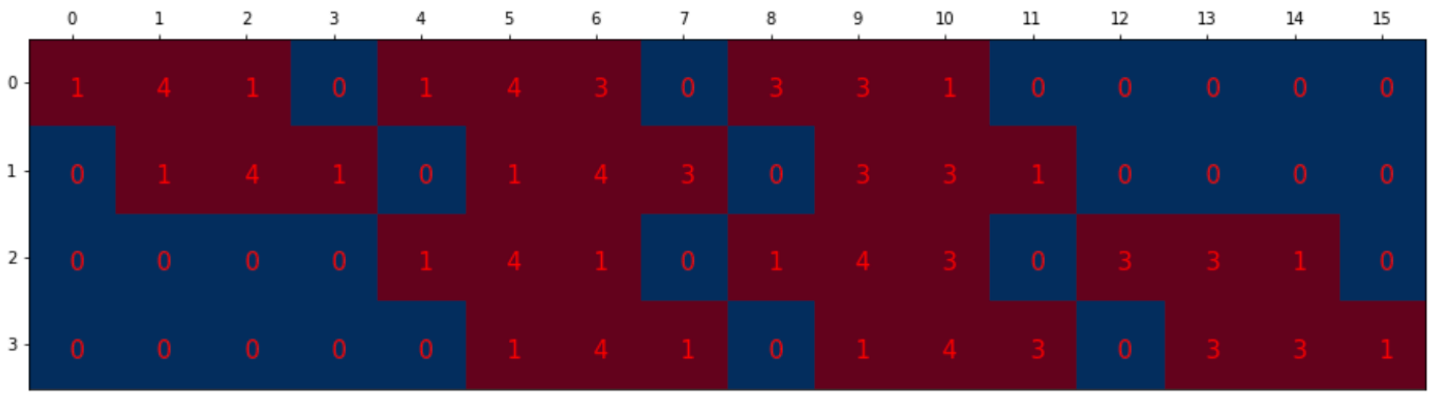
EXAMPLE TAKEN FROM HERE

CONVOLUTION MATRIX



Kernel (3, 3)

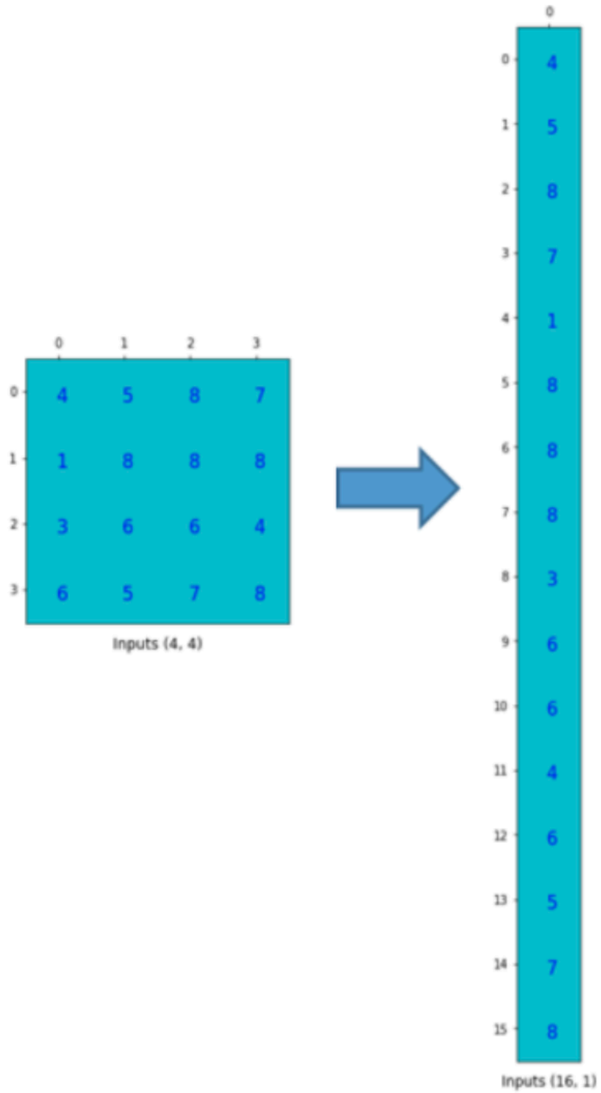
THE KERNEL CAN BE ARRANGED IN FORM OF A MATRIX:



Convolution Matrix (4, 16)

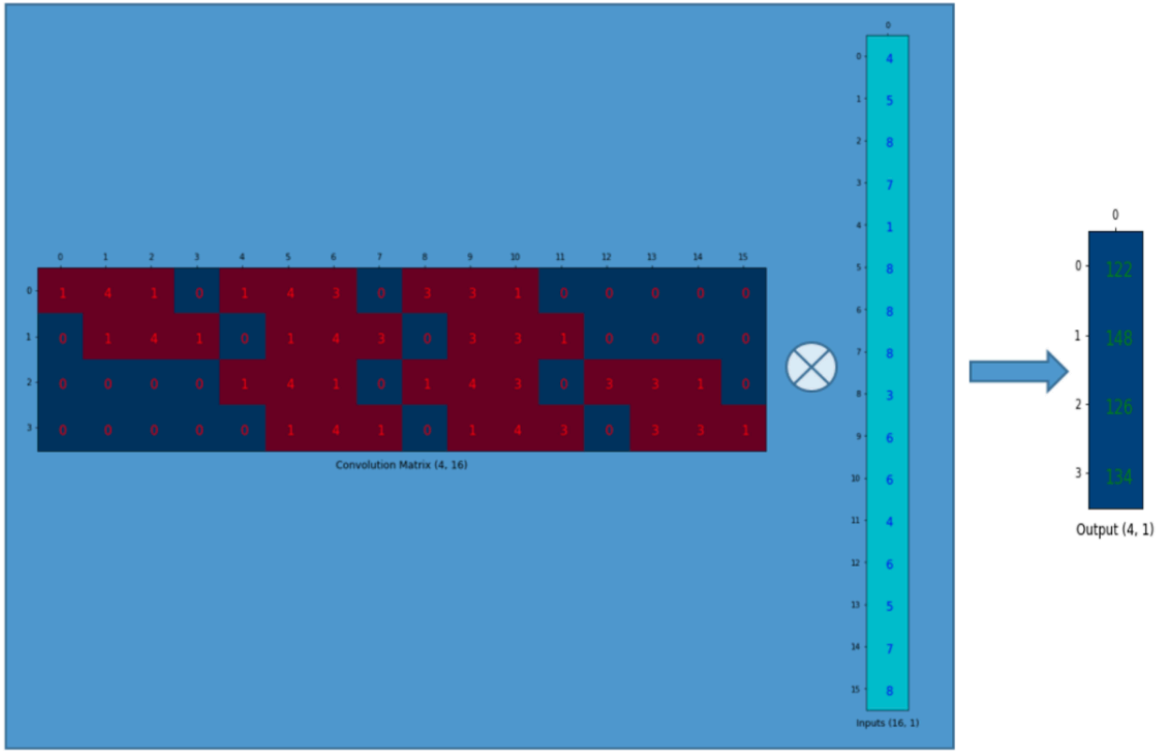
<u>EXAMPLE TAKEN FROM HERE</u>

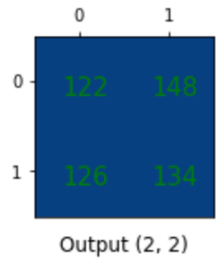
THE INPUT IS FLATTENED INTO A COLUMN VECTOR



EXAMPLE TAKEN FROM HERE

THE CONVOLUTION IS TRANSFORMED INTO A PRODUCT OF MATRICES

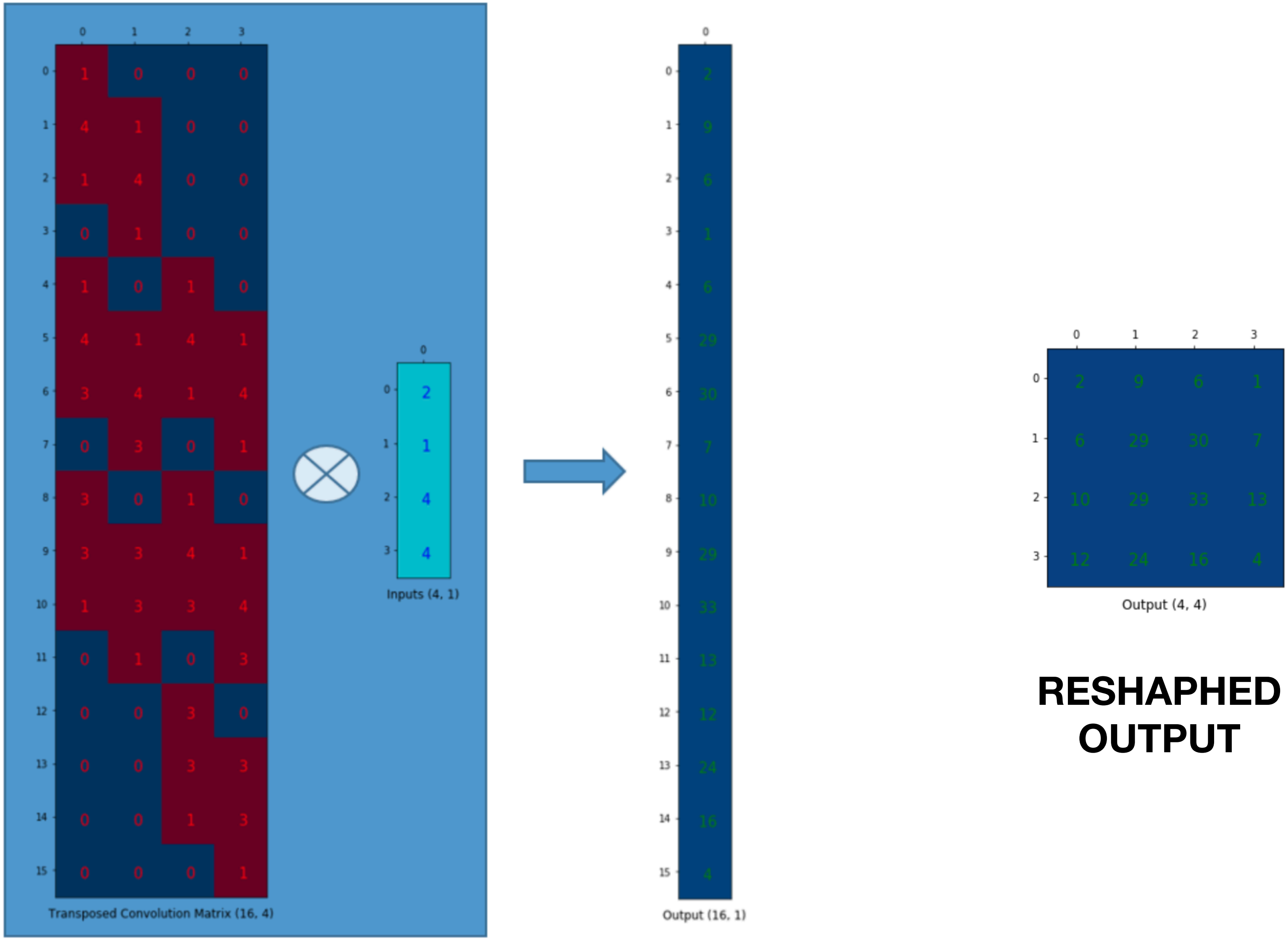




RESHAPED OUTPUT

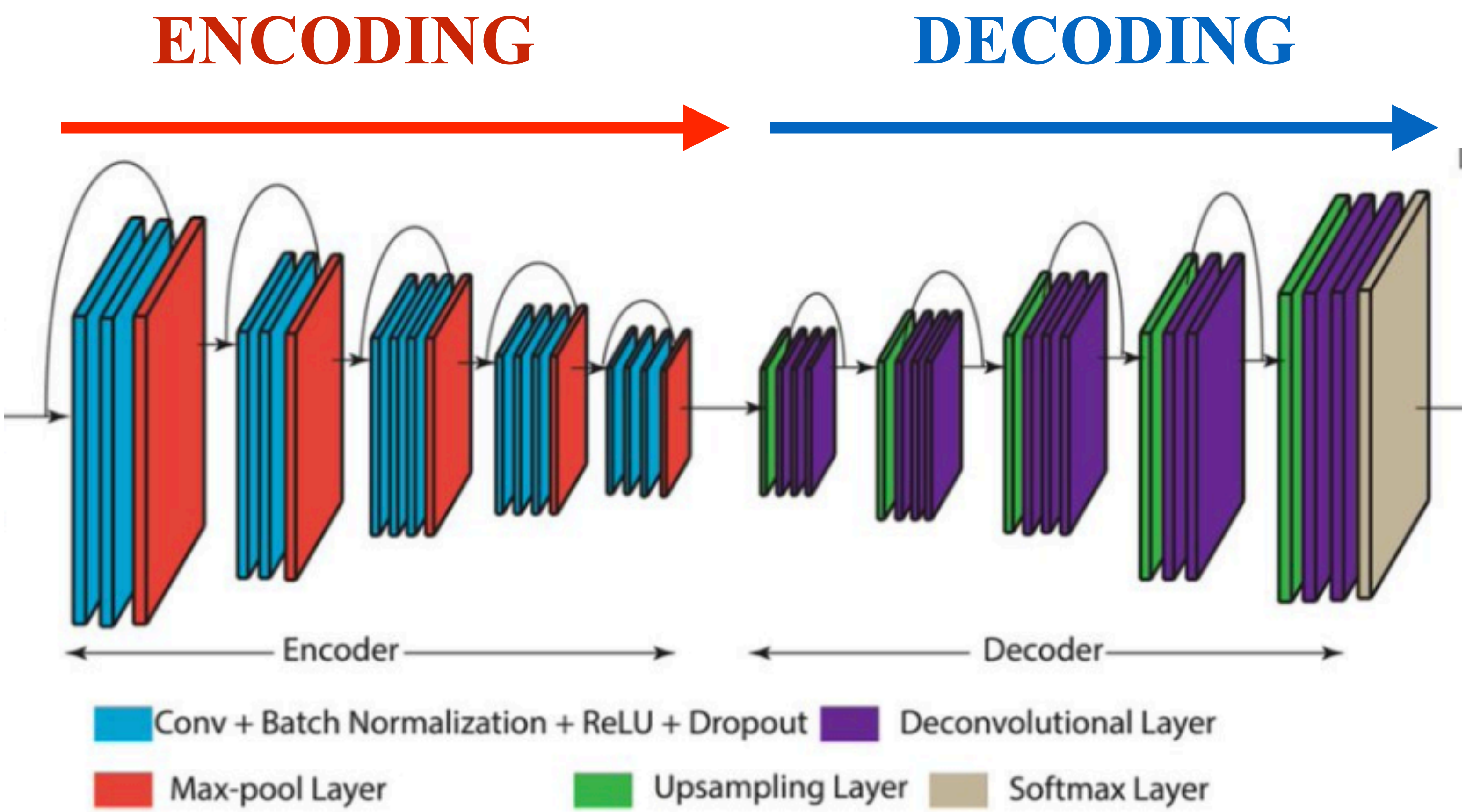
EXAMPLE TAKEN FROM HERE

THE TRANSPOSED CONVOLUTION IS THE INVERSE OPERATION



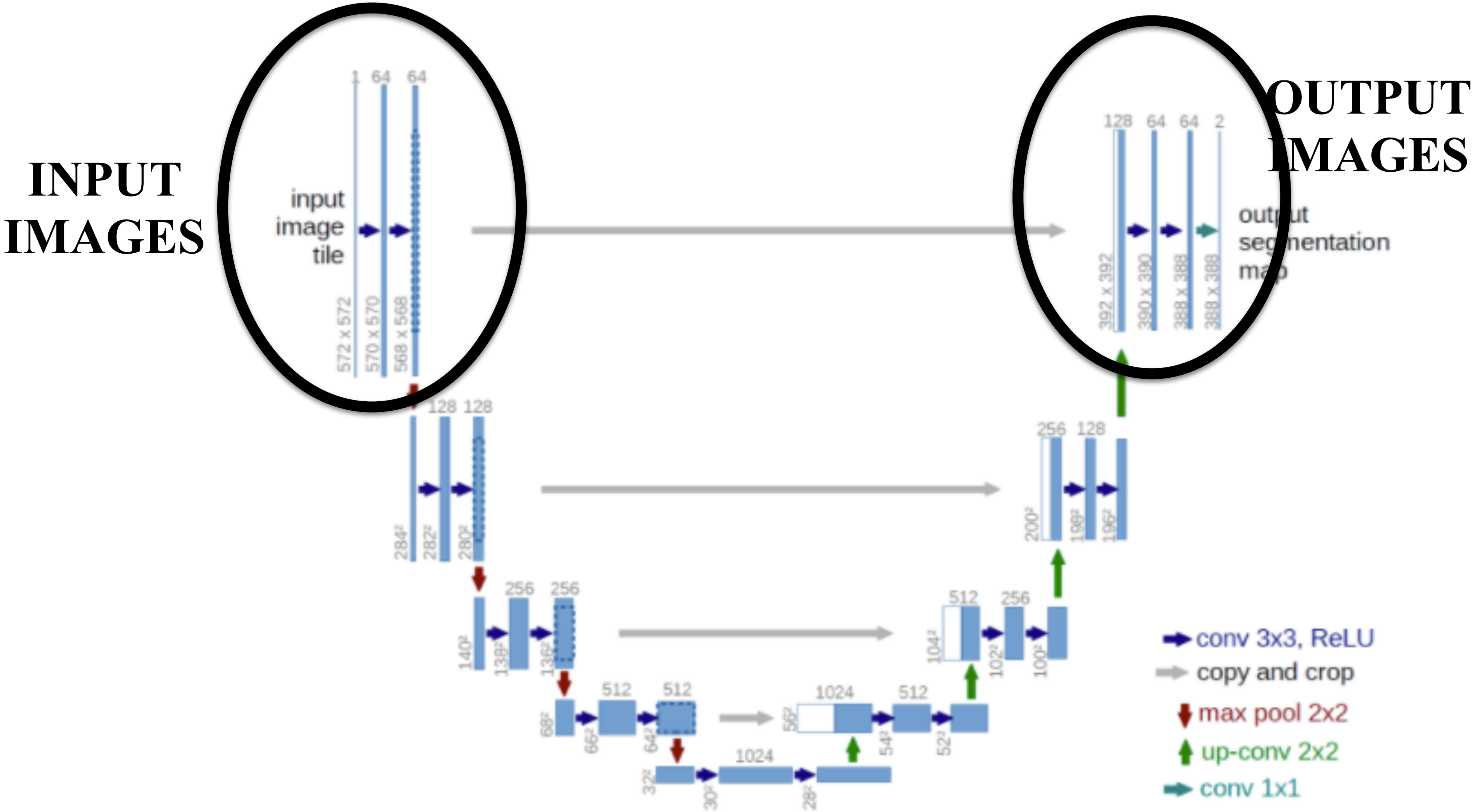
EXAMPLE TAKEN FROM HERE

ENCODER-DECODERS GO FROM IMAGE 2 IMAGE



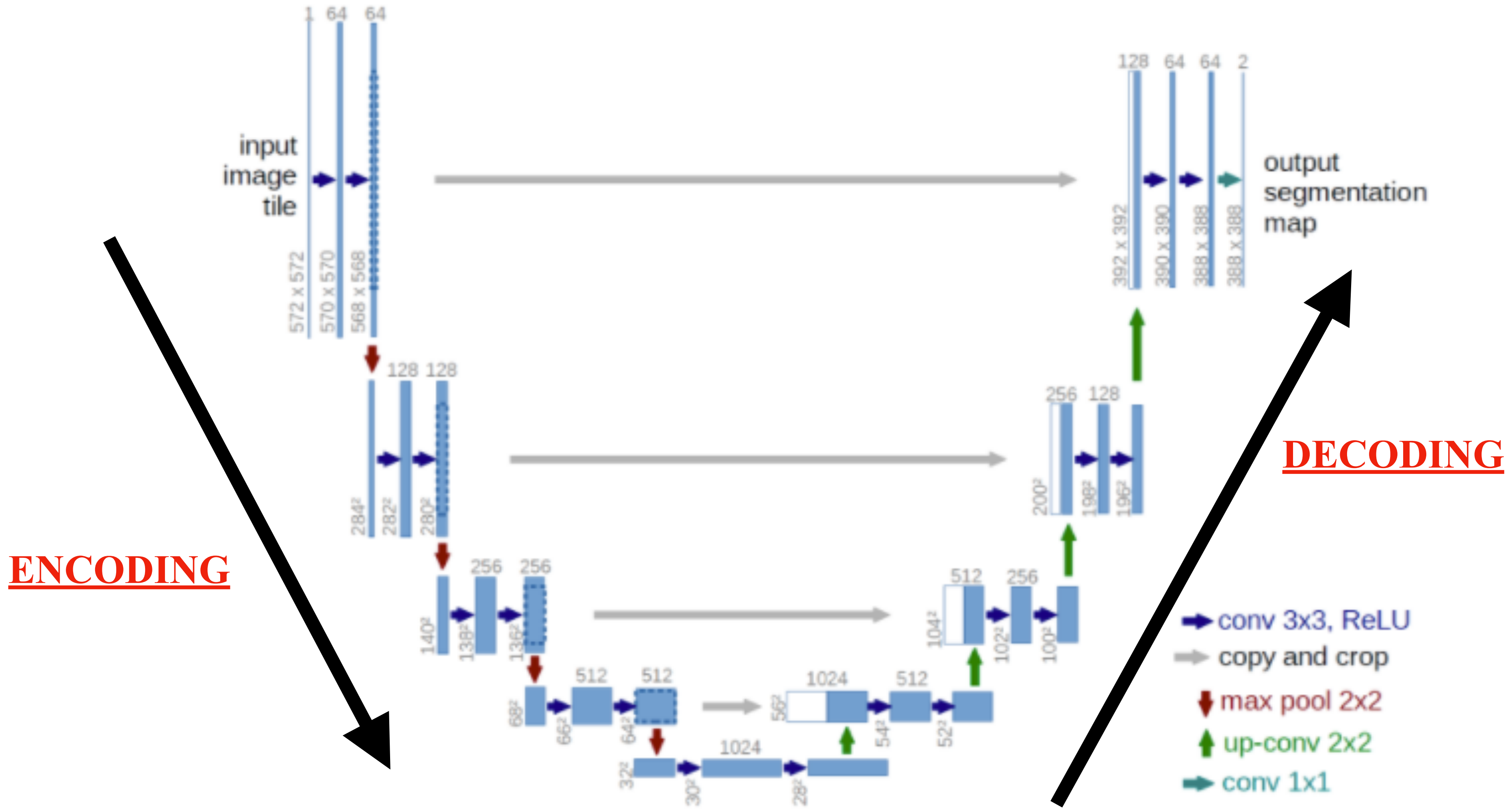
WE CALL THIS FULLY CONVOLUTIONAL NEURAL NETWORKS

ENCODING-DECODING TO EXTRACT IMAGE FEATURES: U-NET



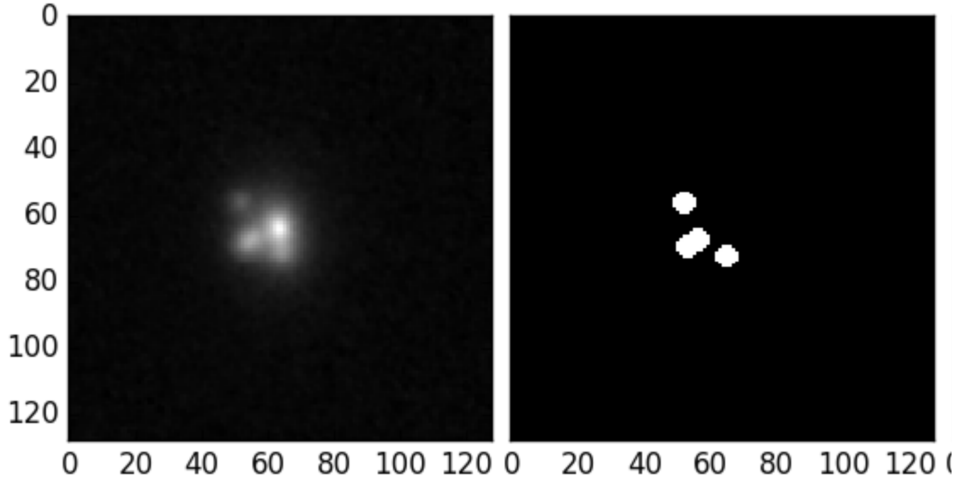
Ronnerberger+15

ENCODING-DECODING TO EXTRACT IMAGE FEATURES: THE U-NET

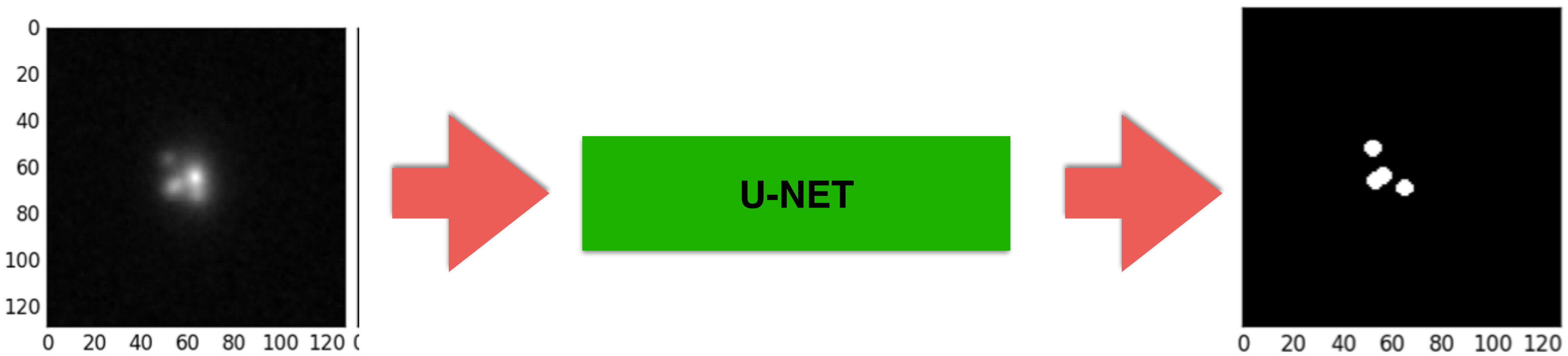


Ronnerberger+15

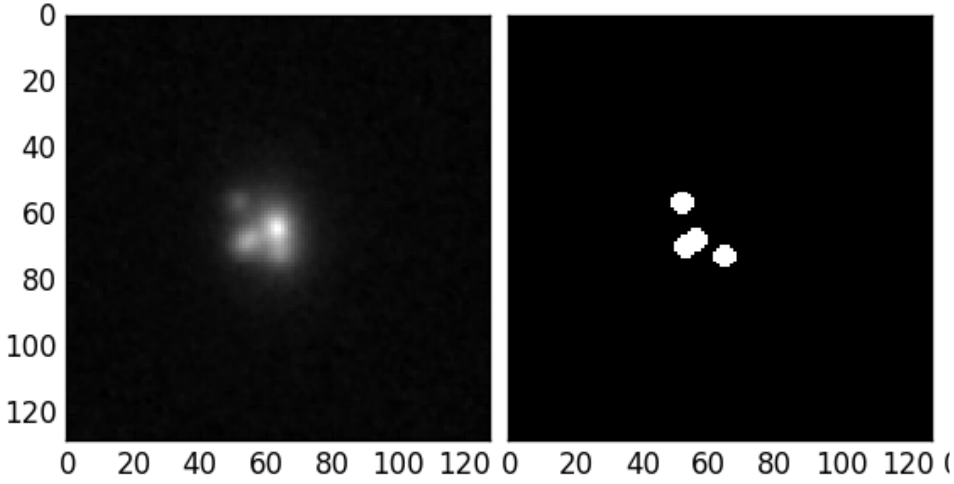
VERY SIMPLE SERSIC ANALYTIC SIMULATIONS + UNRESOLVED CLUMPS



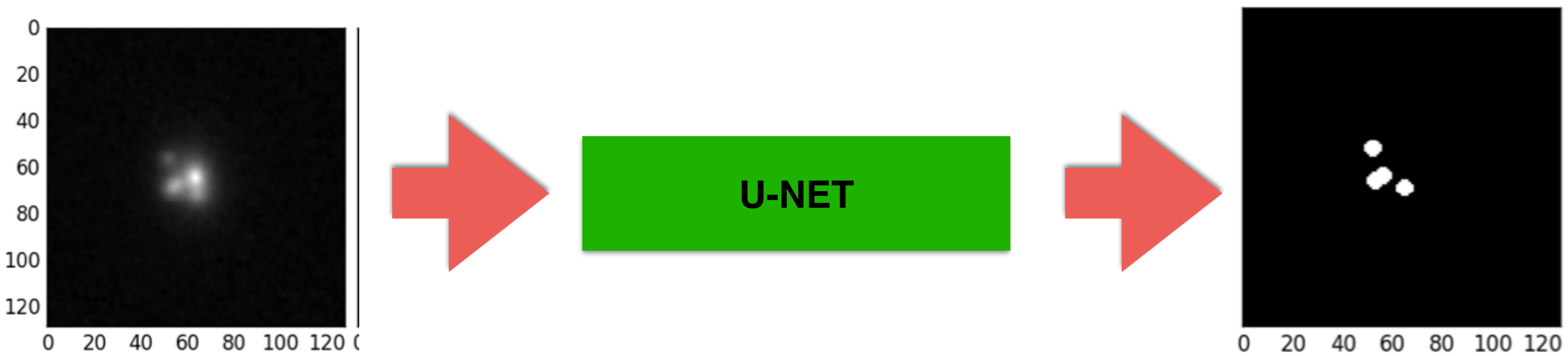
CLUMP POSITION IS KNOWN



VERY SIMPLE SERSIC ANALYTIC SIMULATIONS + UNRESOLVED CLUMPS



CLUMP POSITION IS KNOWN



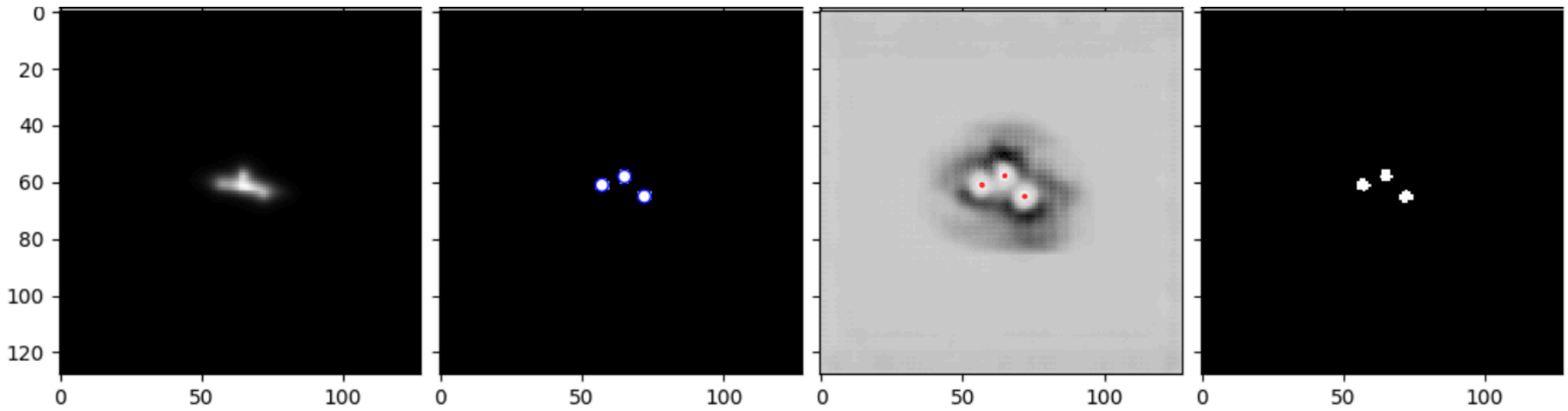
WHAT LOSS FUNCTION?

SIMULATED GALAXY

CLUMP MASK

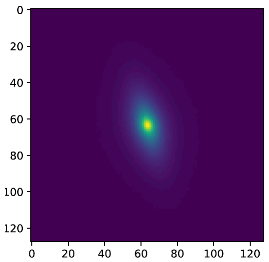
NETWORK PROBA MAP

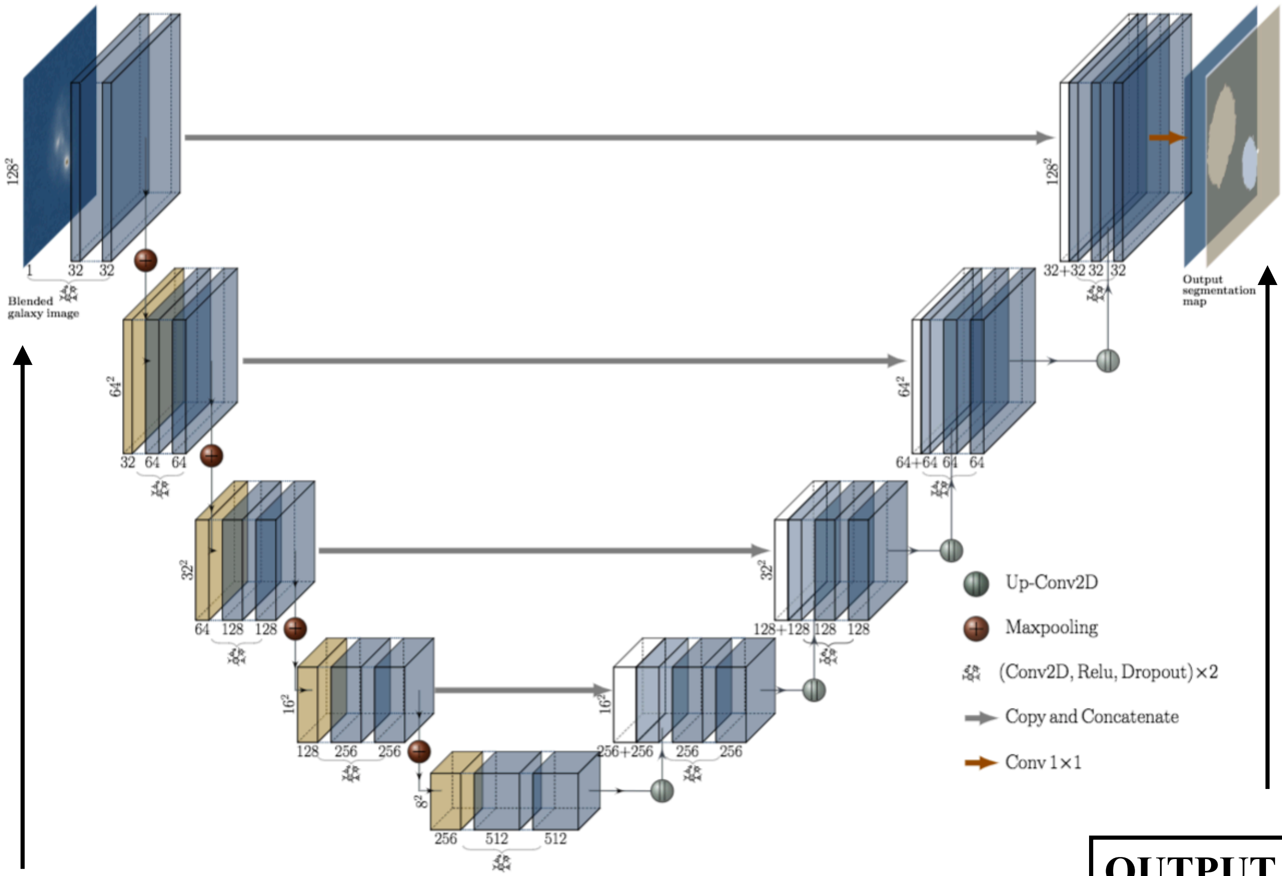
NETWORK OUTPUT THRESHOLDED (SEXTRACTOR)



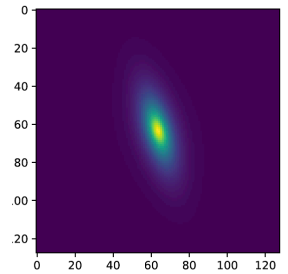
LEE, MHC, PRIMACK+ 19

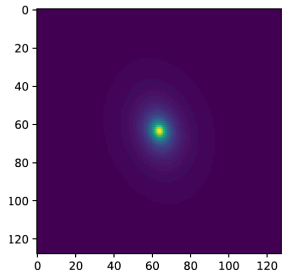
ALSO REGRESSION…





DISK





BULGE

GALAXY STAMP

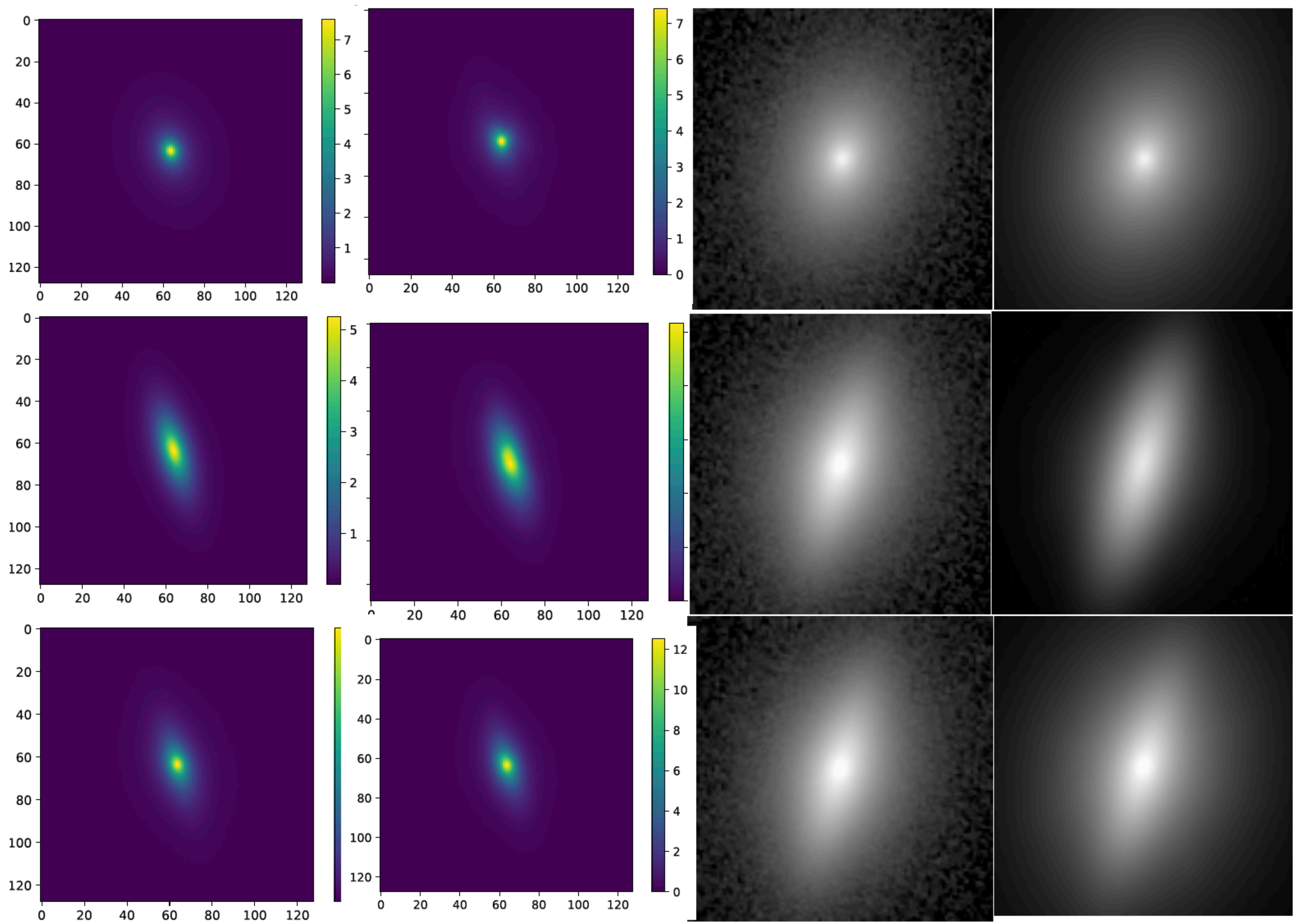
BULGE AND DISK PARAMETERS (SIZE, INCLINATION ETC)

OUTPUT IMAGE OF BULGE AND DISK COMPONENTS

Tuccillo, MHC+18,19

DEEP LEARNING

GALFIT

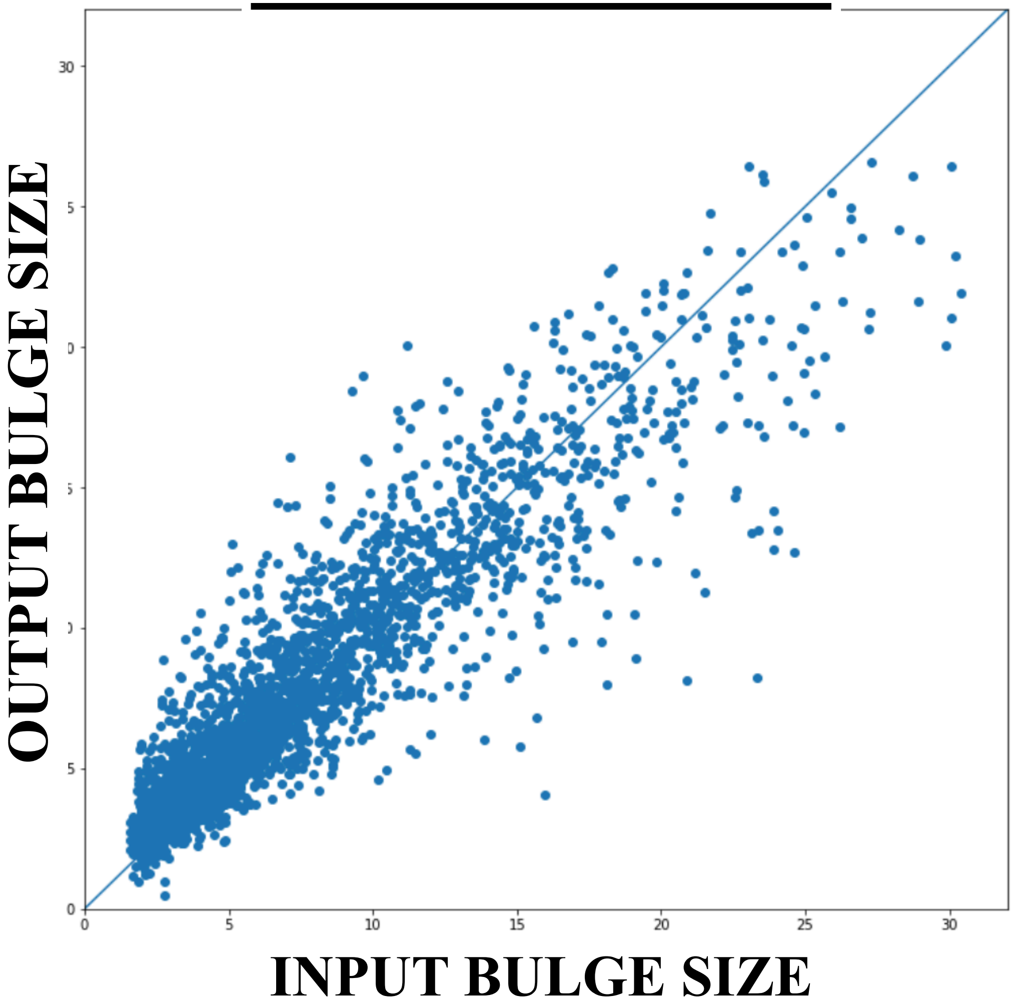


ORIGINAL **RECONSTRUCTION** **ORIGINAL** **RECONSTRUCTION**

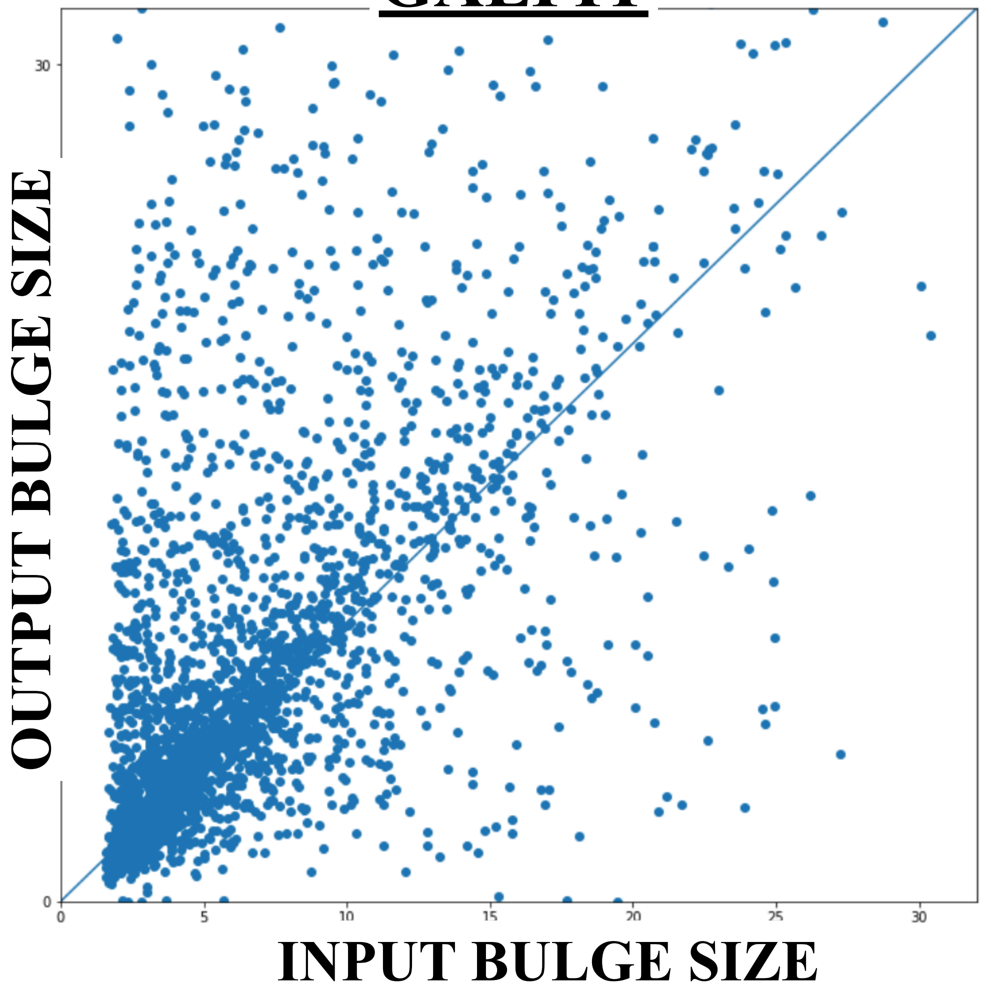
Tuccillo, MHC+18,19

PRELIMINARY!!

DEEP LEARNING



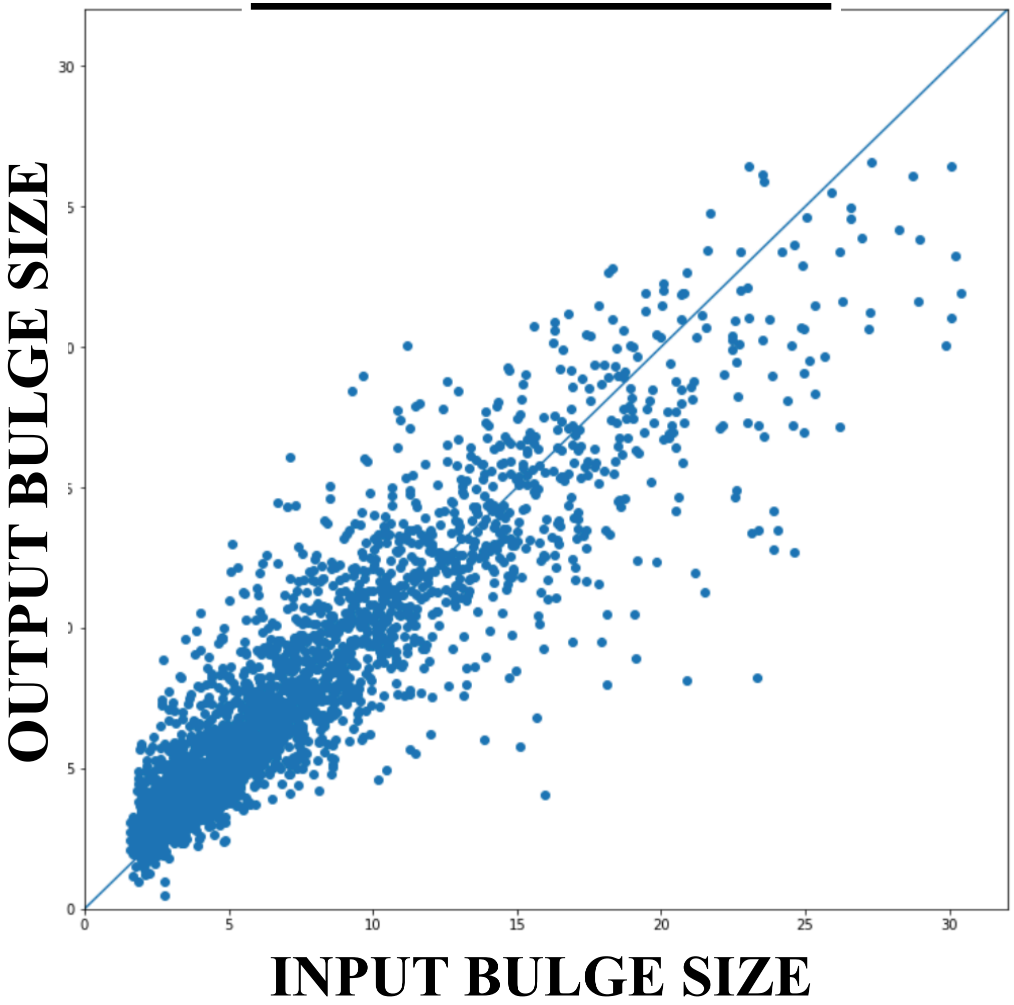
GALFIT



Tuccillo, MHC+18,19

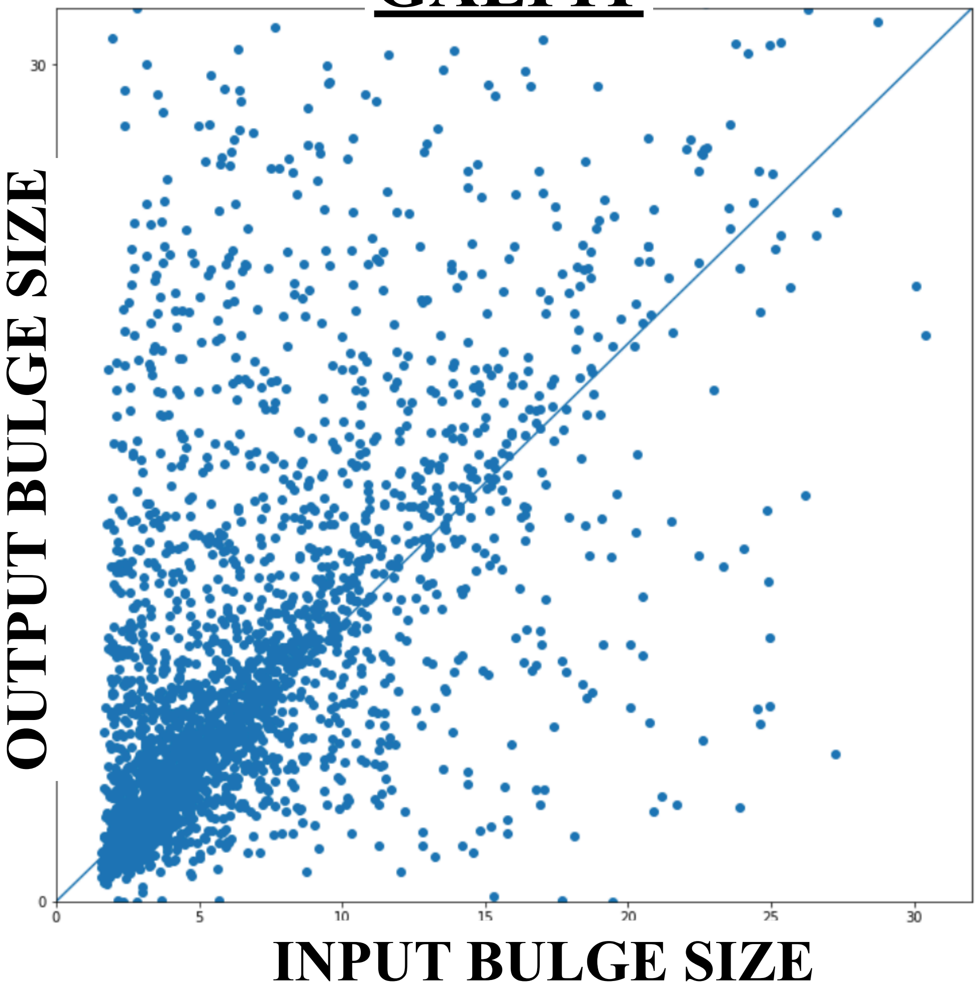
4s [ONCE TRAINED]

DEEP LEARNING



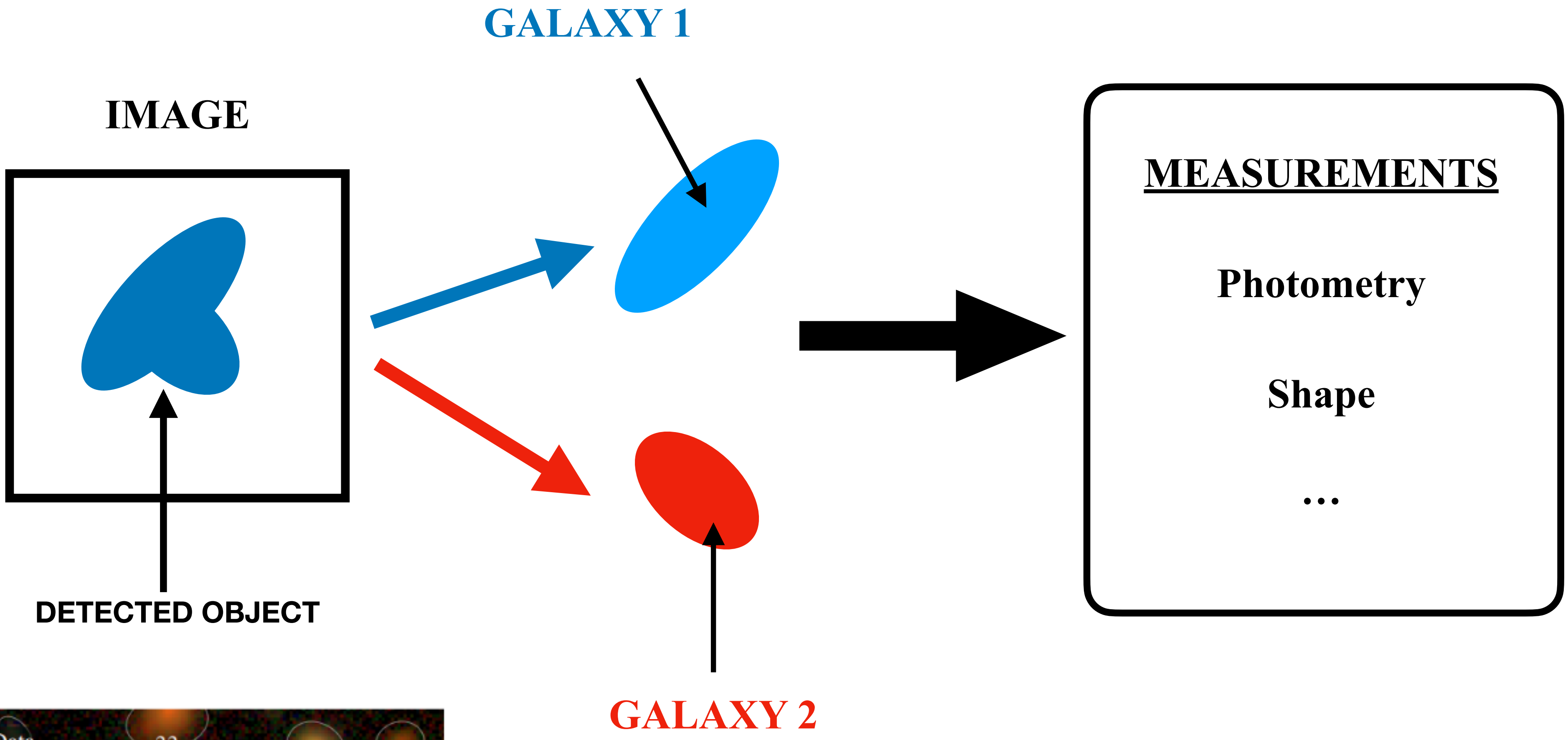
4hrs

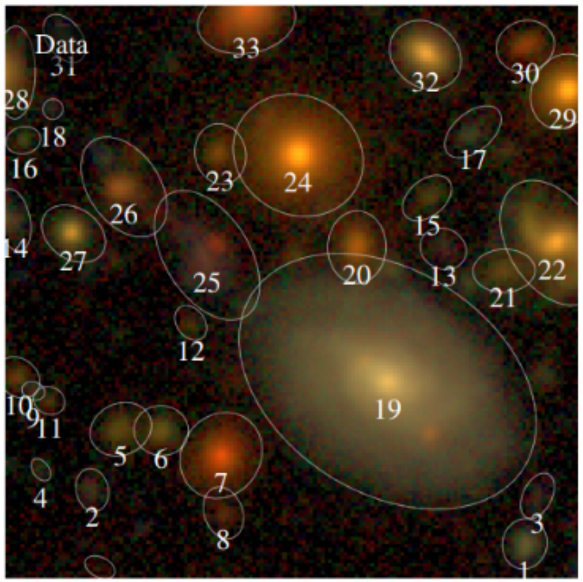
GALFIT



PRELIMINARY!!

Tuccillo, MHC+18,19

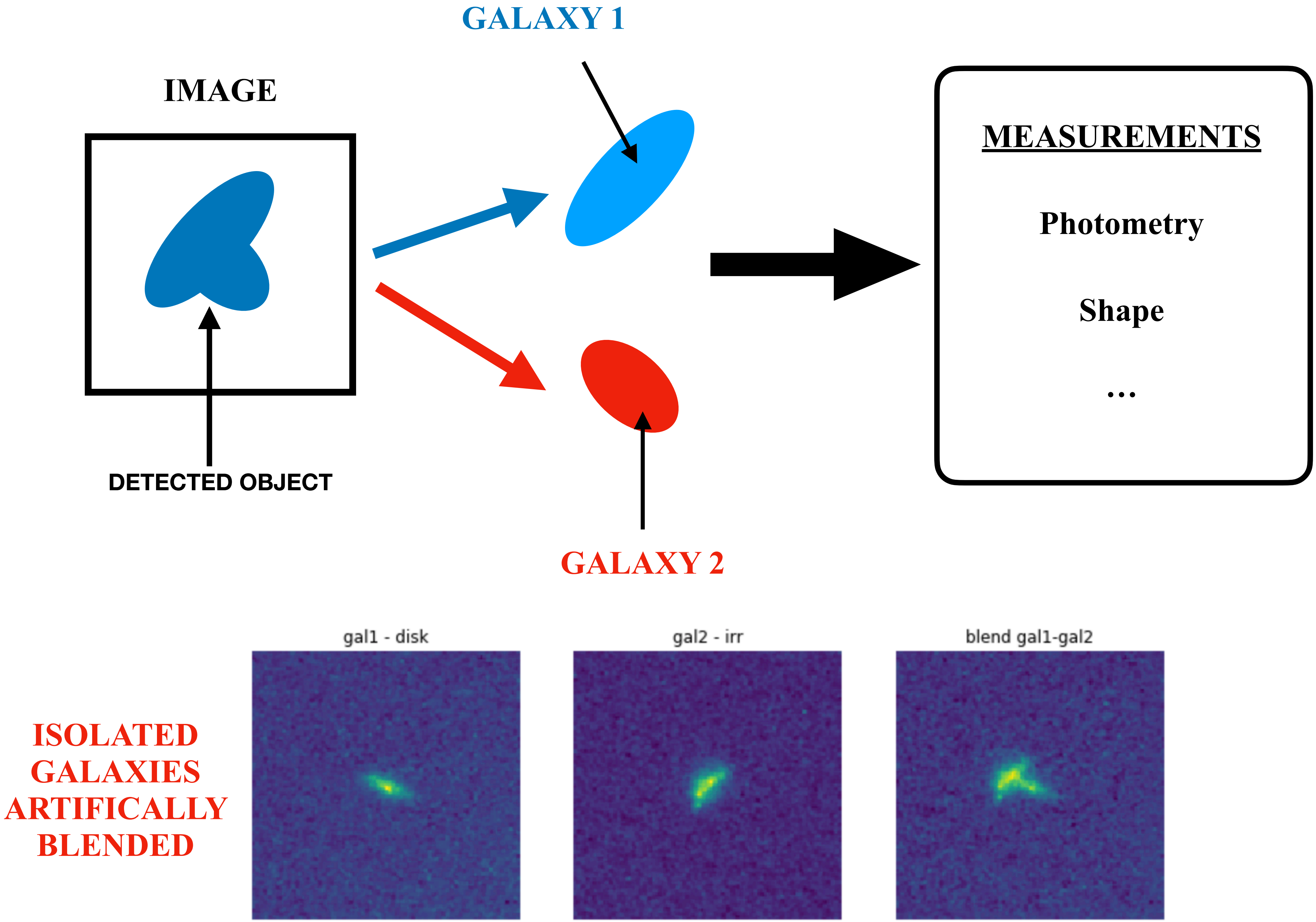




Bosch+17

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

Boucaud+19



GALAXY 1
IMAGE
MEASUREMENTS
Photometry
Shape
...
DETECTED OBJECT
GALAXY 2
gal1 - disk
gal2 - irr
blend gal1-gal2
ISOLATED GALAXIES ARTIFICALLY BLENDED

U-NET (ENCODER DECODER)

VANILLA CNN

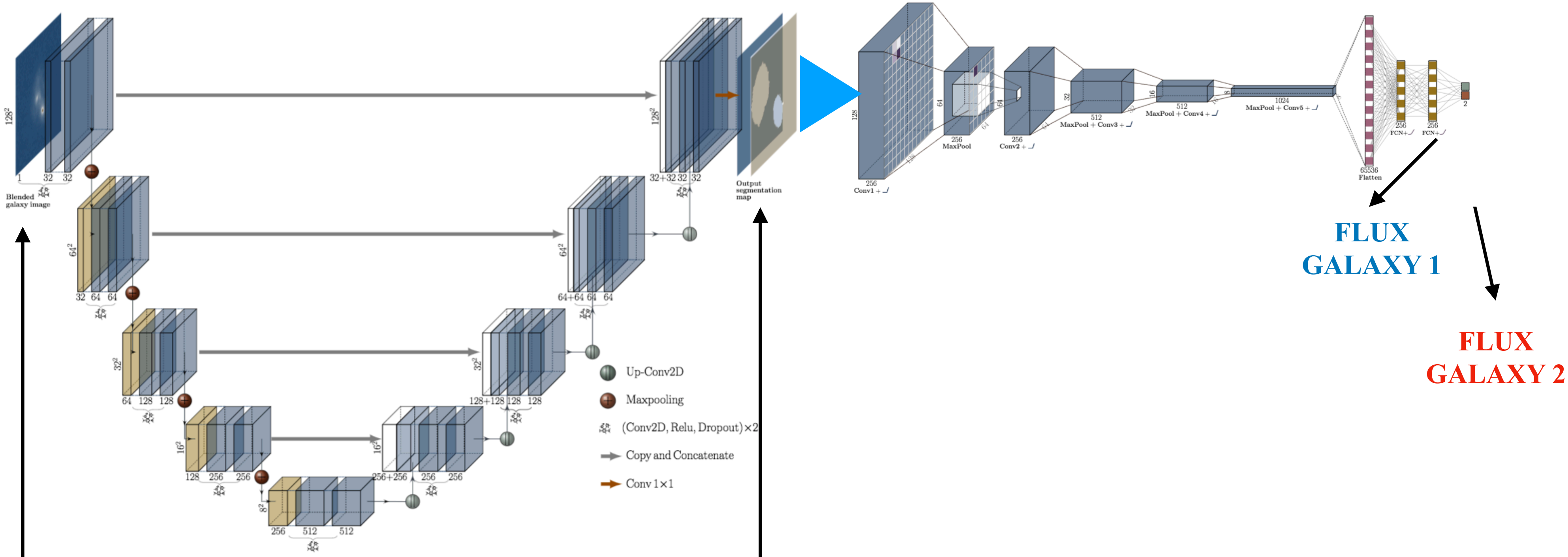
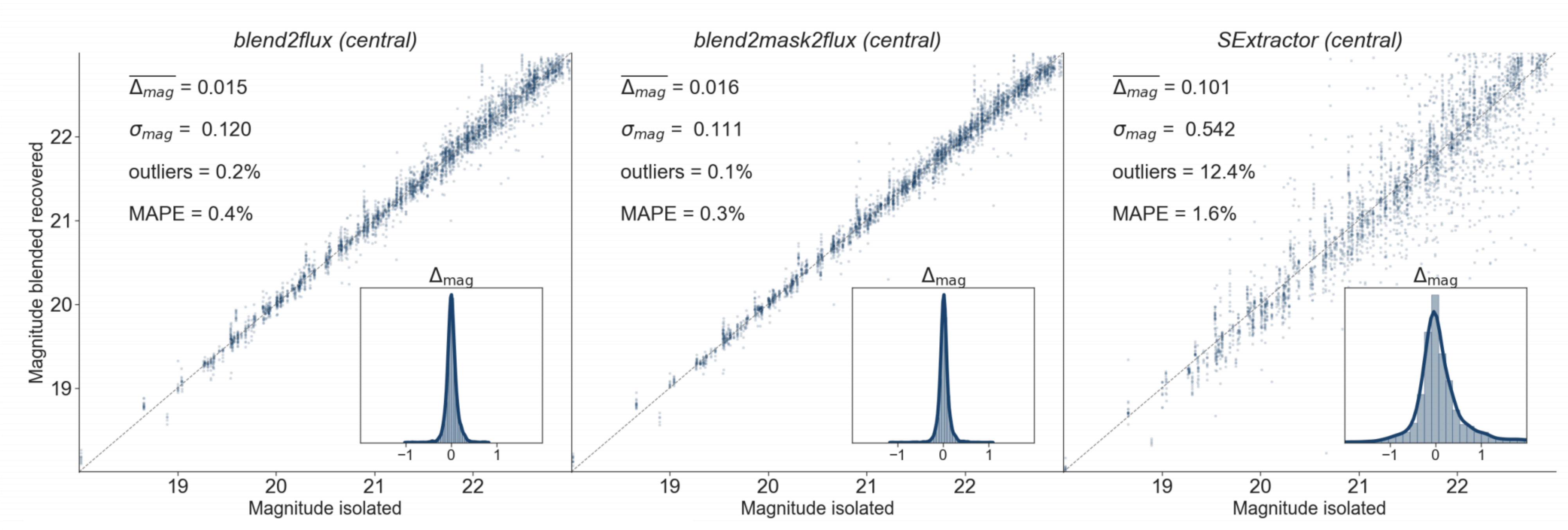
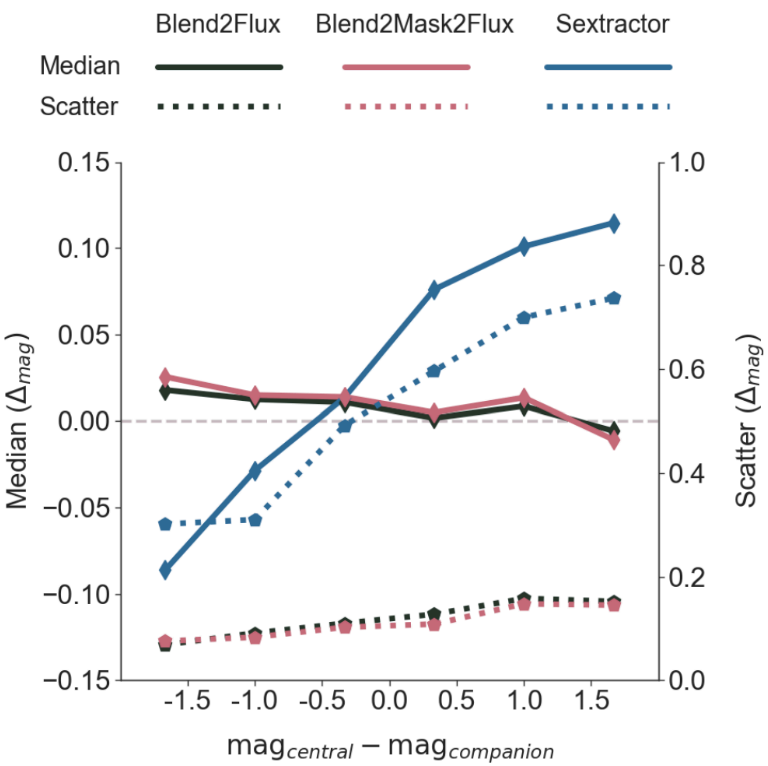


IMAGE OF BLENDED OBJECTS

OUTPUT SEGMENTATION MAP (BINARY 2 CHANNELS)

Boucaud, MHC+19



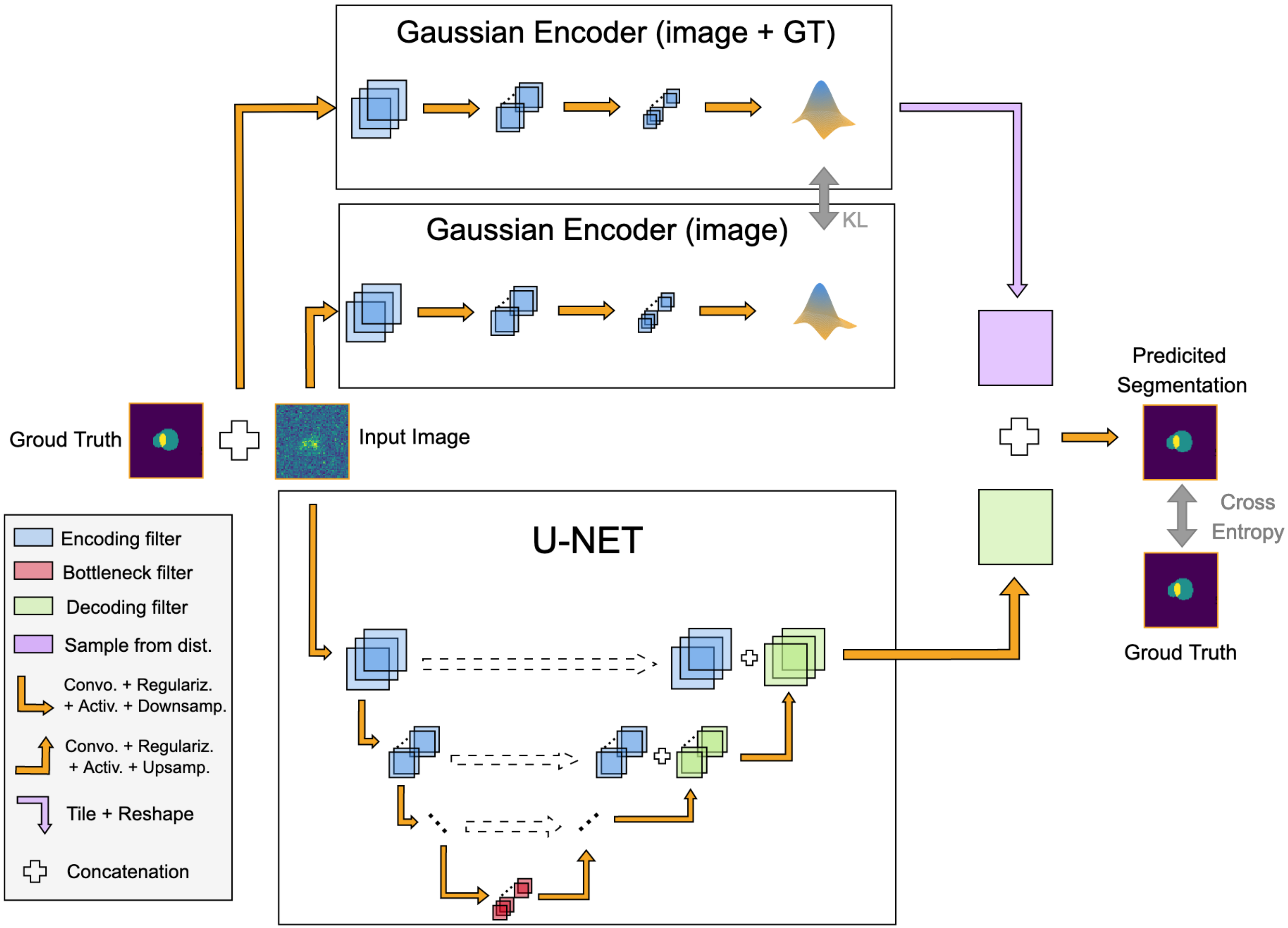


LESSONS LEARNED:

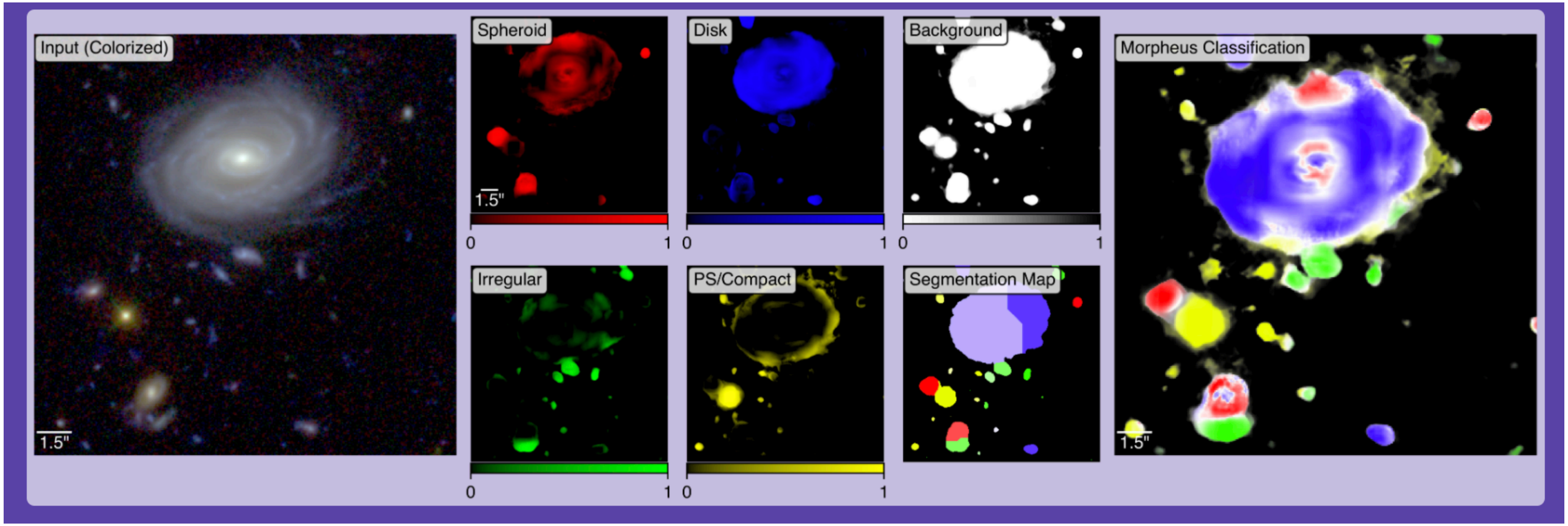
- It is easy to do better than Sextractor

- Masks do not provide additional information

PROBABILISTIC U-NET



Bretonniere+20

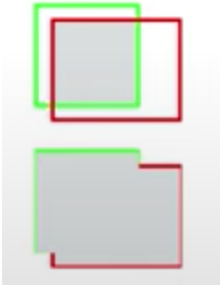


https://www.youtube.com/watch?v=hEL1h_dODkU#action=share

Hausen+20

EVALUATION METRICS FOR IMAGE SEGMENTATION

WE TYPICALLY USE THE INTERSECTION OVER UNION LOSS

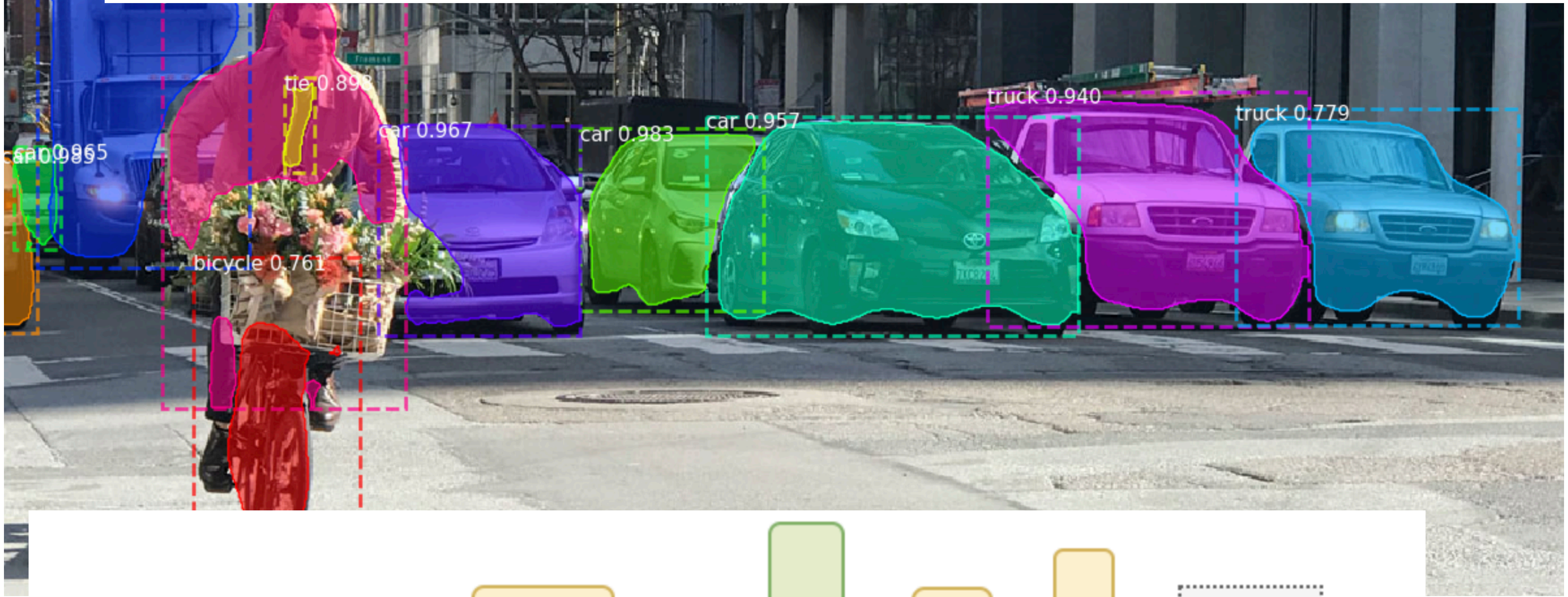


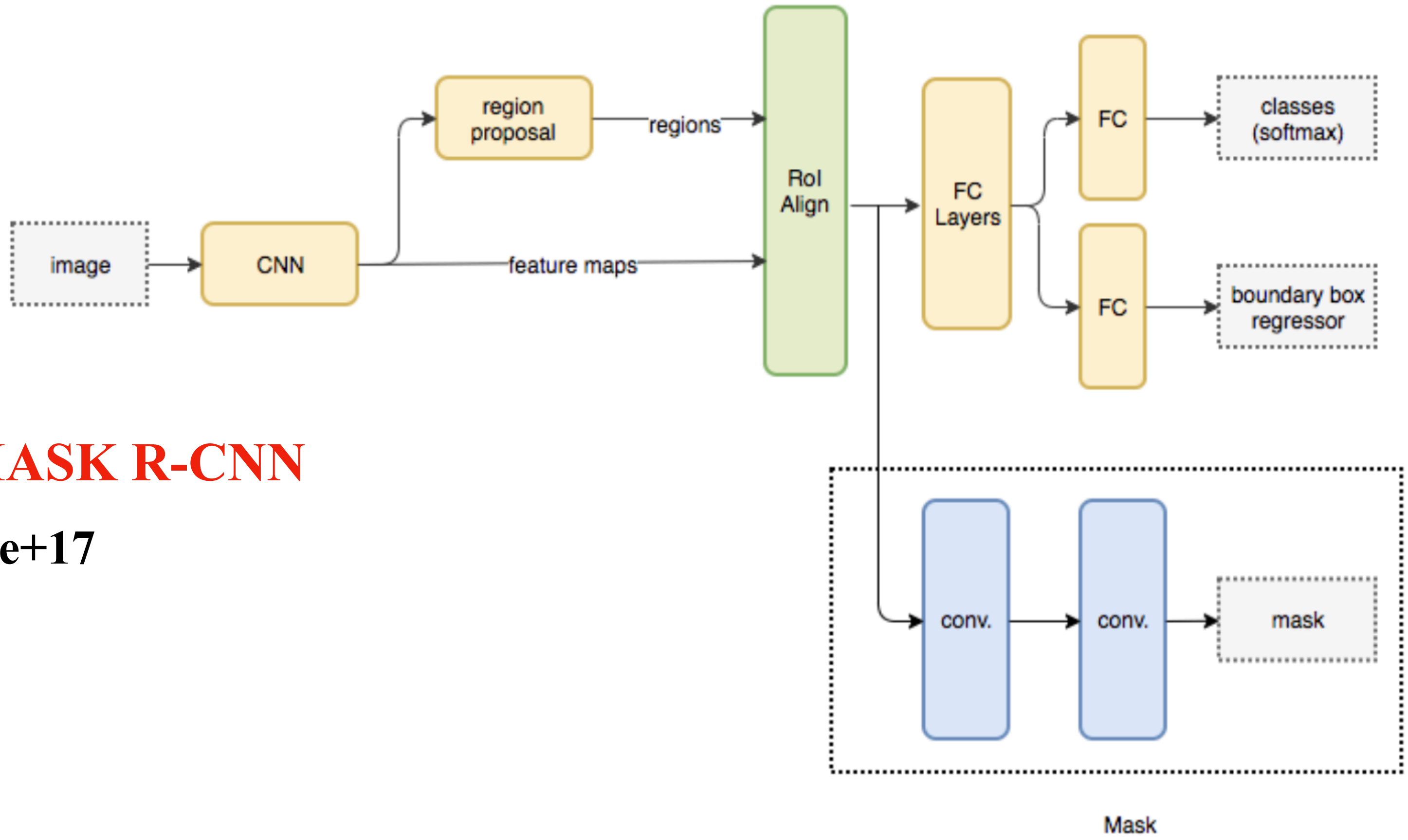
$$\mathcal{J}(\mathbf{P}, \mathbf{T}) = \frac{\mathbf{P} \bigcap \mathbf{T}}{\mathbf{P} \bigcup \mathbf{T}}$$

<u>HOWEVER, THIS IS NOT DIFFERENTIABLE, CANNOT BE USED FOR TRAINING</u>

He+18 Mask R-CNN

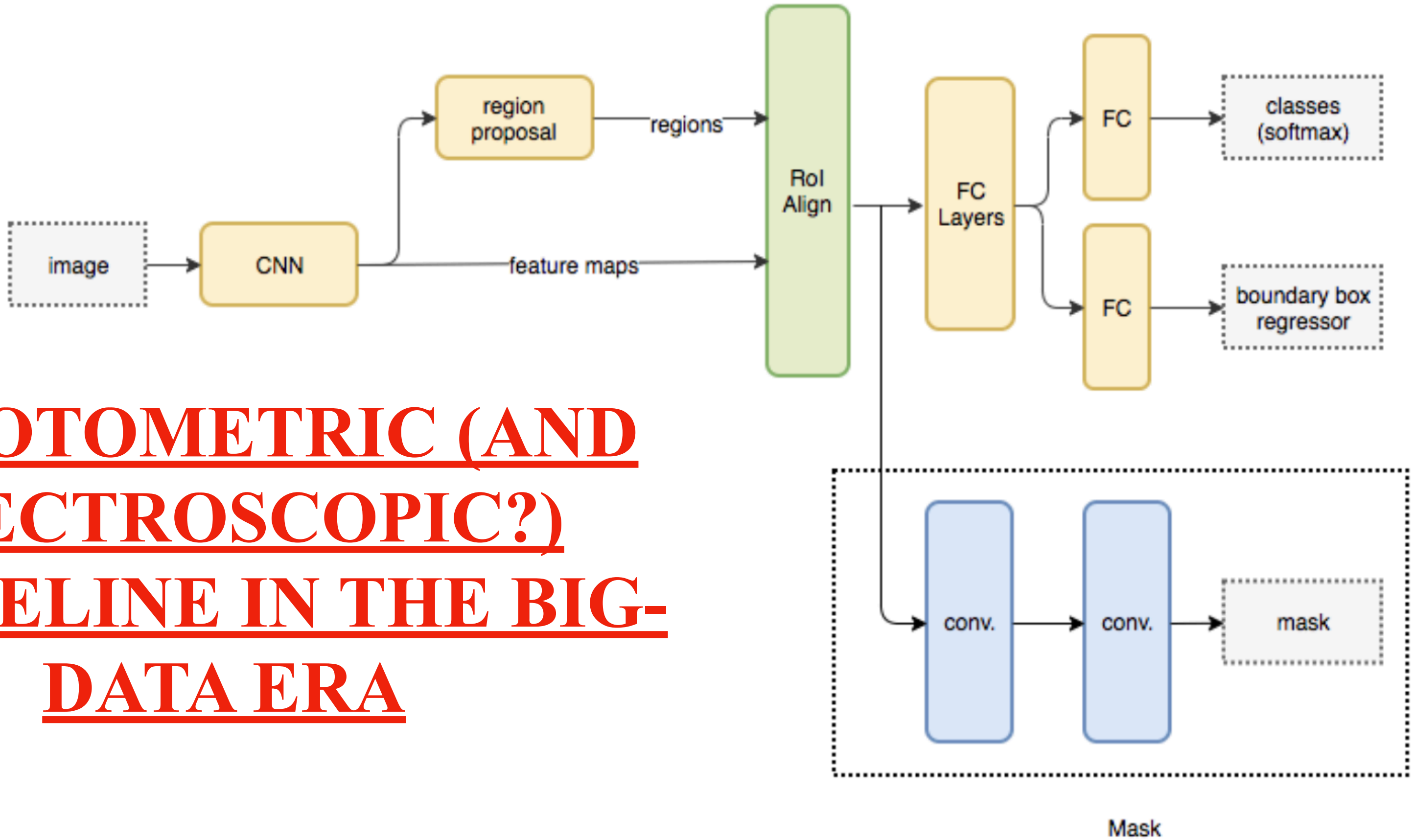
SIMULTANEOUS DETECTION + SEGMENTATION + CLASSIFICATION





MASK R-CNN

He+17

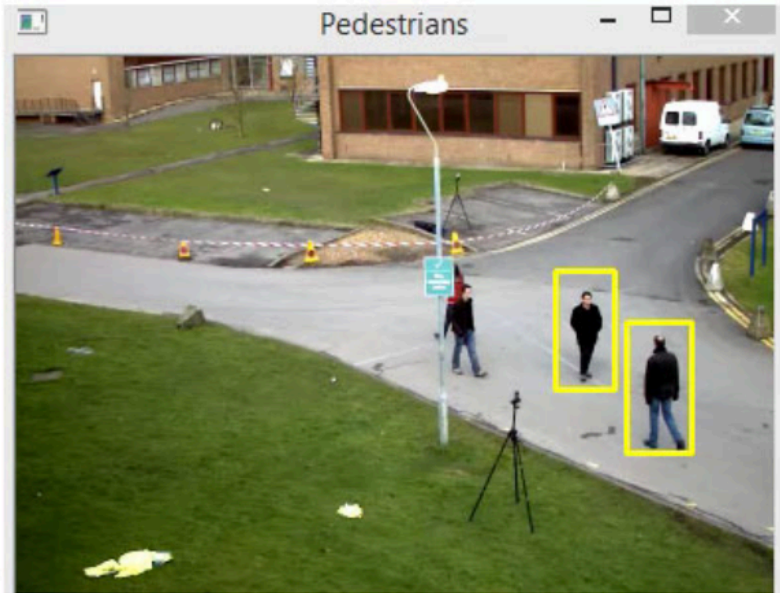


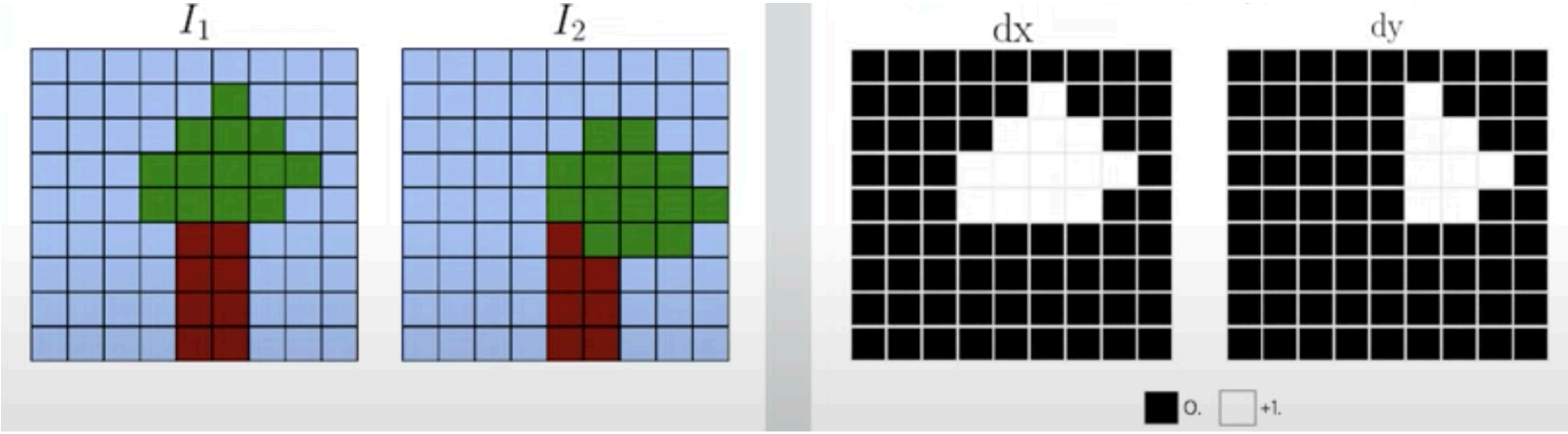
A PHOTOMETRIC (AND SPECTROSCOPIC?) PIPELELINE IN THE BIG-DATA ERA

He+17

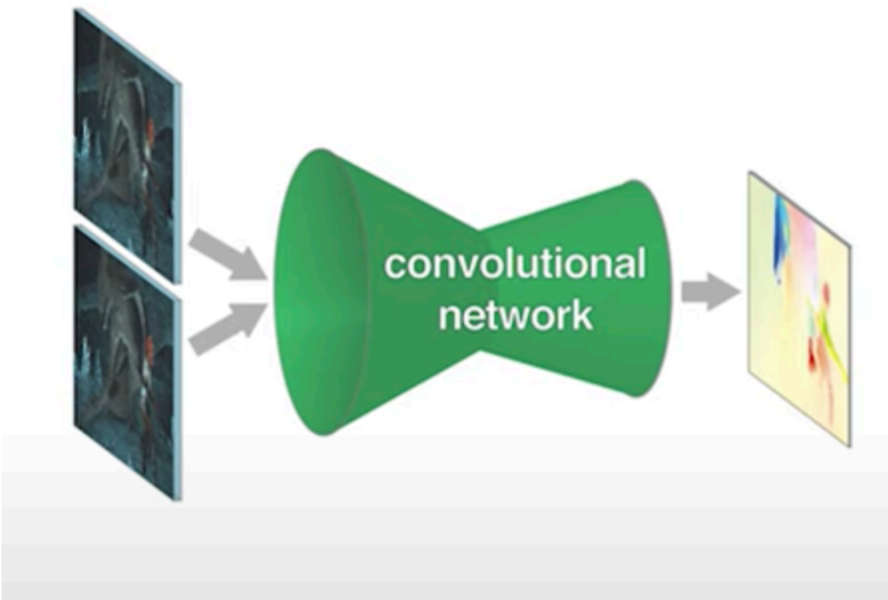
BEYOND SINGLE IMAGE INPUT...

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