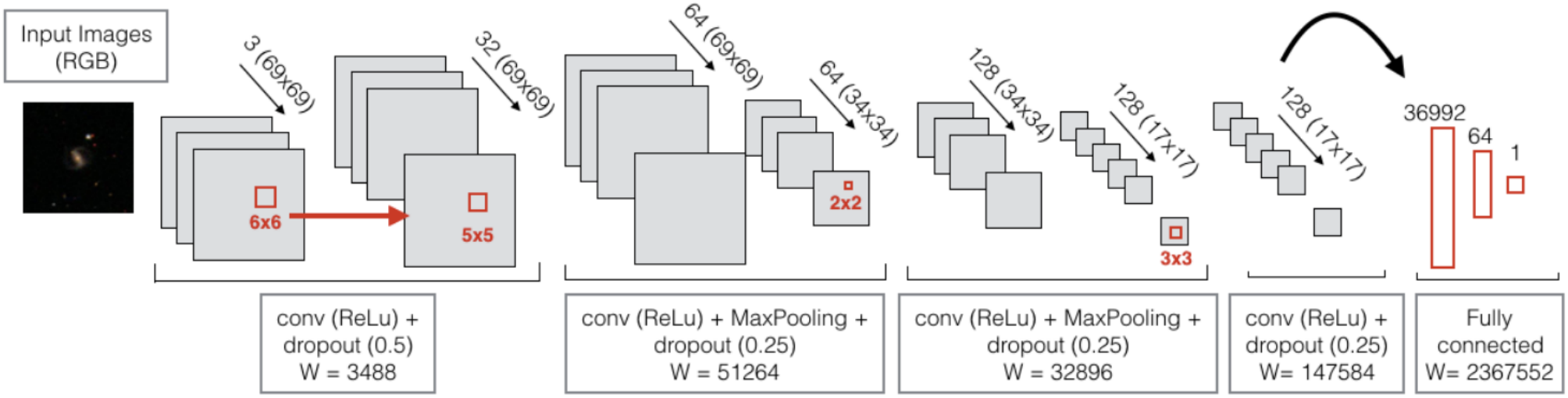
PART IV: BEYOND CLASSIFICATION: IMAGE2IMAGE NETWORKS

UP TO NOW CNNs MAP IMAGES (SIGNALS) INTO FLOATS



Dominguez-Sanchez+18

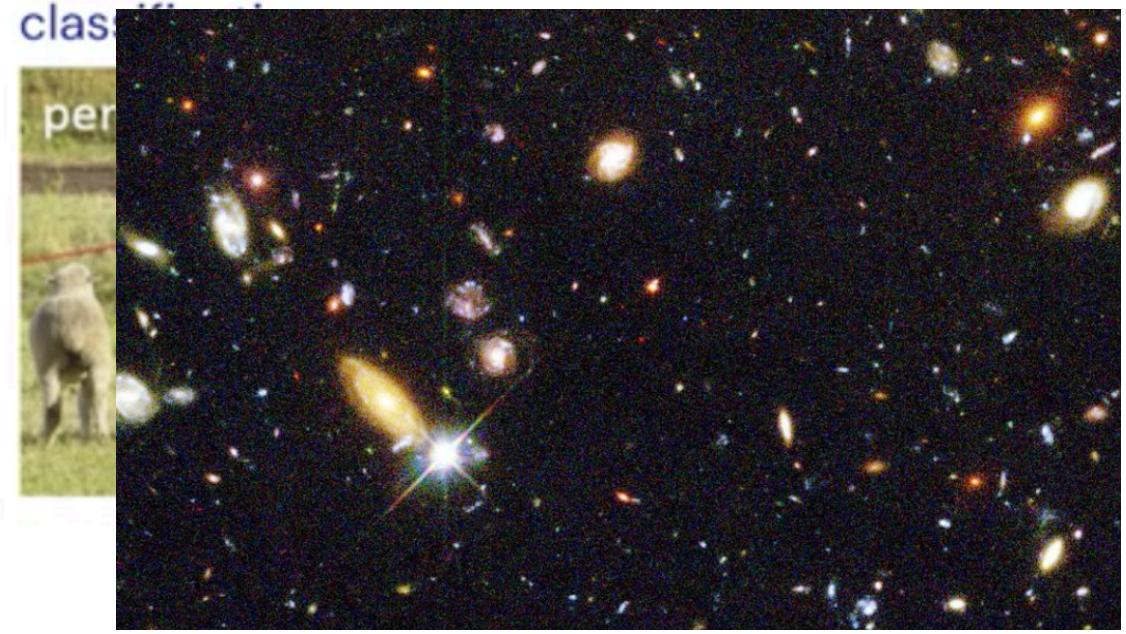
Classification has its limits ....

HOW DO I CLASSIFY THIS IMAGE?

Classification has its limits ....

HOW DO I CLASSIFY THIS IMAGE?

Classification has its limits ....

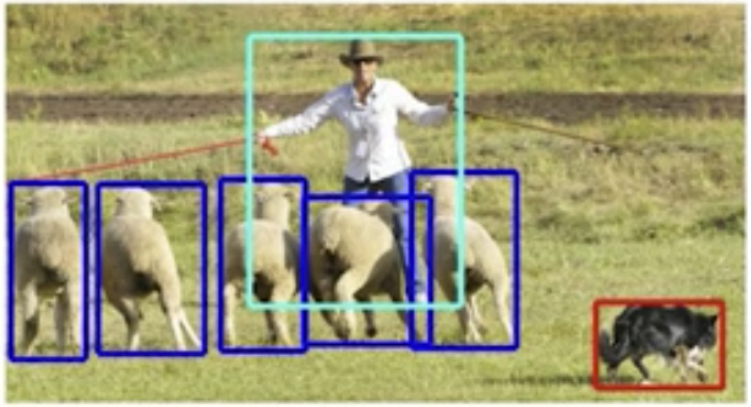


HOW DO I CLASSIFY THIS IMAGE?

Going beyond classificaiton: increasing complexity

classification

object detection



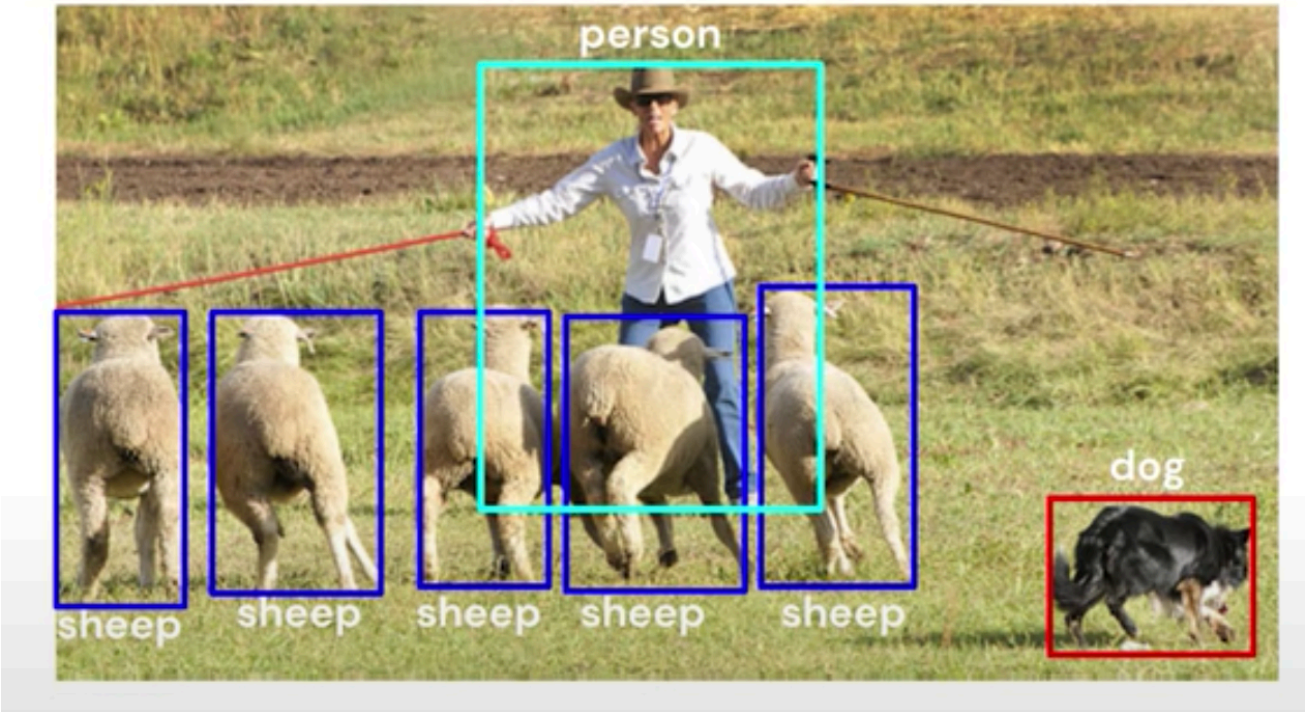
semantic segmentation

instance segmentation

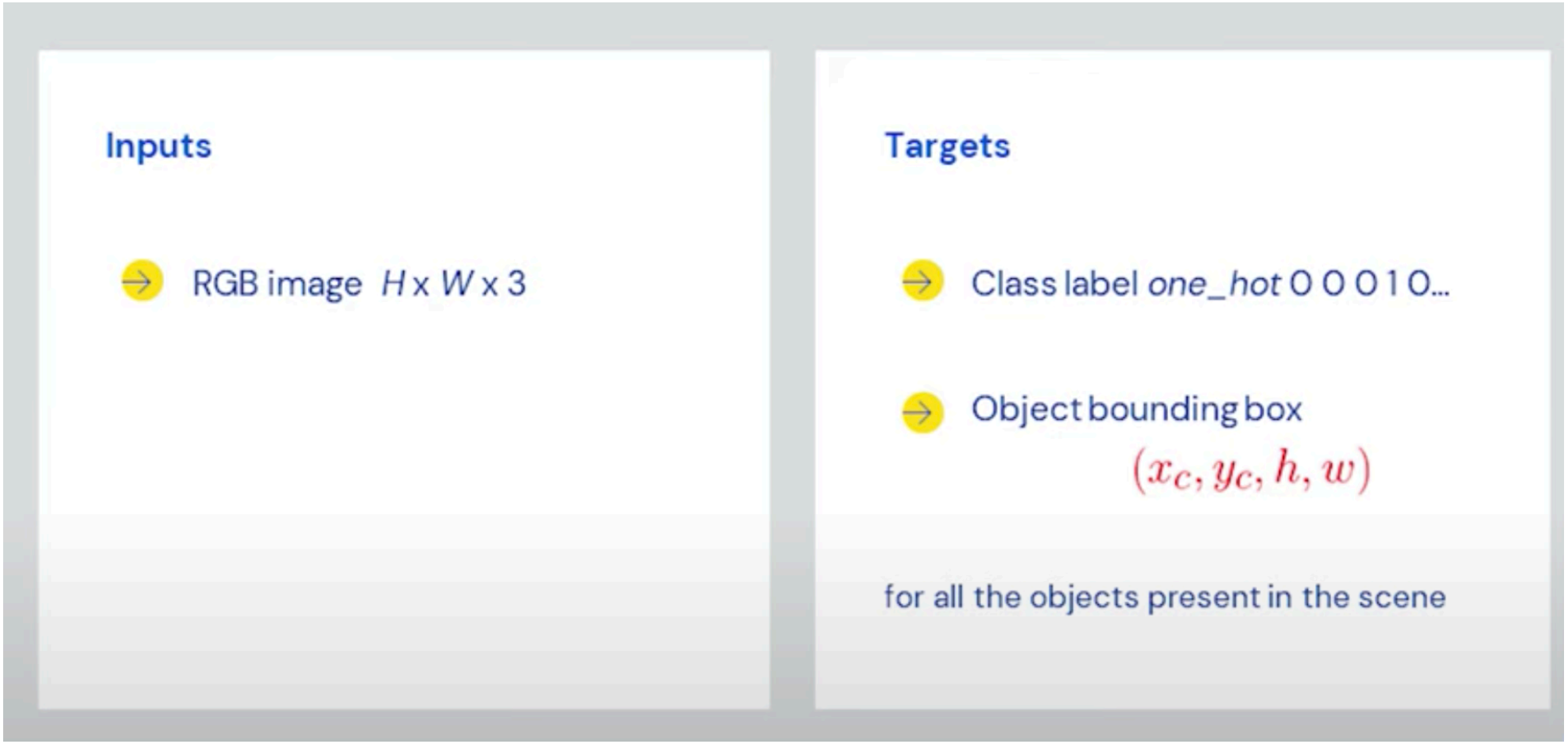
@deepmind (V. Patraucean)

Object detection

First task is to find a bounding box for every object. How we do that?



@deepmind (V. Patraucean)



@deepmind (V. Patraucean)

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Text **MARCHUERTASC257** to **22333** once to join

What would be the loss function of such a problem?

Cross Entropy

MSE

Other

Don't know

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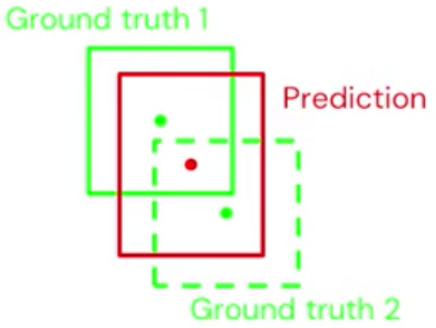
WHAT WOULD BE THE LOSS FUNCTION OF SUCH A PROBLEM?

$$\frac{1}{N}\sum_{i=1}^{N}(y_i - p_i)^2$$



IT IS A REGRESSION WITH A SIMPLE QUADRATIC LOSS. WE TRY TO FIND THE BEST COORDINATES OF THE BOUNDING BOX.

@deepmind (V. Patraucean)

WHAT WOULD BE THE LOSS FUNCTION OF SUCH A PROBLEM?

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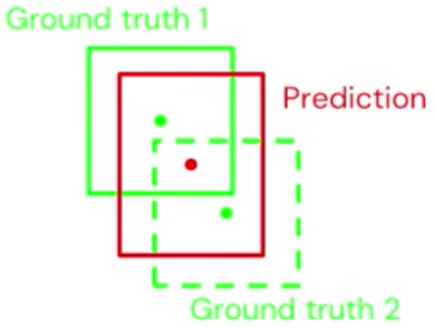
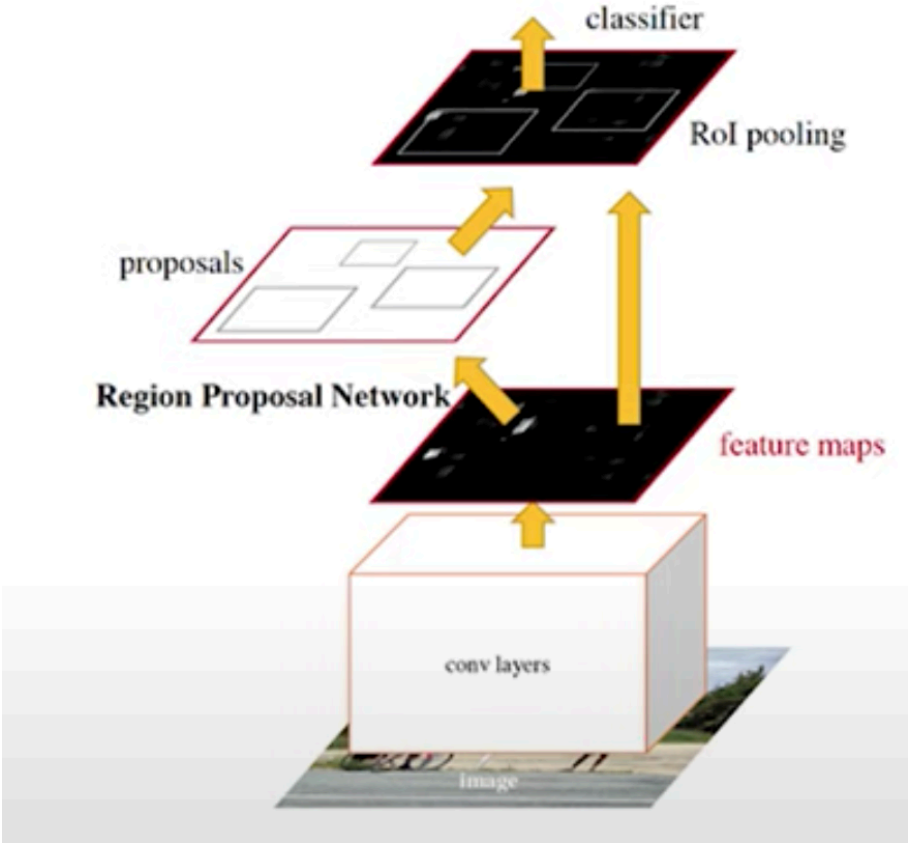


IT IS A REGRESSION WITH A SIMPLE QUADRATIC LOSS. WE TRY TO FIND THE BEST COORDINATES OF THE BOUNDING BOX.

IT BECOMES MESSY QUITE RAPIDLY...

EXAMPLE: FASTER R-CNN

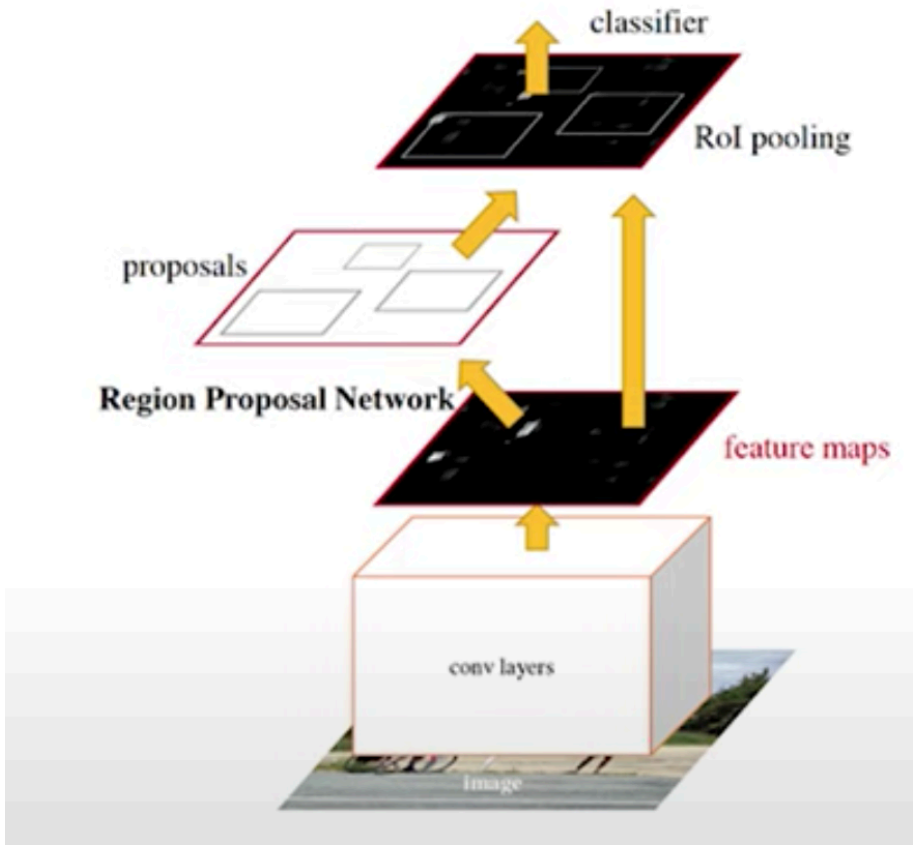


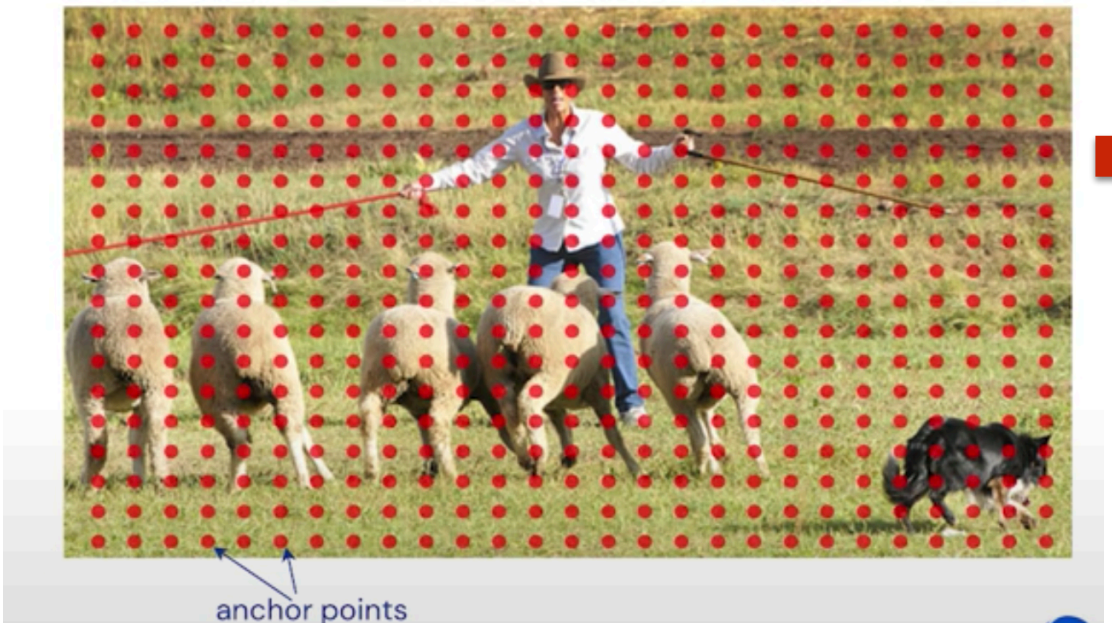
We divide the task in 2 steps:

1. Identify bounding box candidates (CLASSIFICATION)

2. Classify and Refine (REGRESSION)

Ren+16


classifier
RoI pooling
proposals
Region Proposal Network
feature maps
conv layers
image



Discretize Bounding Box Space

Choose n candidates per position

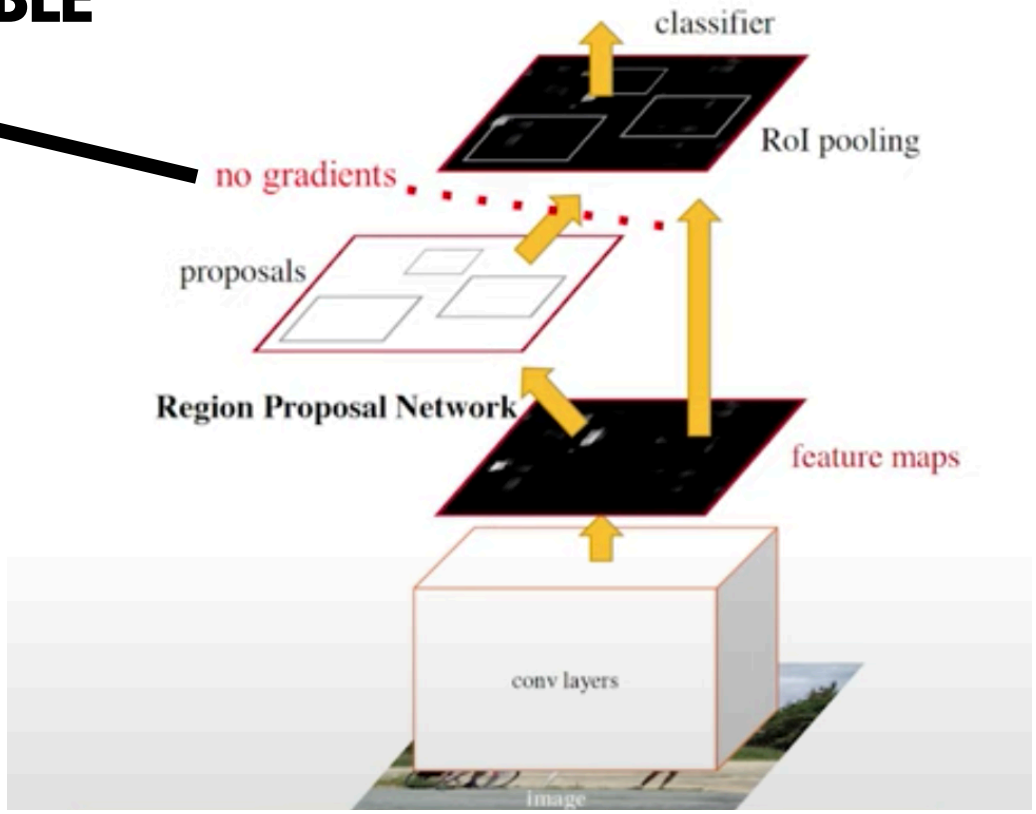
Predict objectness score (classifcation)

Sort and keep top K

@deepmind (V. Patraucean)

THIS IS NOT DIFFERENTIABLE

(FIXED)



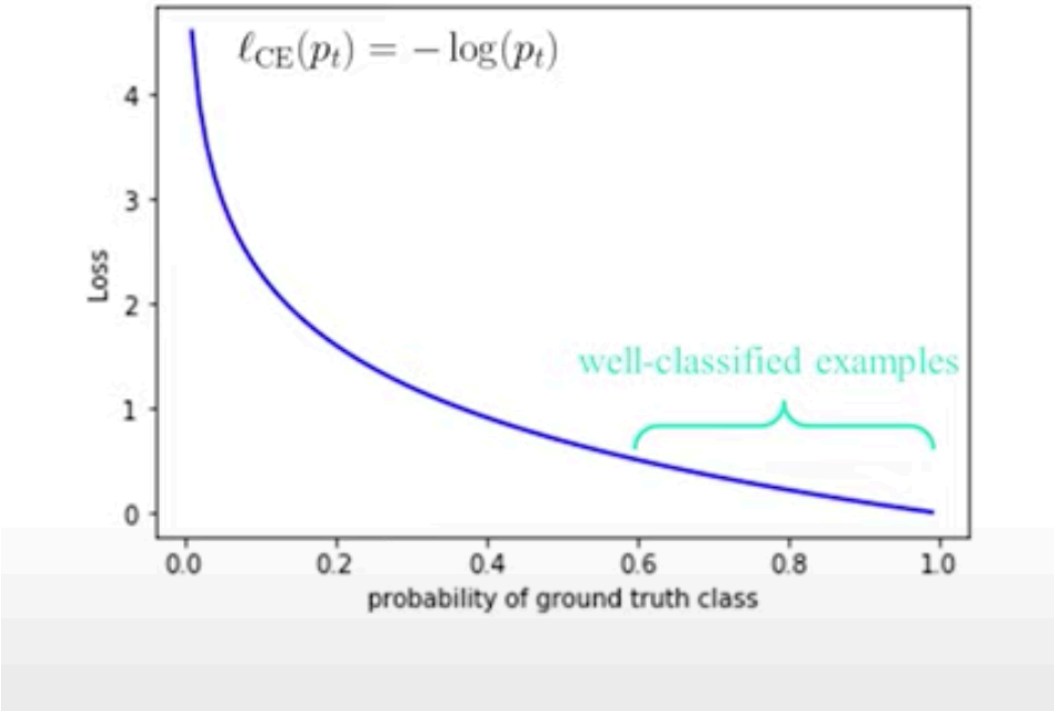
WAYS OF MAKING THIS DIFFERENTIABLE:

Spatial Transformer Networks (Jaderberg+18)

WHY NOT DOING IT ONE STAGE?

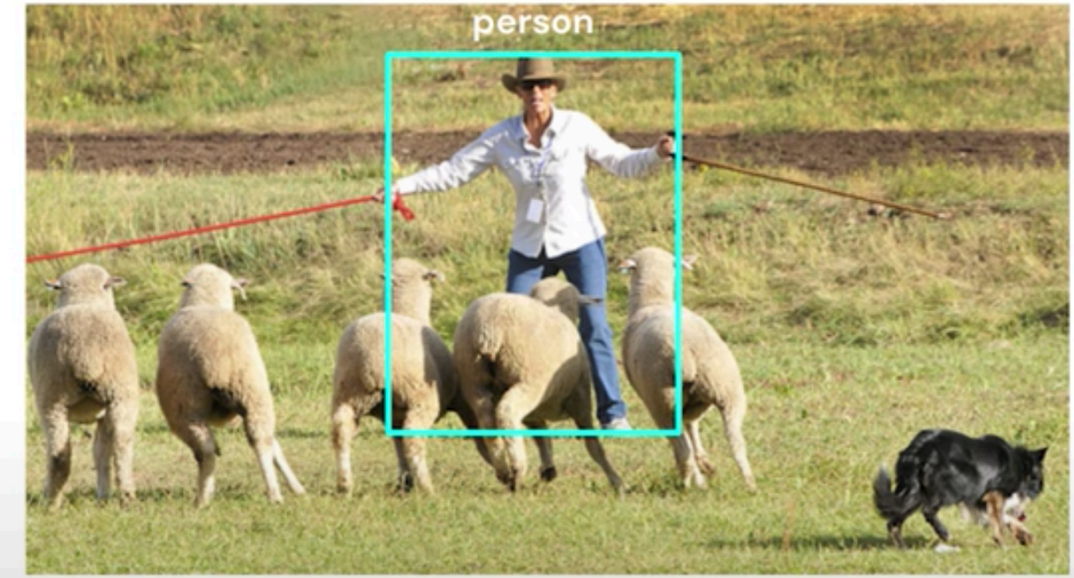
MOST OF THE CANDIDATES
ARE BACKGROUND,
EASY TO IDENTIFY

THE LOSS OF THE MANY
EASY EXAMPLES
DOMINATES OVER THE
RARE USEFUL ONES

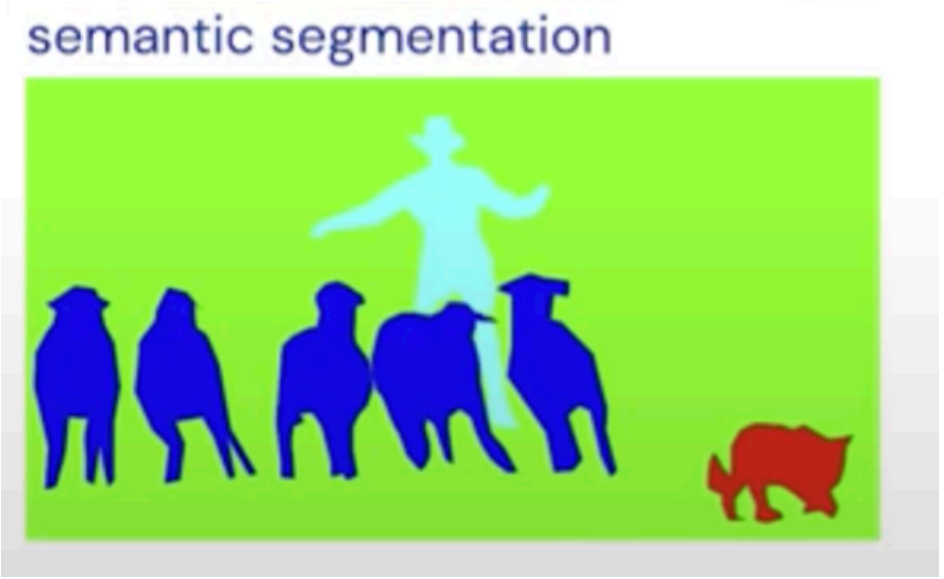


@deepmind (V. Patraucean)

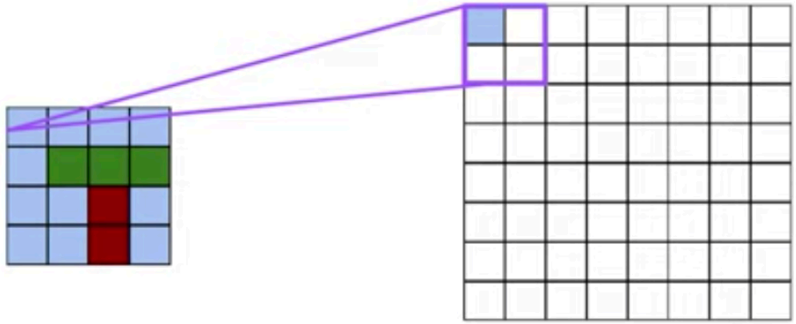
LET'S GO A STEP FURTHER INTO SEMANTIC SEGMENTATION



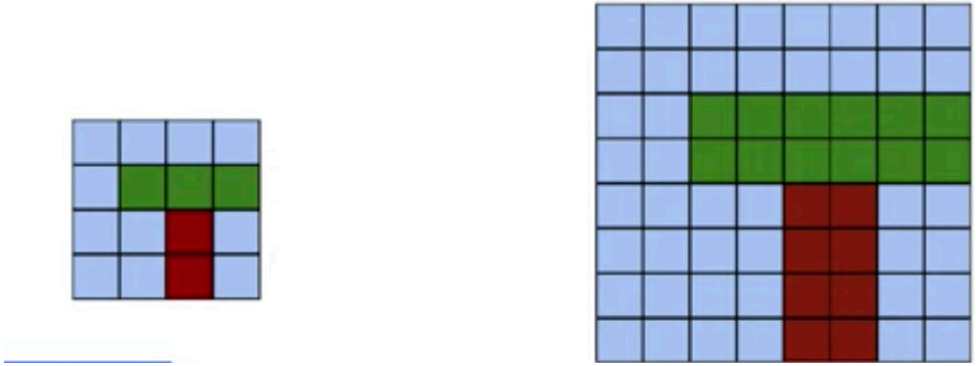
BOUNDING BOXES ARE NOT ALWAYS GOOD REPRESENTATIONS



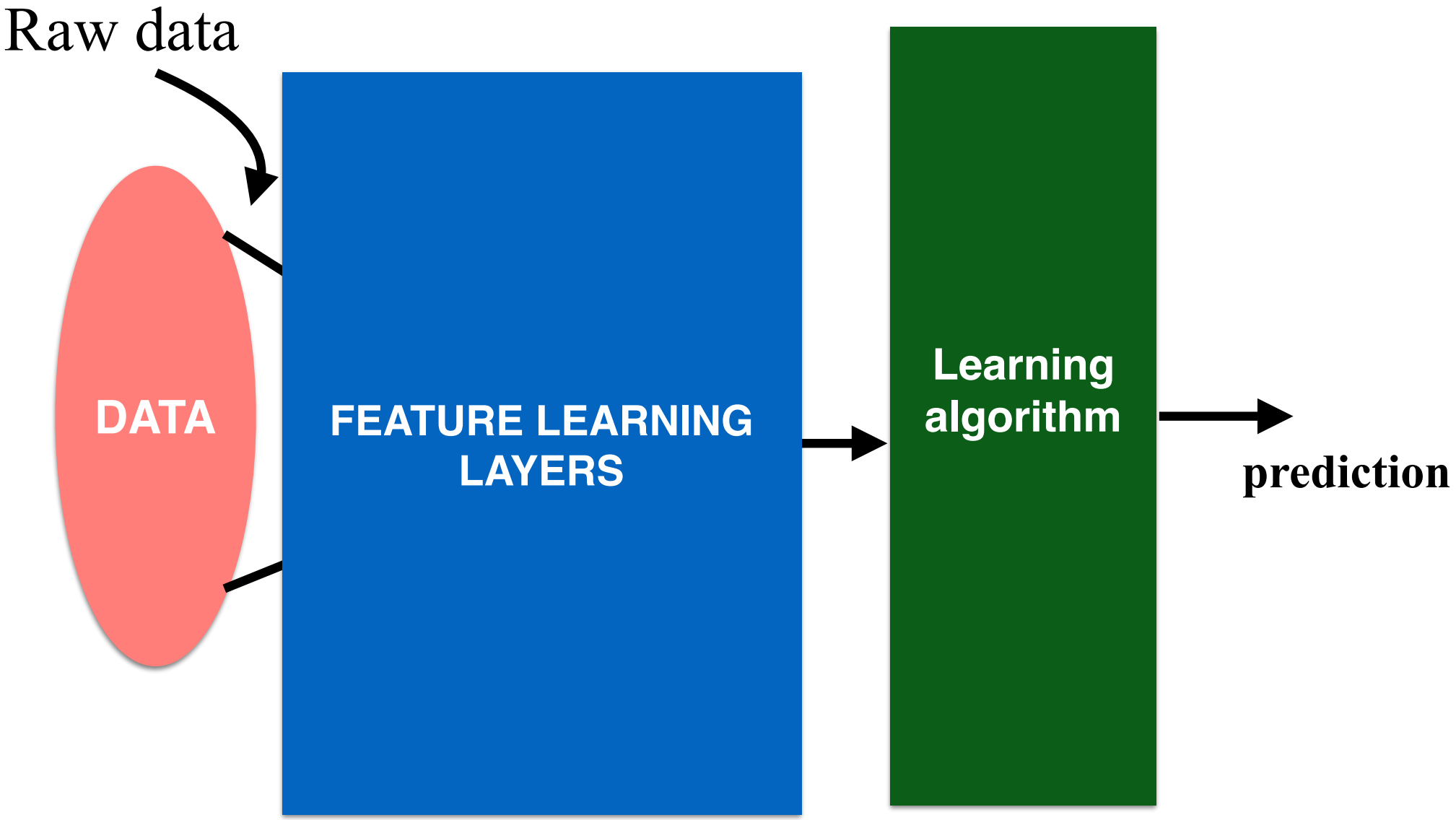
UNPOOLING OPERATION (INVERSE OF POOLING)



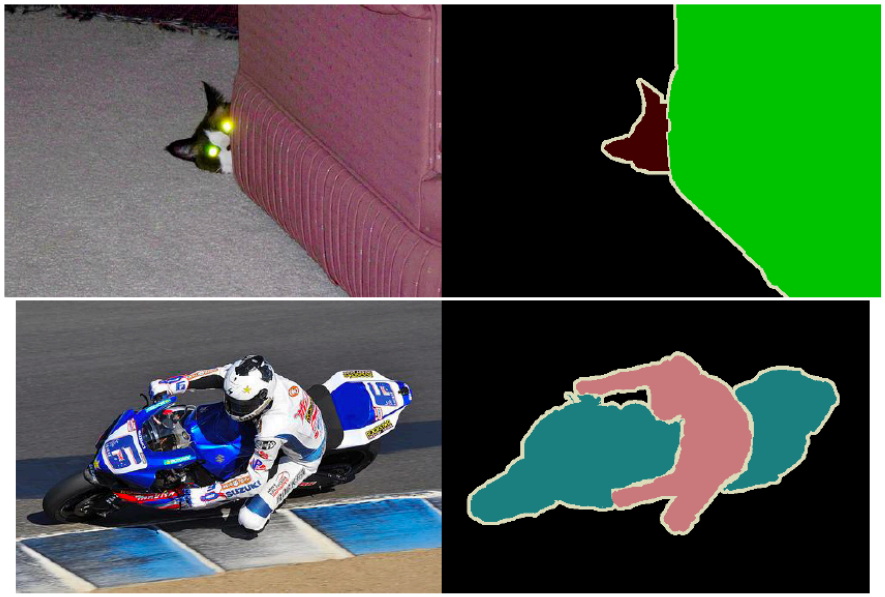
COPY PIXELS IN A GIVEN WINDOW



GENERATES LARGER IMAGES FROM SMALLER ONES

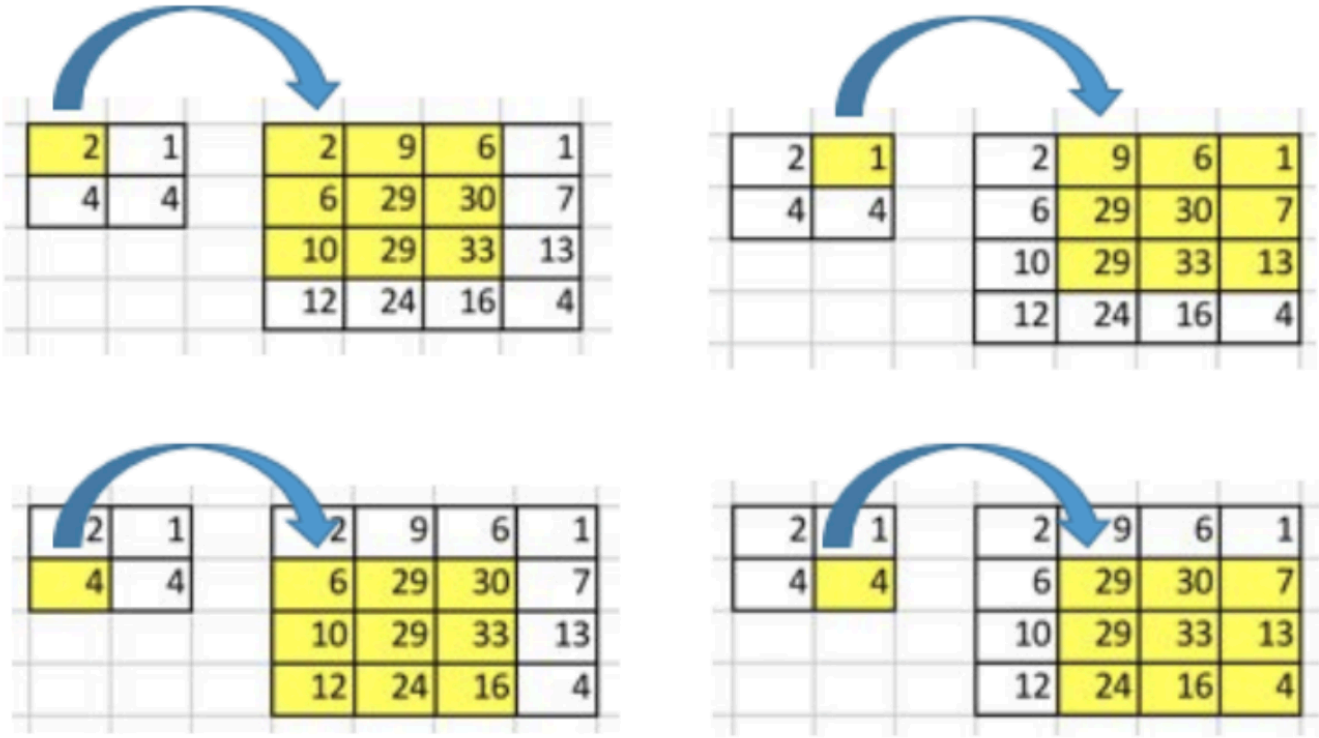

Raw data
DATA
FEATURE LEARNING LAYERS
Learning algorithm
prediction

FIRST: IMAGE SEGMENTATION WITH ENCODERS-DECODERS



TRANSPOSED CONVOLUTION

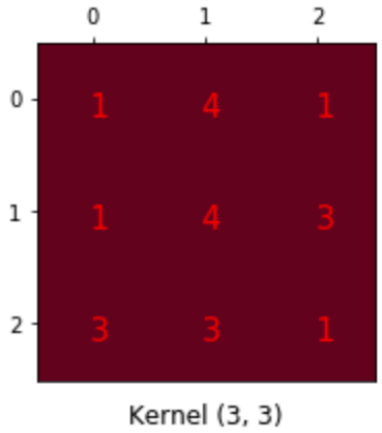
ALLOWS TO INCREASE THE SIZE



Going Backward of Convolution

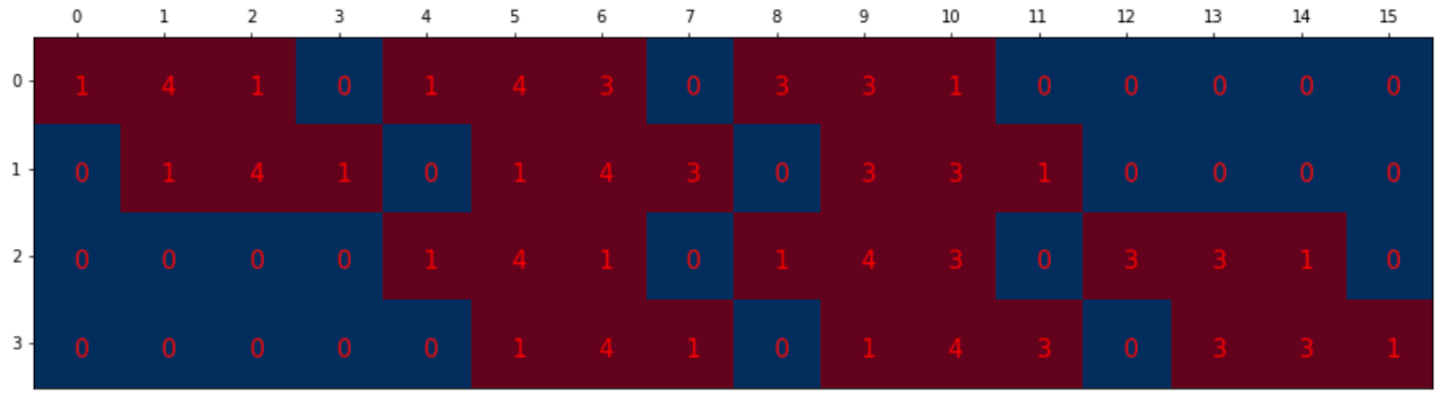
EXAMPLE TAKEN FROM HERE

CONVOLUTION MATRIX



Kernel (3, 3)

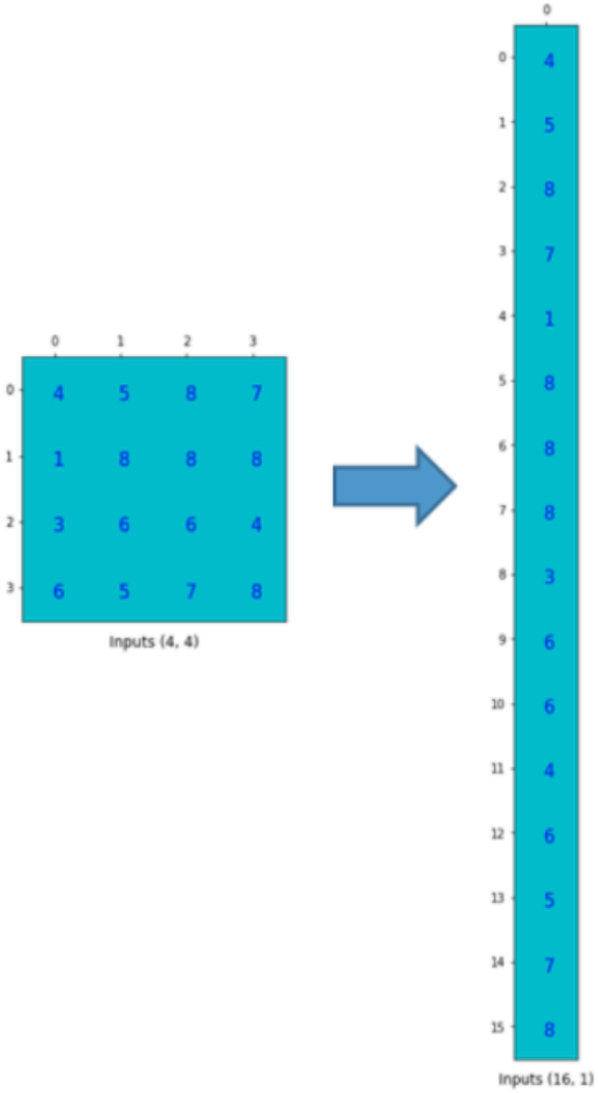
THE KERNEL CAN BE ARRANGED IN FORM OF A MATRIX:



Convolution Matrix (4, 16)

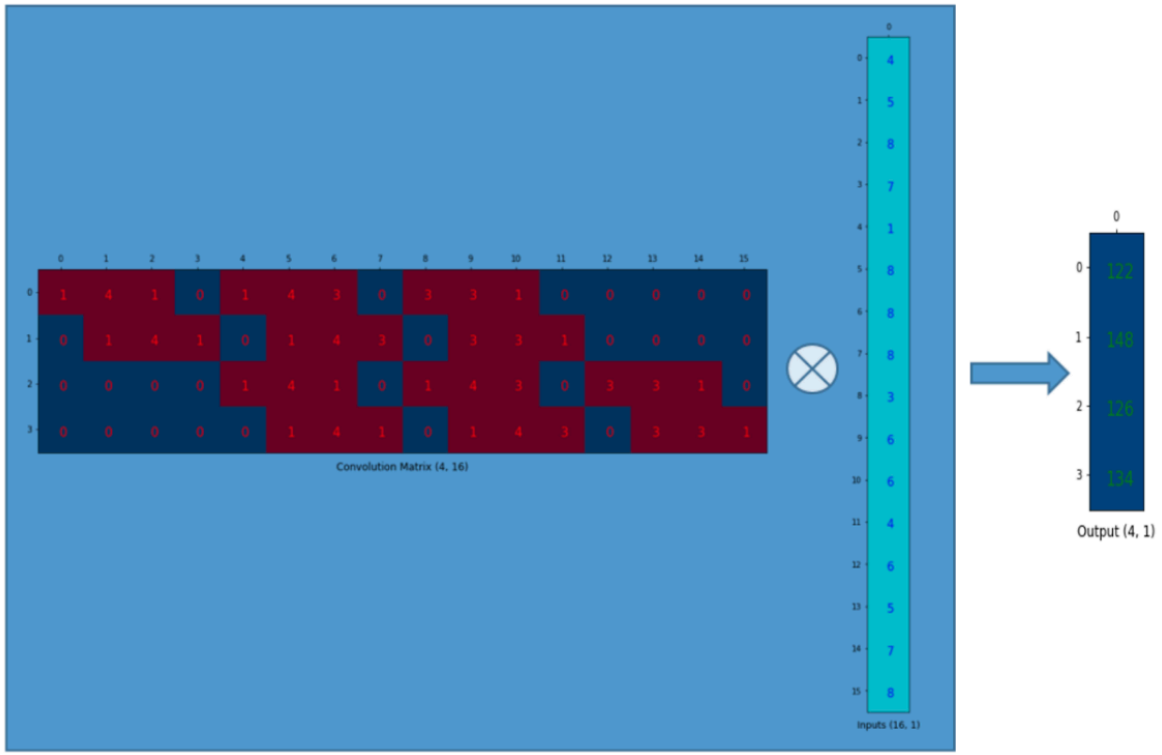
EXAMPLE TAKEN FROM HERE

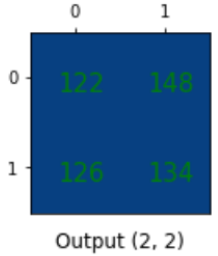
THE INPUT IS FLATTENED INTO A COLUMN VECTOR



EXAMPLE TAKEN FROM HERE

THE CONVOLUTION IS TRANSFORMED INTO A PRODUCT OF MATRICES

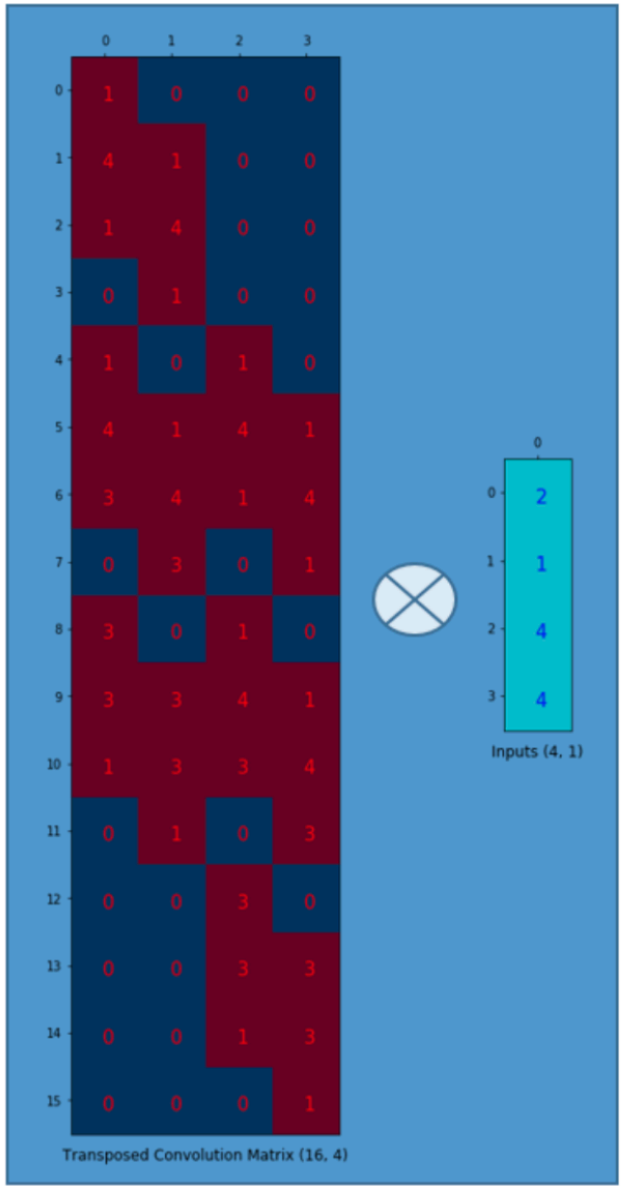


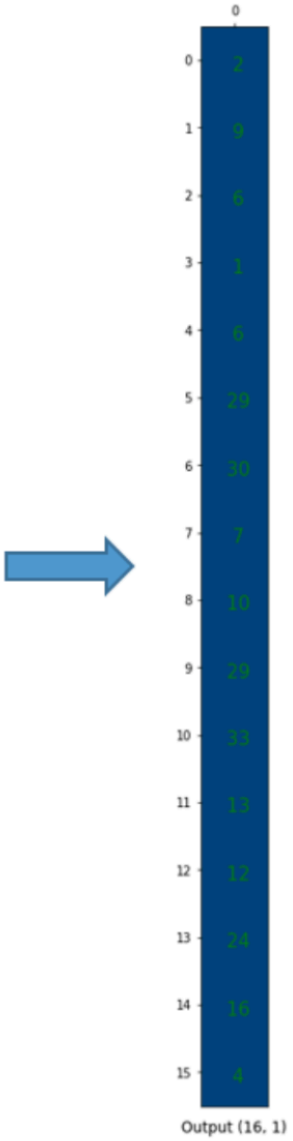


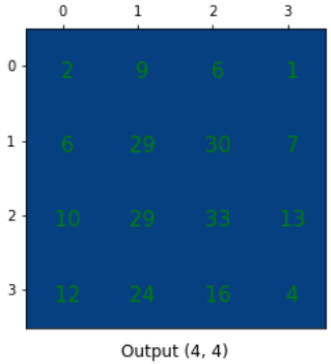
RESHAPED OUTPUT

EXAMPLE TAKEN FROM HERE

THE TRANSPOSED CONVOLUTION IS THE INVERSE OPERATION



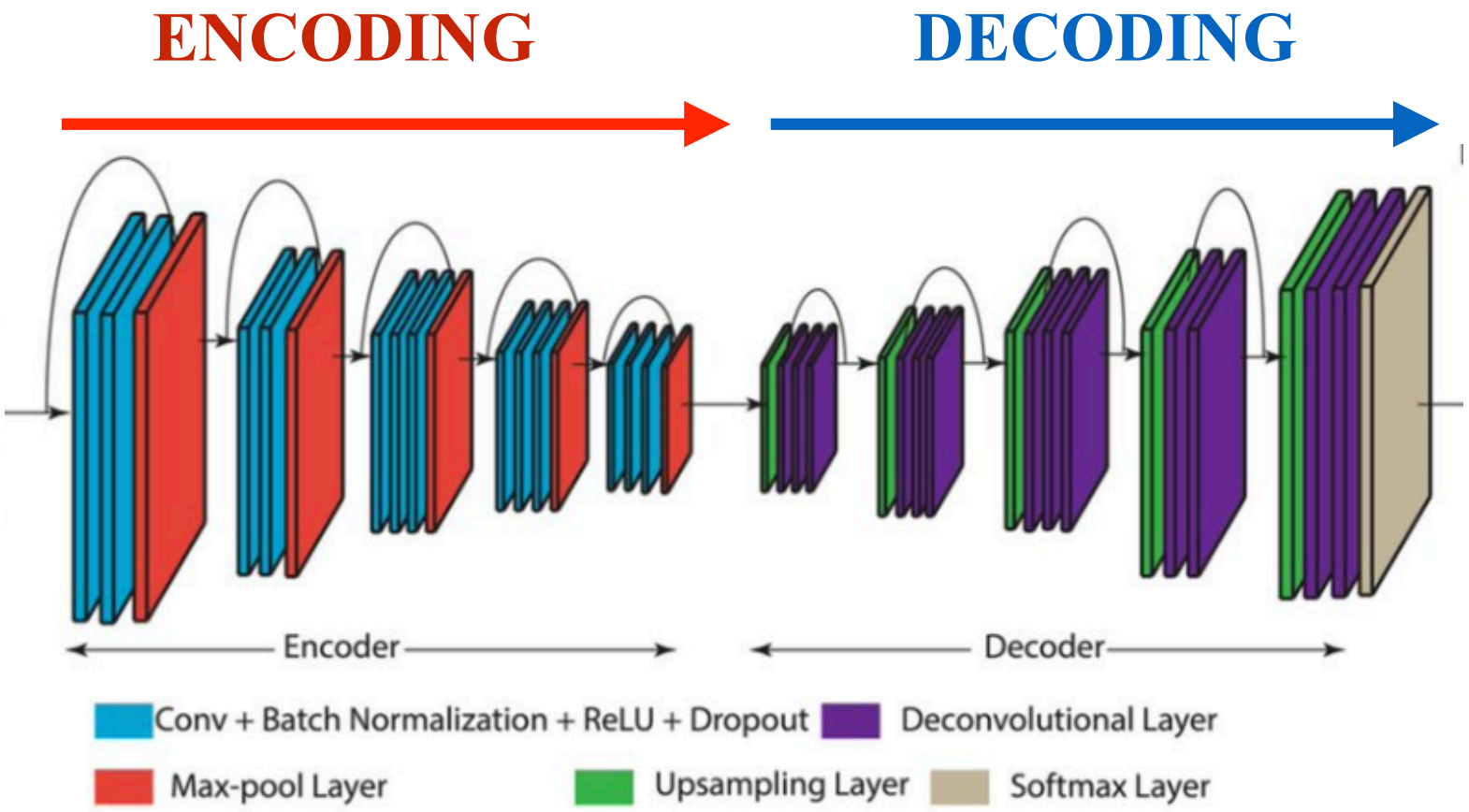




RESHAPED OUTPUT

EXAMPLE TAKEN FROM HERE

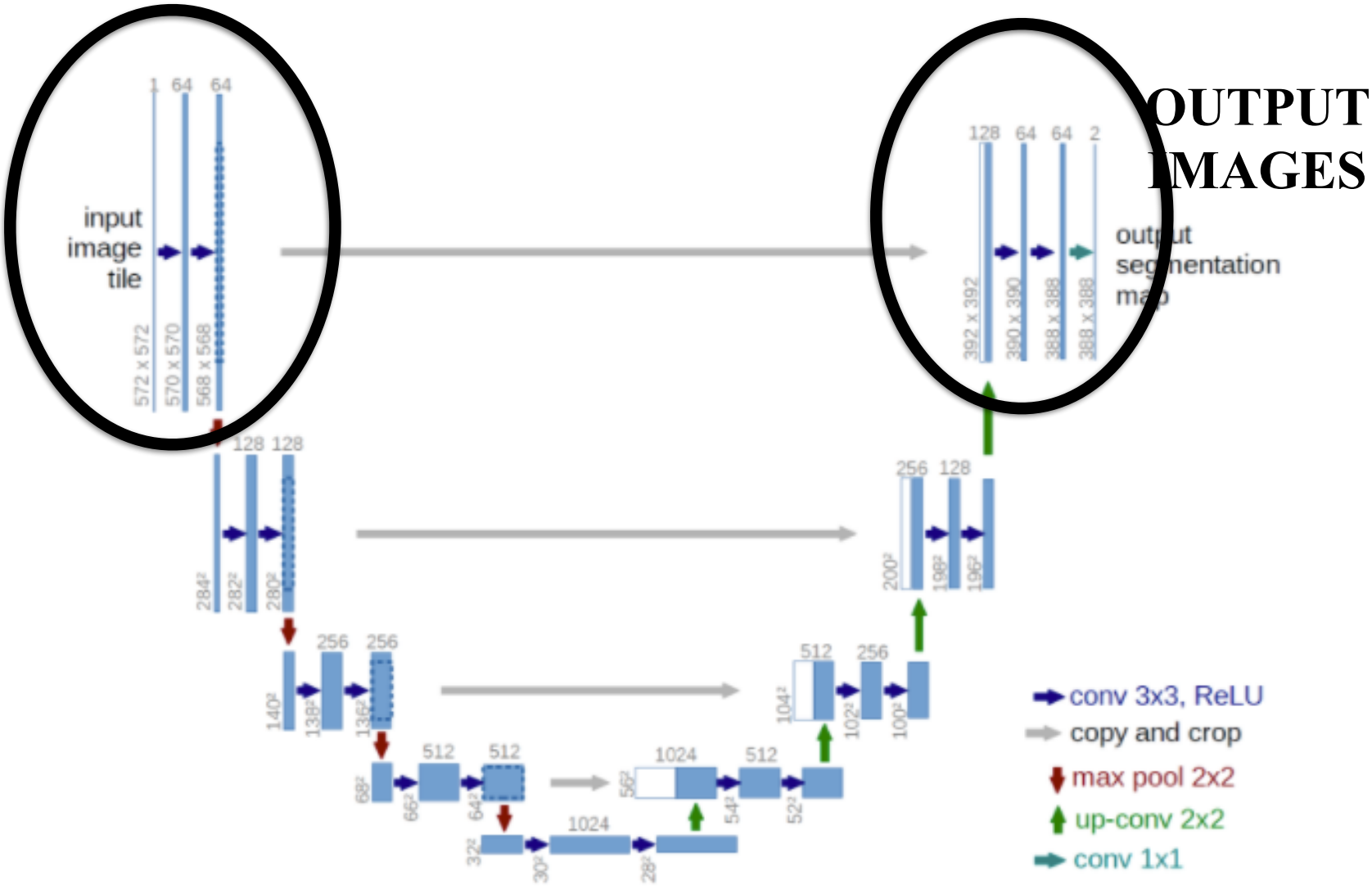
ENCODER-DECODERS GO FROM IMAGE 2 IMAGE



WE CALL THIS FULLY CONVOLUTIONAL NEURAL NETWORKS

ENCODING-DECODING TO EXTRACT IMAGE FEATURES: U-NET

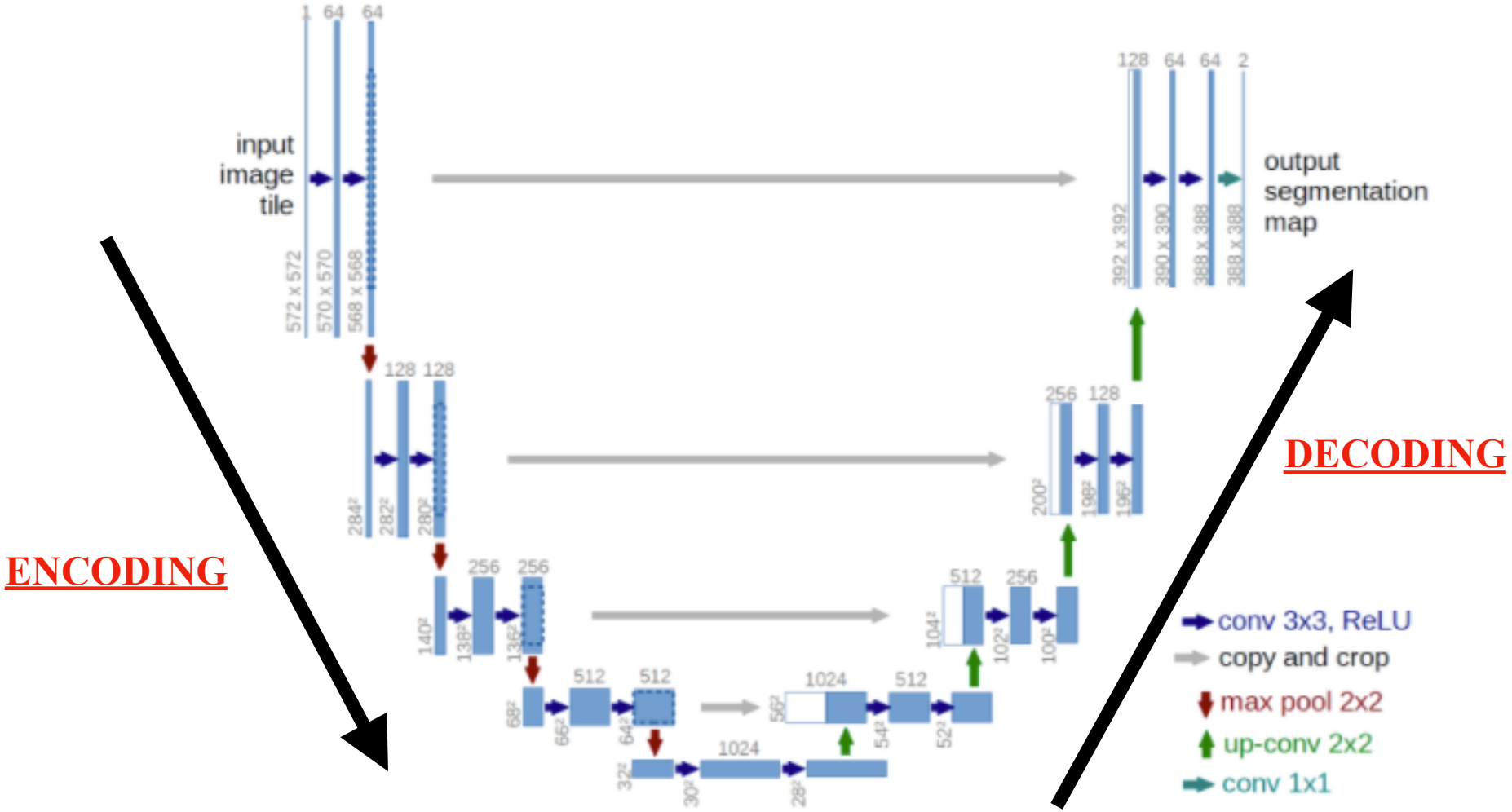
INPUT IMAGES



OUTPUT IMAGES

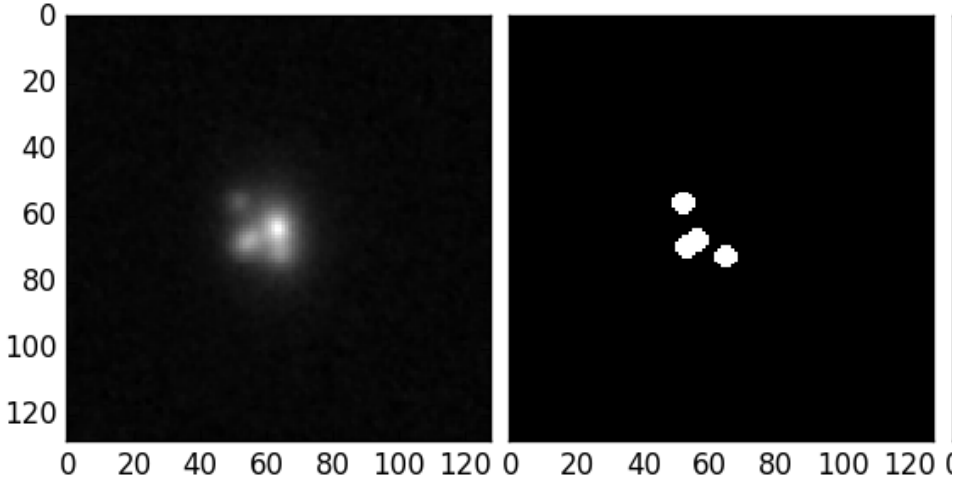
Ronnerberger+15

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

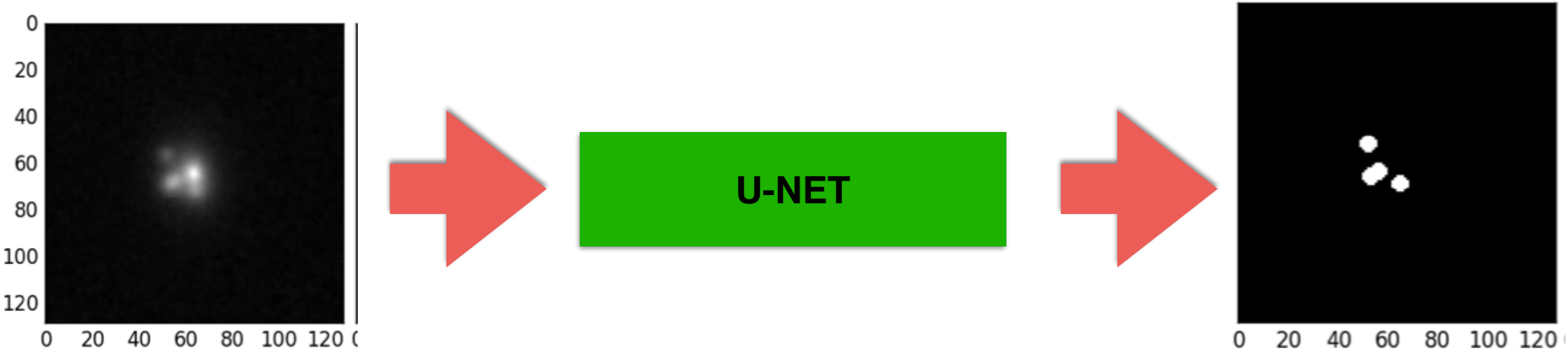


Ronnerberger+15

VERY SIMPLE SERSIC ANALYTIC SIMULATIONS + UNRESOLVED CLUMPS



CLUMP POSITION IS KNOWN



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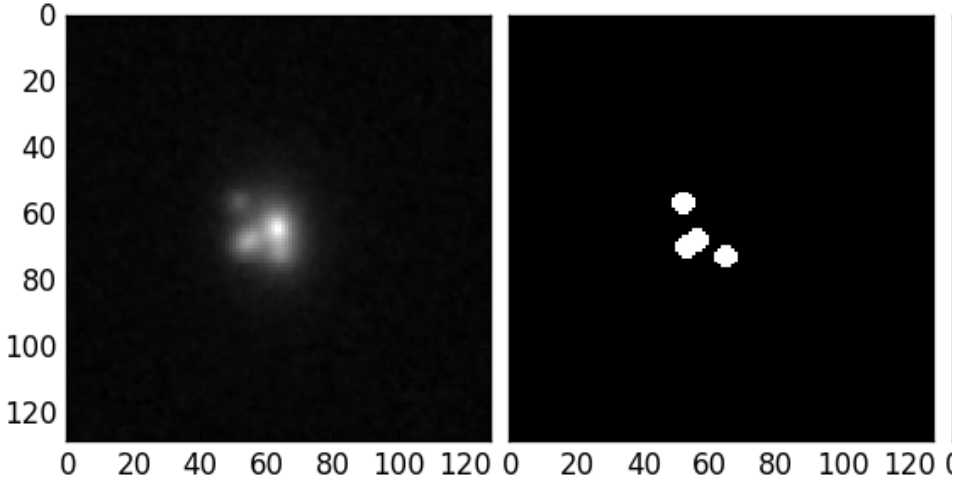
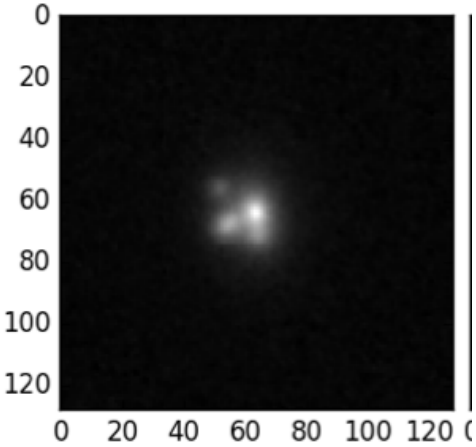
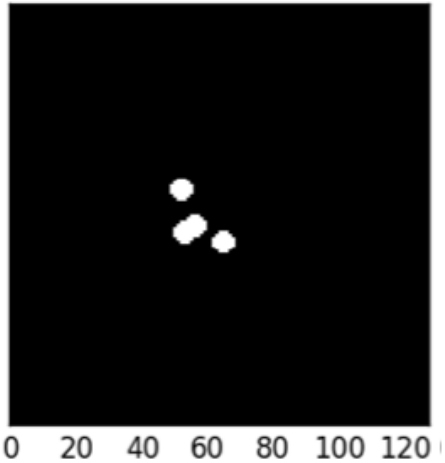


CLUMP POSITION IS KNOWN



U-NET



WHAT LOSS FUNCTION?

When poll is active, respond at **pollev.com/marchuertasc257**
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What loss function for the UNet?

Binary CrossEntropy

Mean Square Error

Both combined

Other

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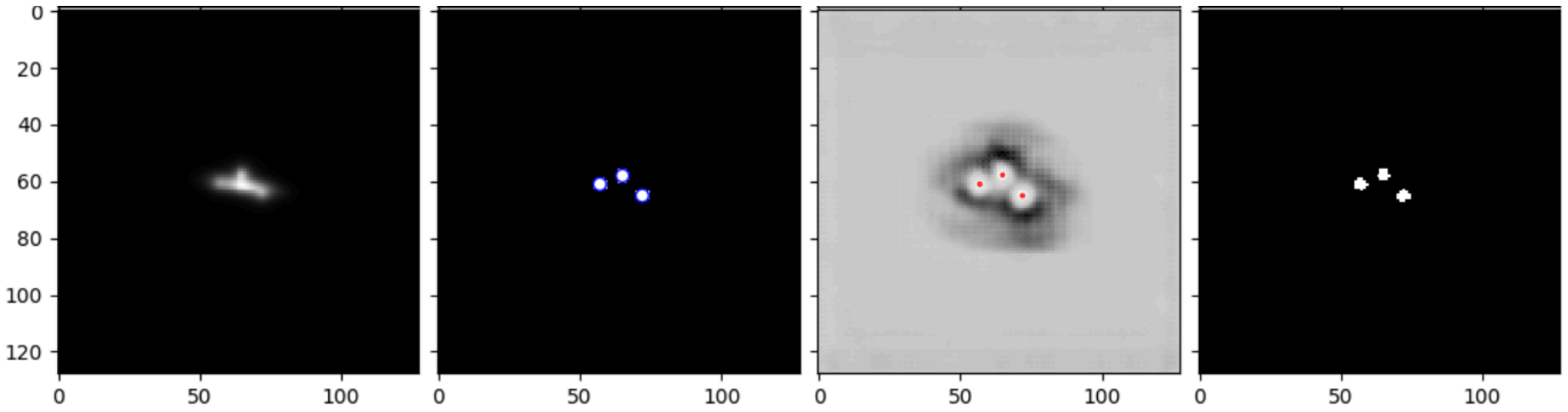
SIMULATED GALAXY

CLUMP MASK

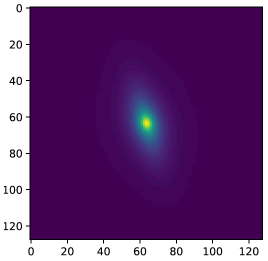
NETWORK PROBA MAP

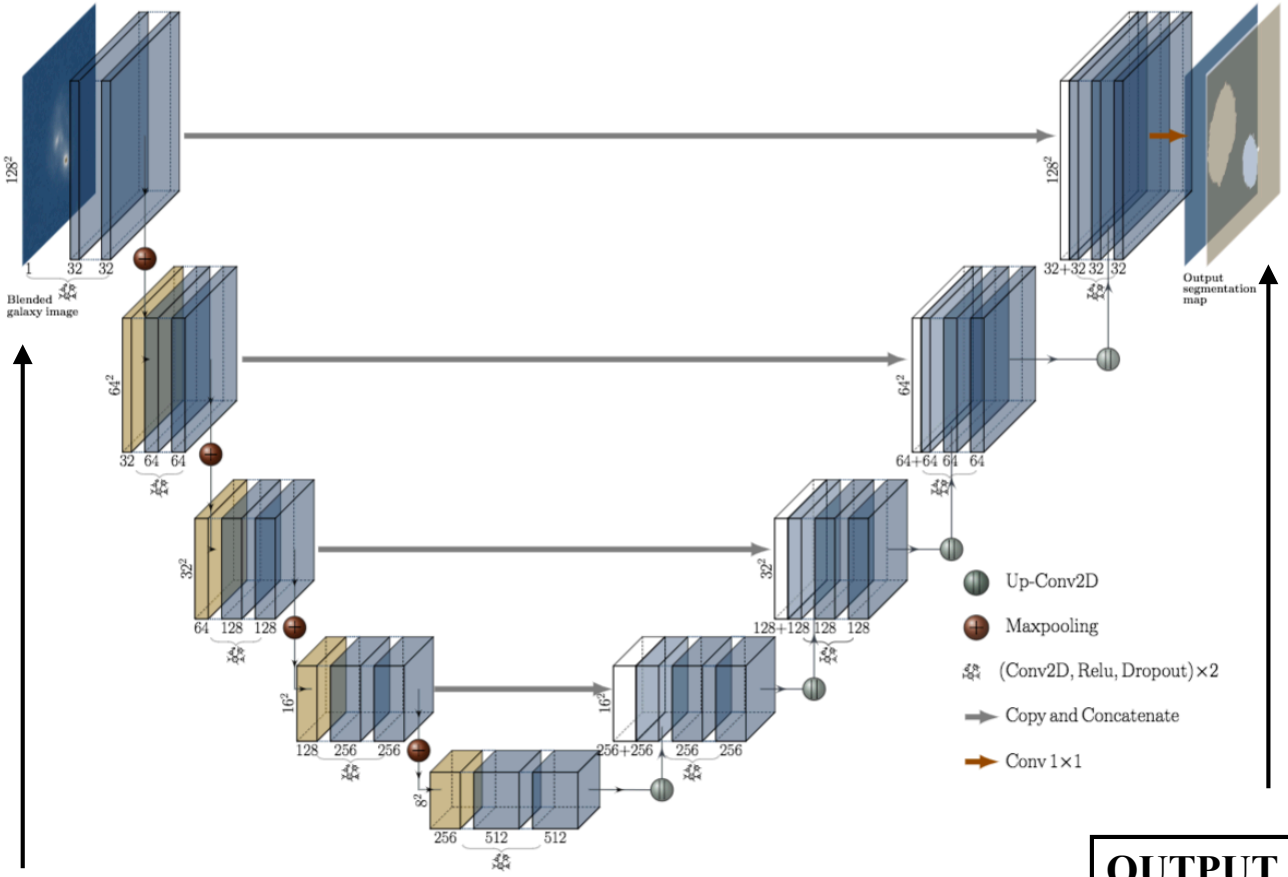
NETWORK OUTPUT THRESHOLDED (SEXTRACTOR)



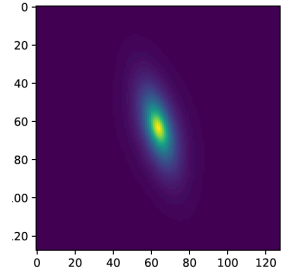
LEE, MHC, PRIMACK+ 19

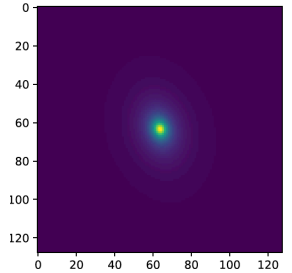
ALSO REGRESSION…





DISK





BULGE

GALAXY STAMP

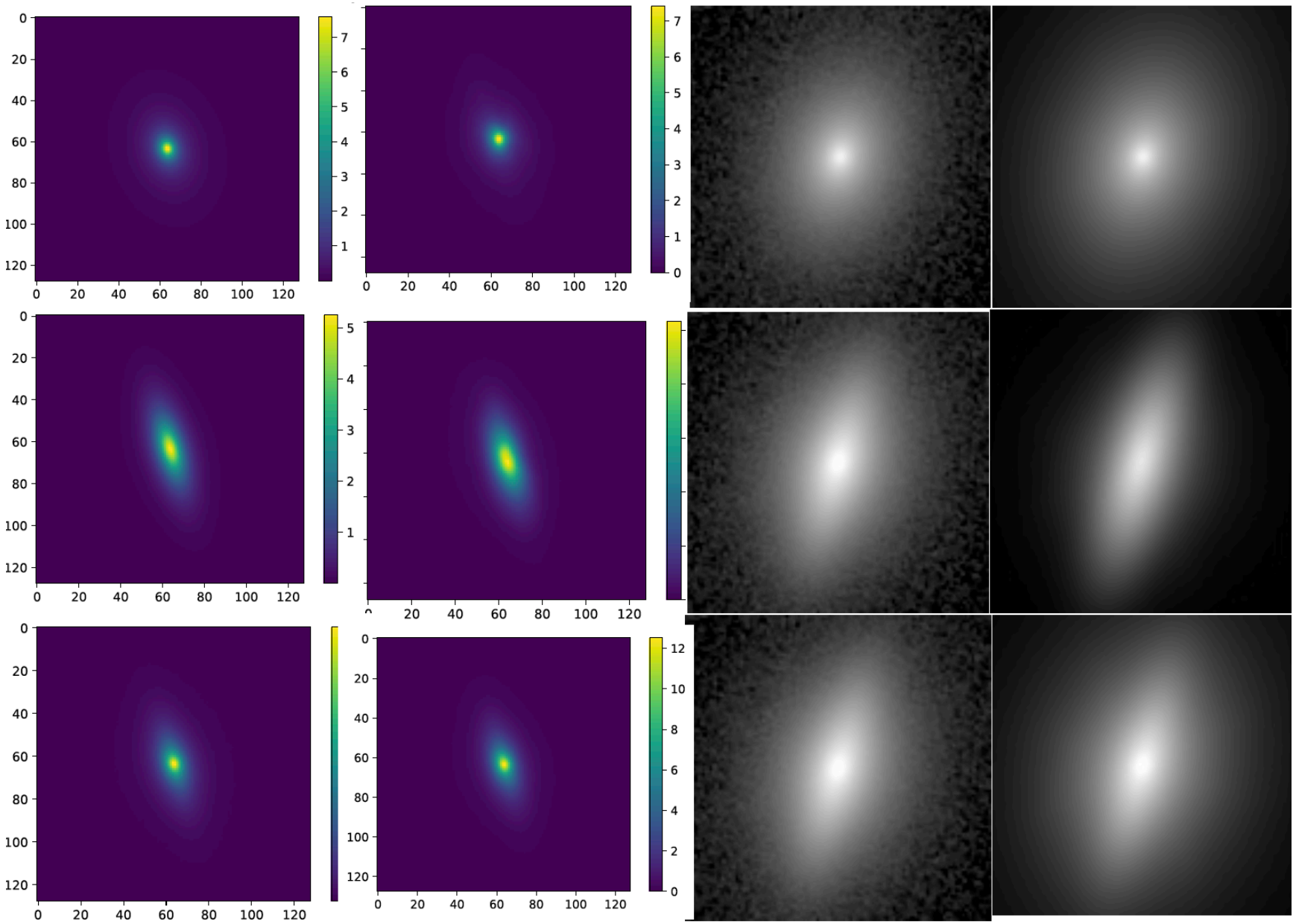
BULGE AND DISK PARAMETERS (SIZE, INCLINATION ETC)

OUTPUT IMAGE OF BULGE AND DISK COMPONENTS

Tuccillo, MHC+18,19

DEEP LEARNING

GALFIT

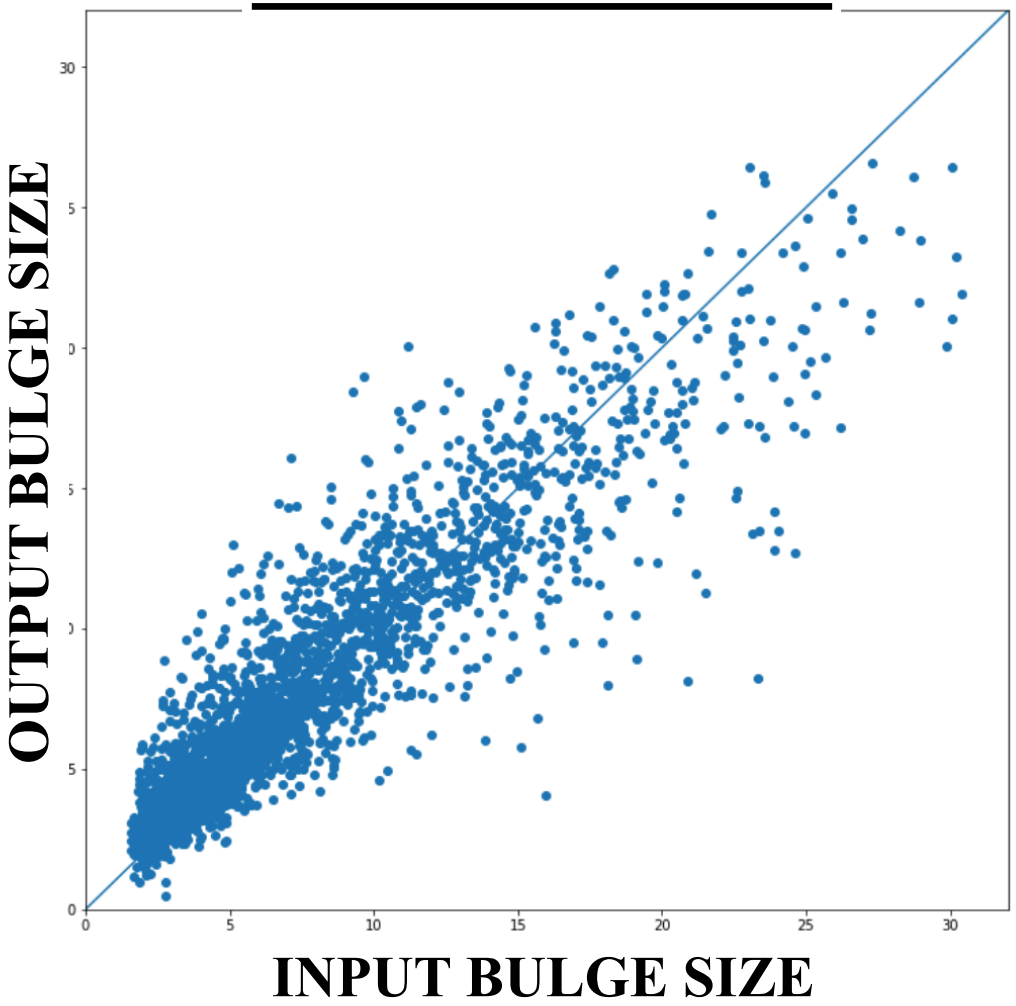


ORIGINAL RECONSTRUCTION ORIGINAL RECONSTRUCTION

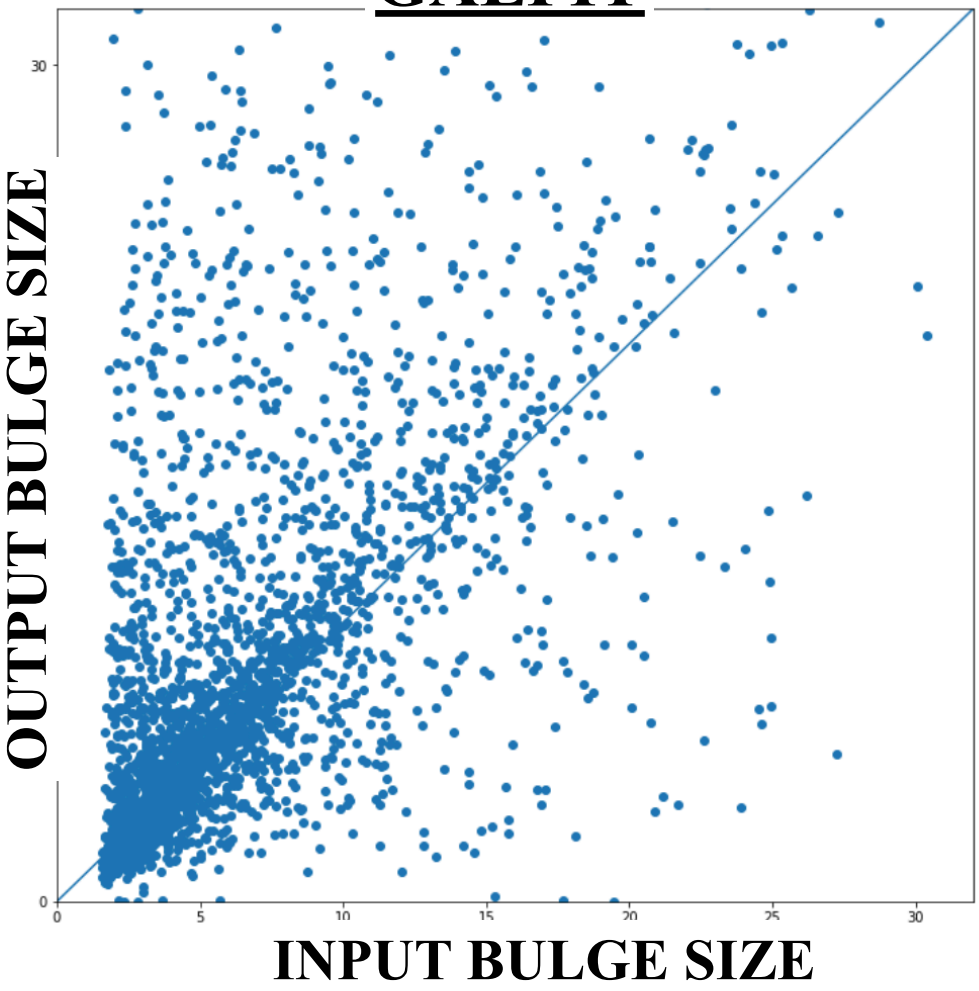
Tuccillo, MHC+18,19

PRELIMINARY!!

DEEP LEARNING



GALFIT

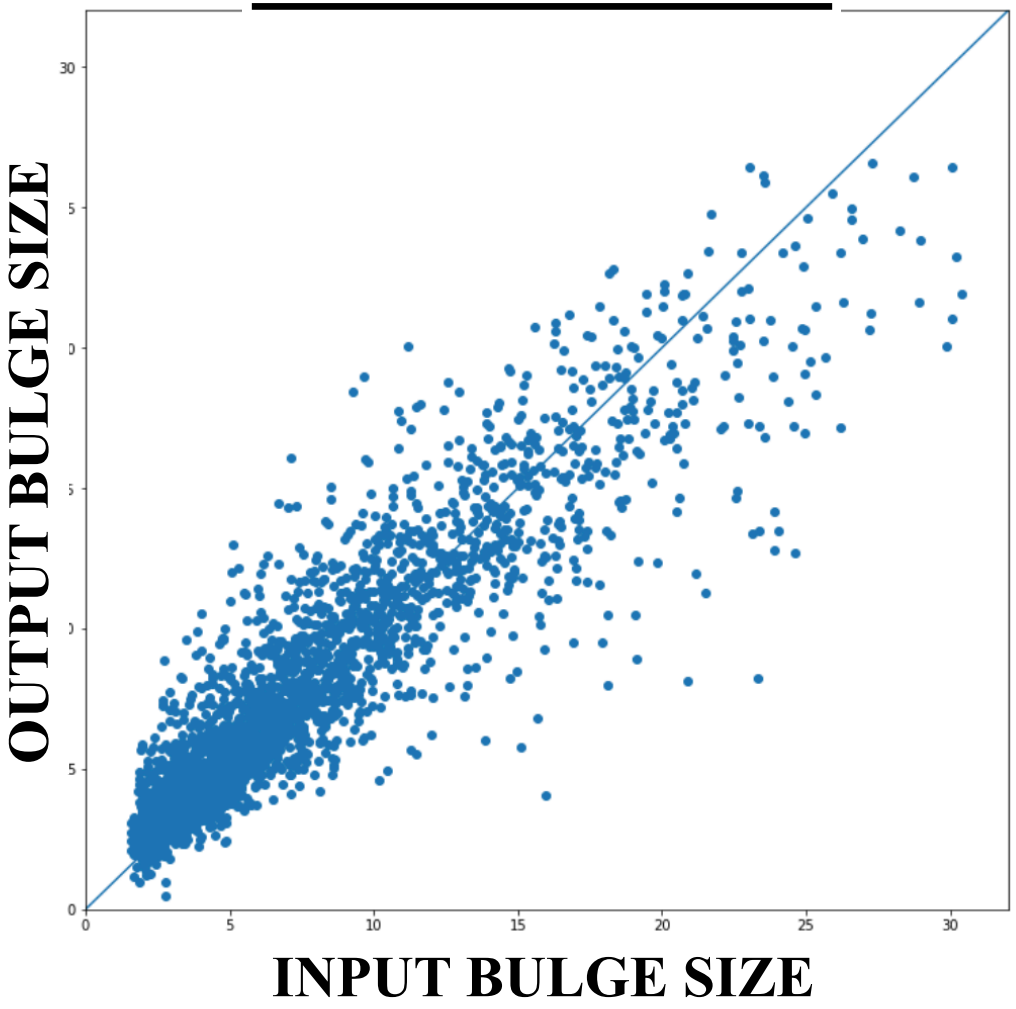


Tuccillo, MHC+18,19

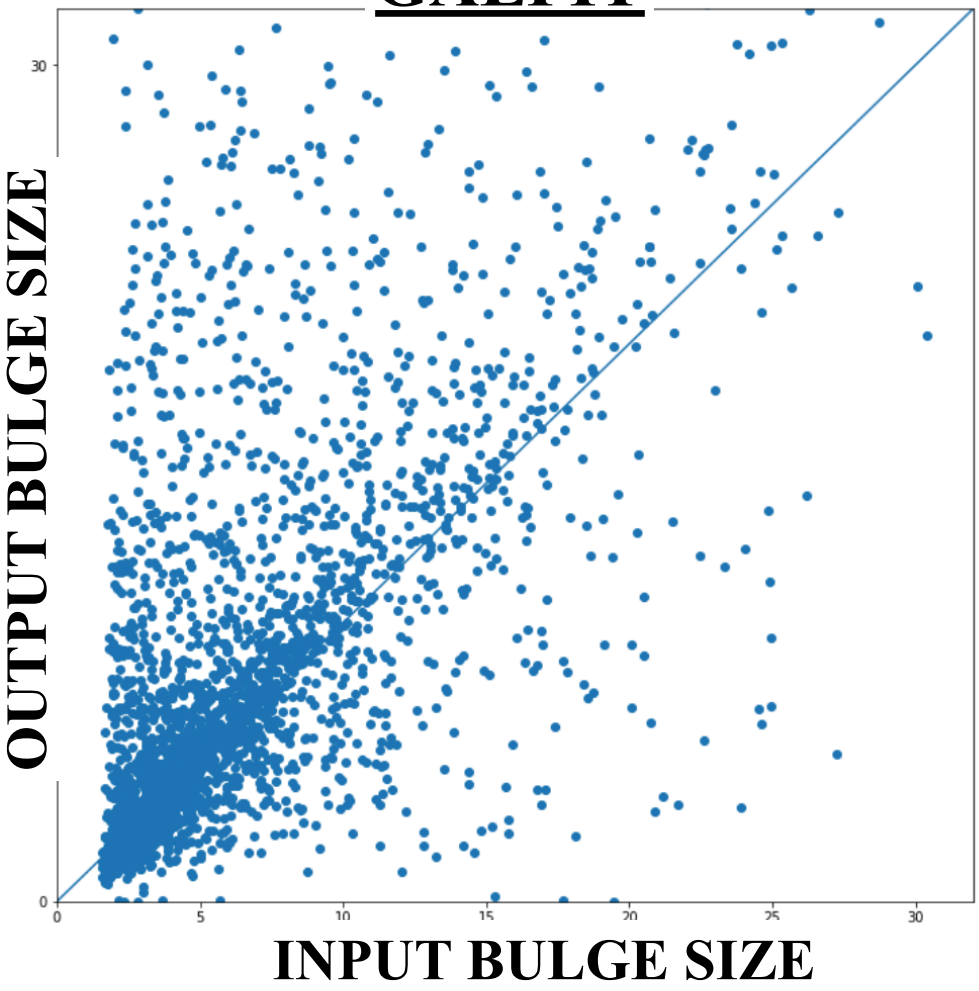
4s [ONCE TRAINED]

4hrs

DEEP LEARNING

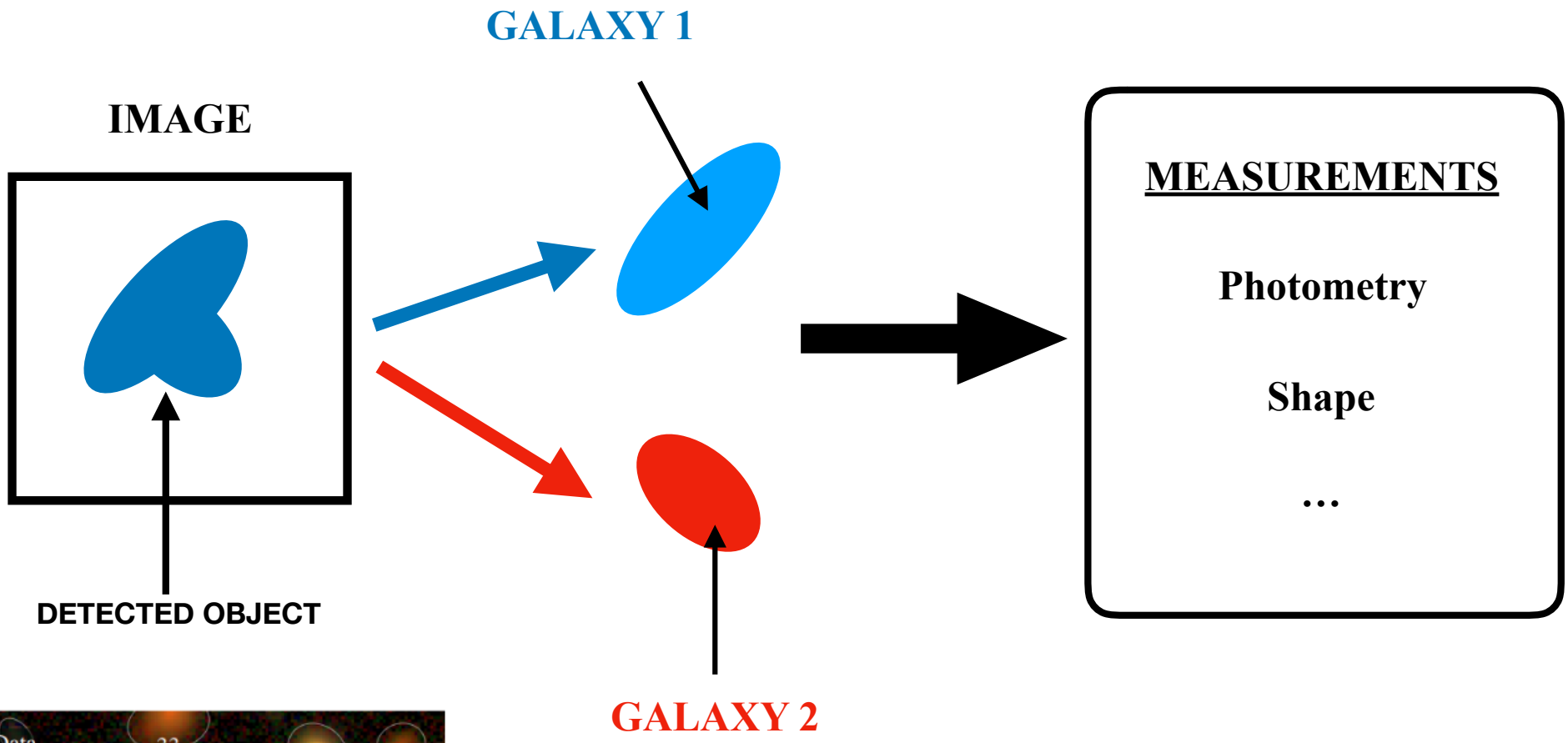


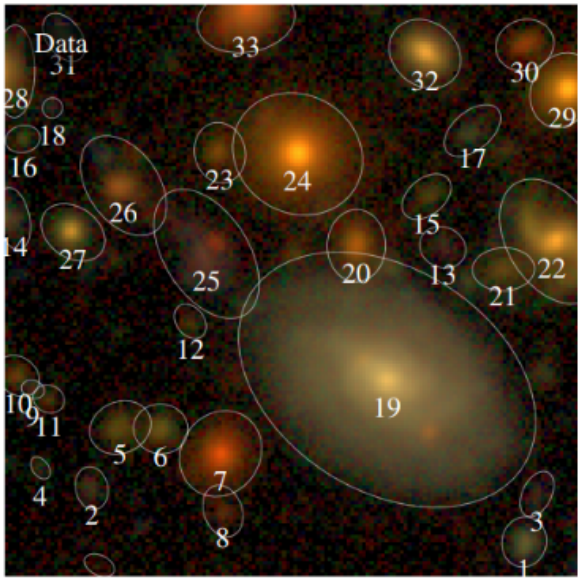
GALFIT



PRELIMINARY!!

Tuccillo, MHC+18,19





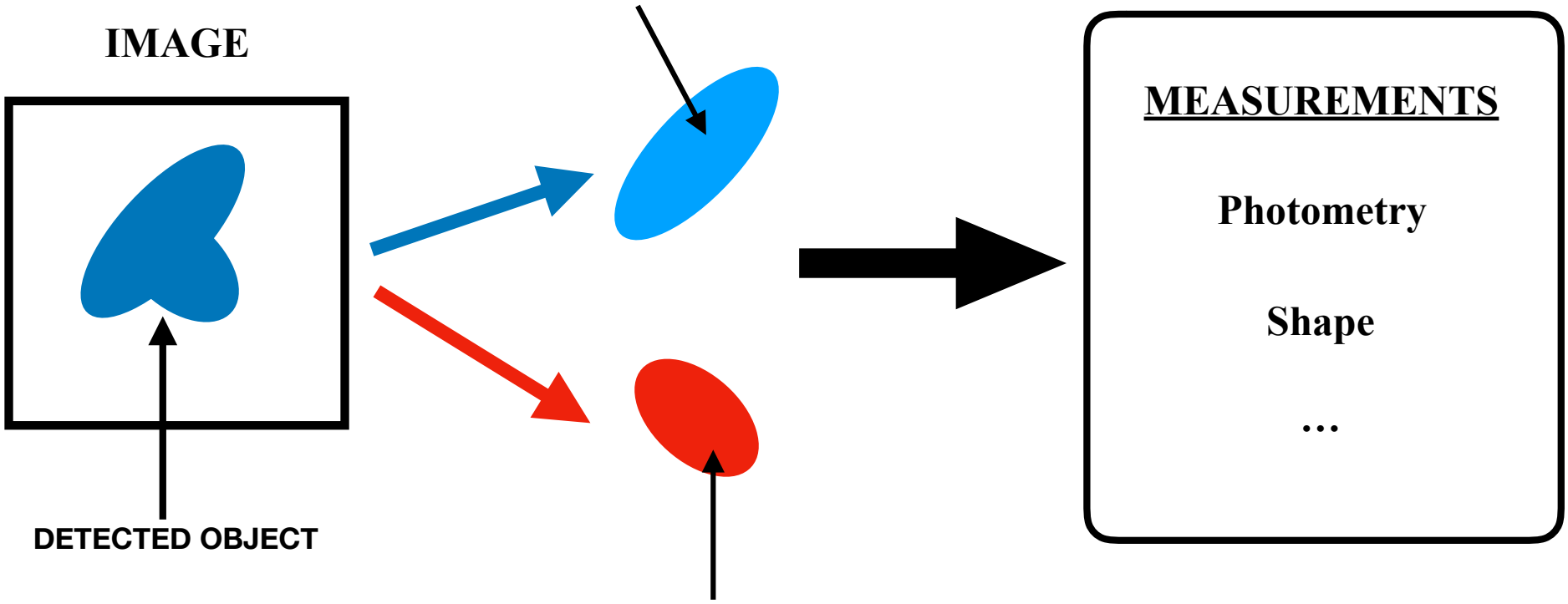
Bosch+17

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

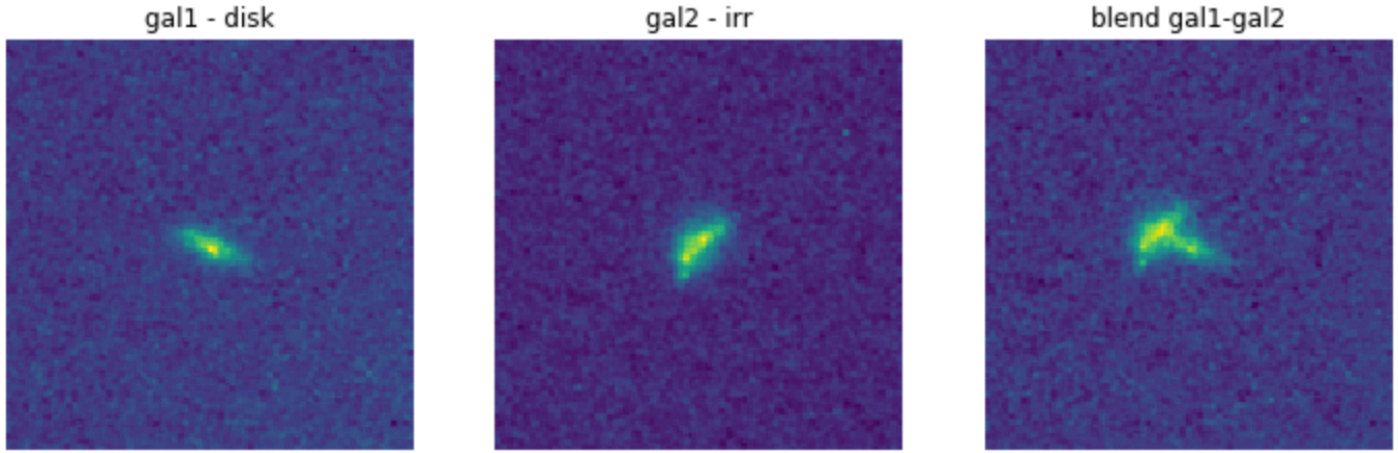
Boucaud+19

GALAXY 1

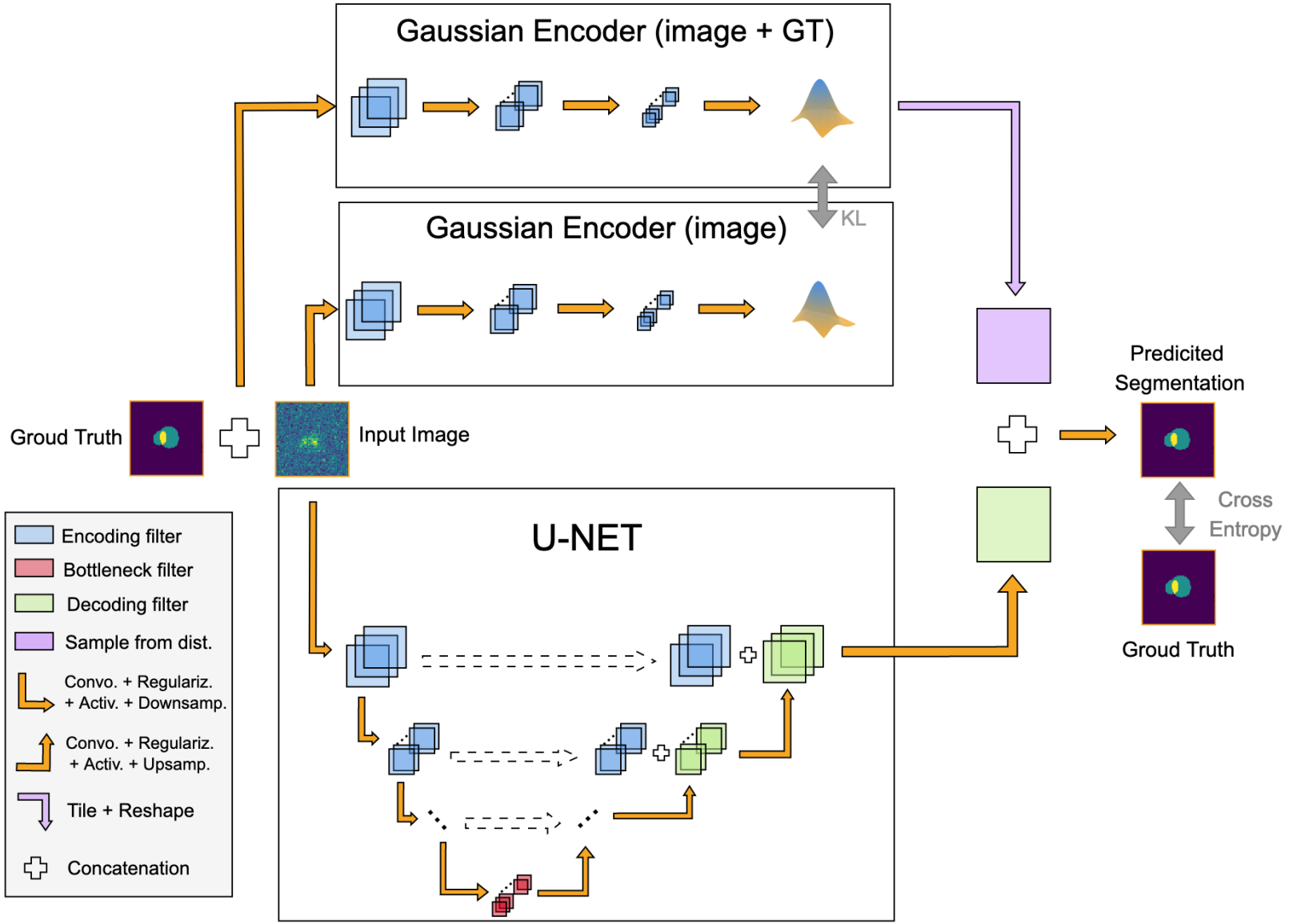
IMAGE



ISOLATED GALAXIES ARTIFICALLY BLENDED



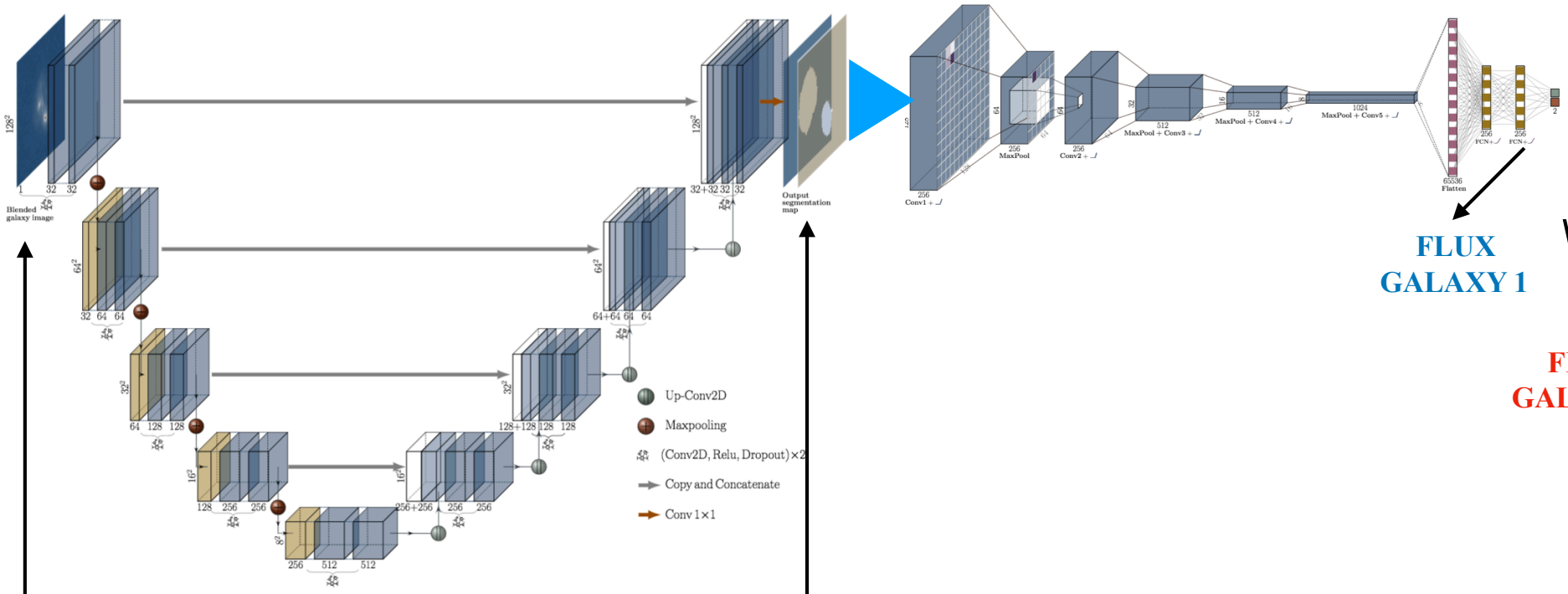
PROBABILISTIC U-NET



Bretonniere+20

U-NET (ENCODER DECODER)

VANILLA CNN



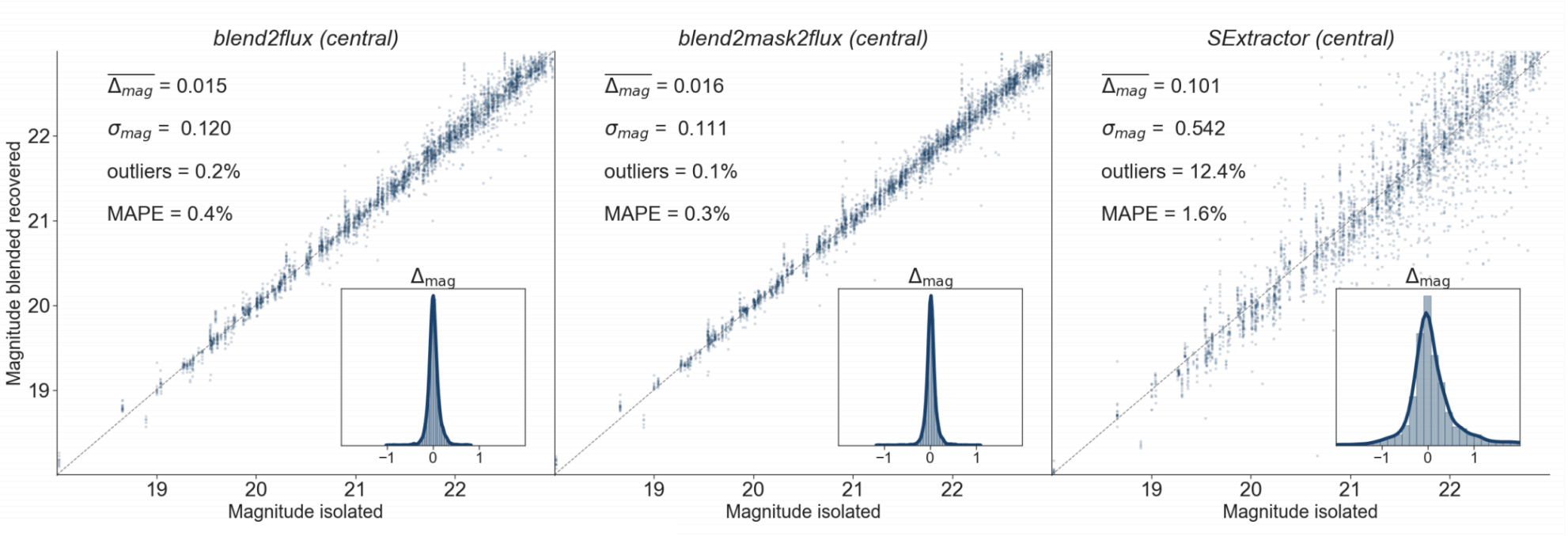
FLUX GALAXY 1

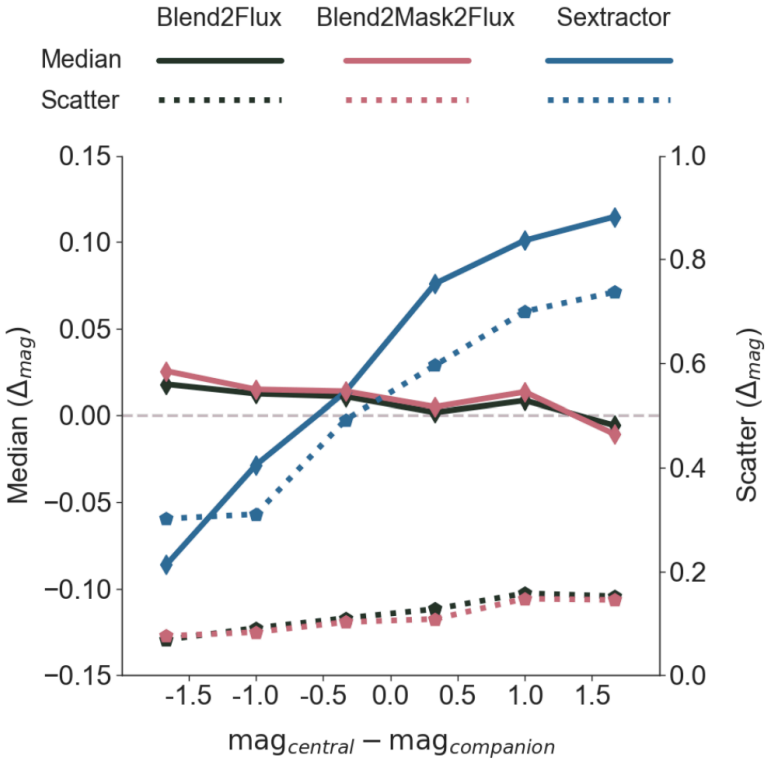
FLUX GALAXY 2

IMAGE OF BLENDED OBJECTS

OUTPUT SEGMENTATION MAP (BINARY 2 CHANNELS)

Boucaud, MHC+19

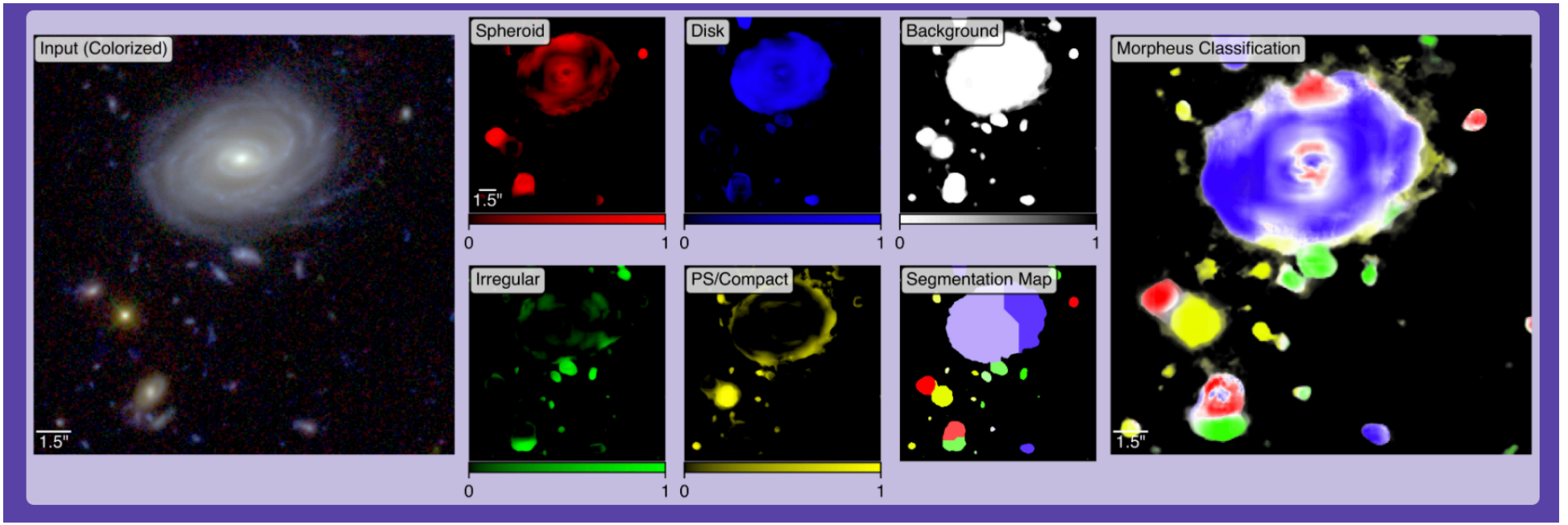




LESSONS LEARNED:

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

- **Masks do not provide additional information**

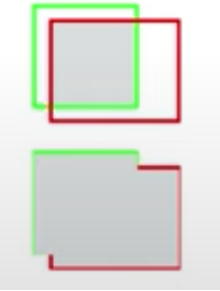


https://www.youtube.com/watch?v=hEL1h_dODkU#action=share

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

GO HERE:

https://github.com/mhuertascompany/Saas-Fee/blob/main/hands-on/session3/deblending_Saas_Fee.ipynb