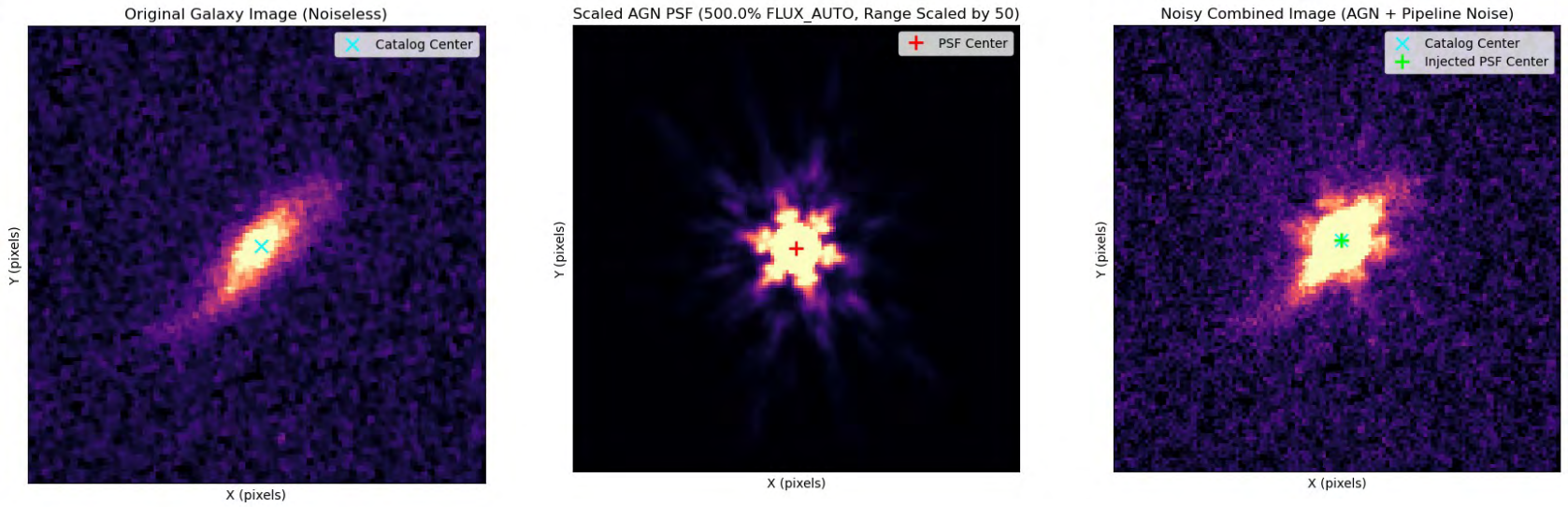
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Quantifying AGN-contribution in Galaxies with Deep Neural Network

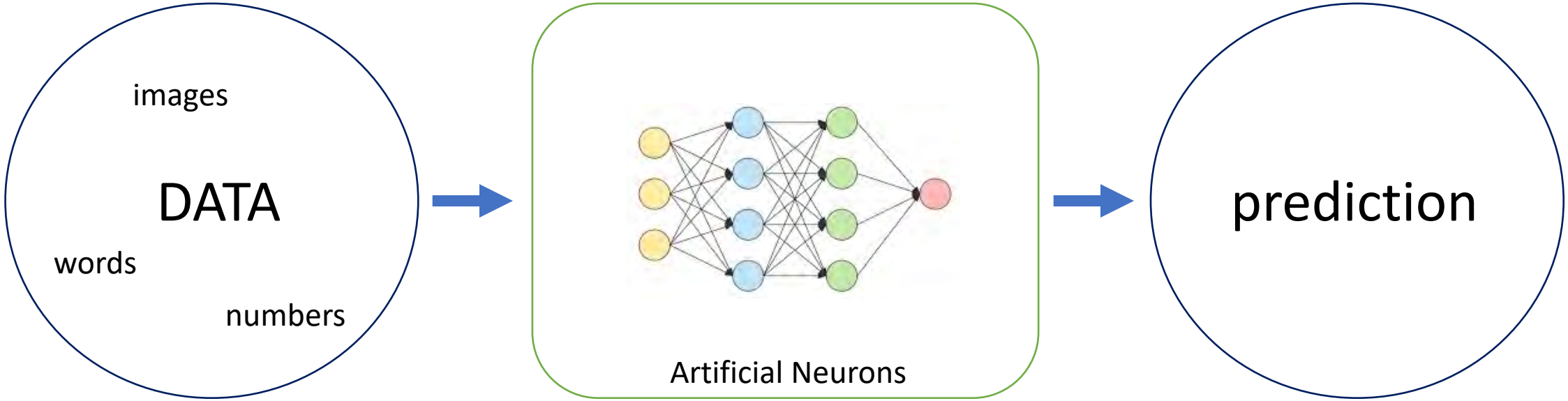


presented by Chitsanupong Somma (James)
supervised by Krittapas Chanchaiworawit

EAMA 11

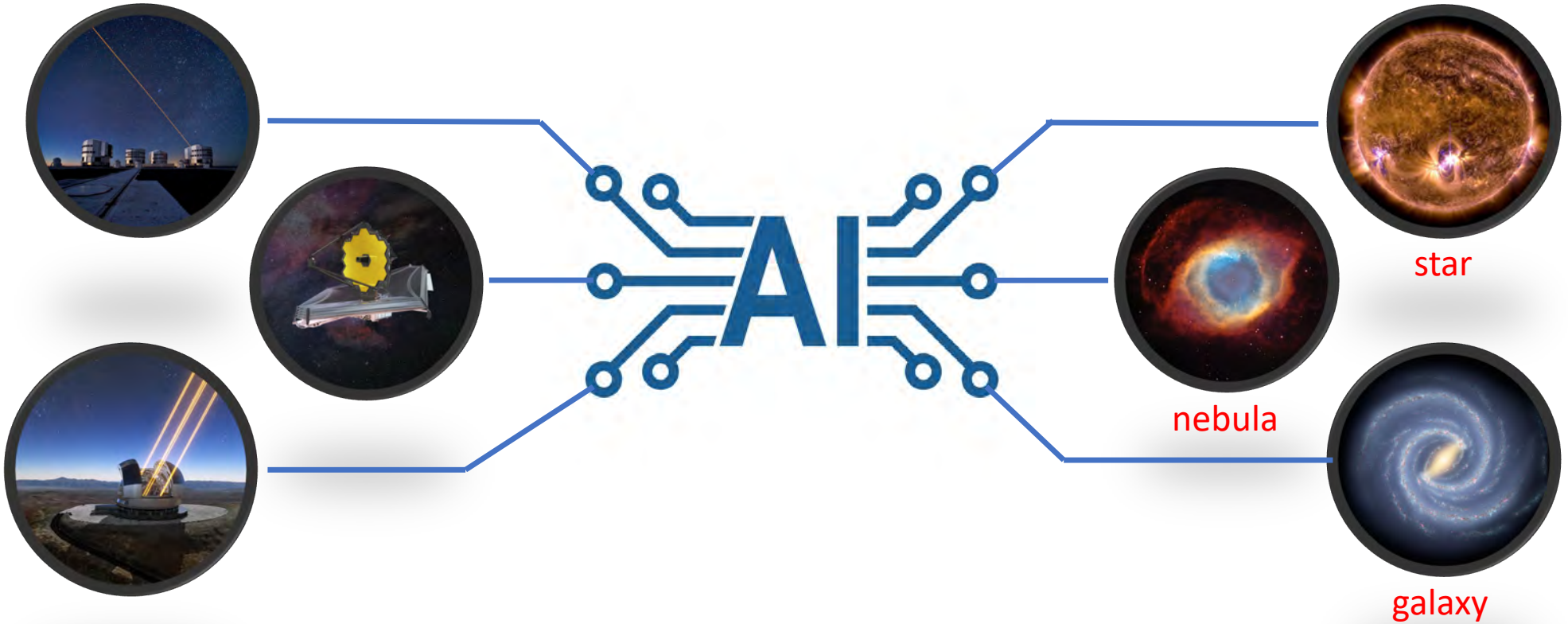
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What is Deep Learning?



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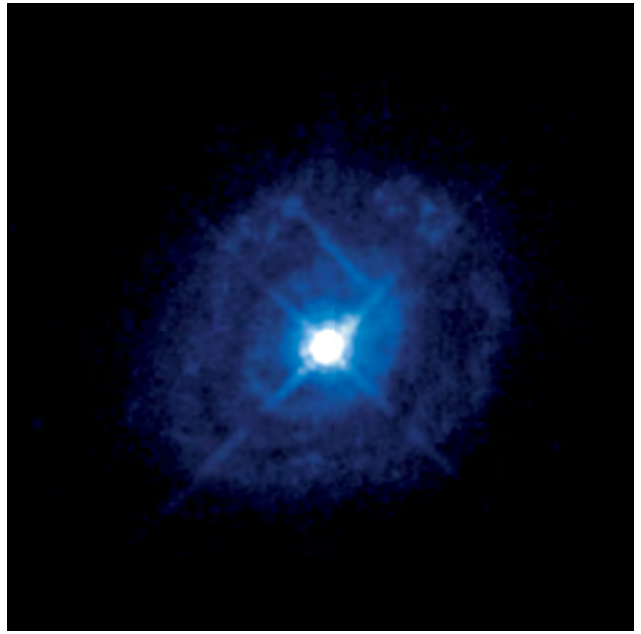
Why do we need Deep Learning in astronomy?



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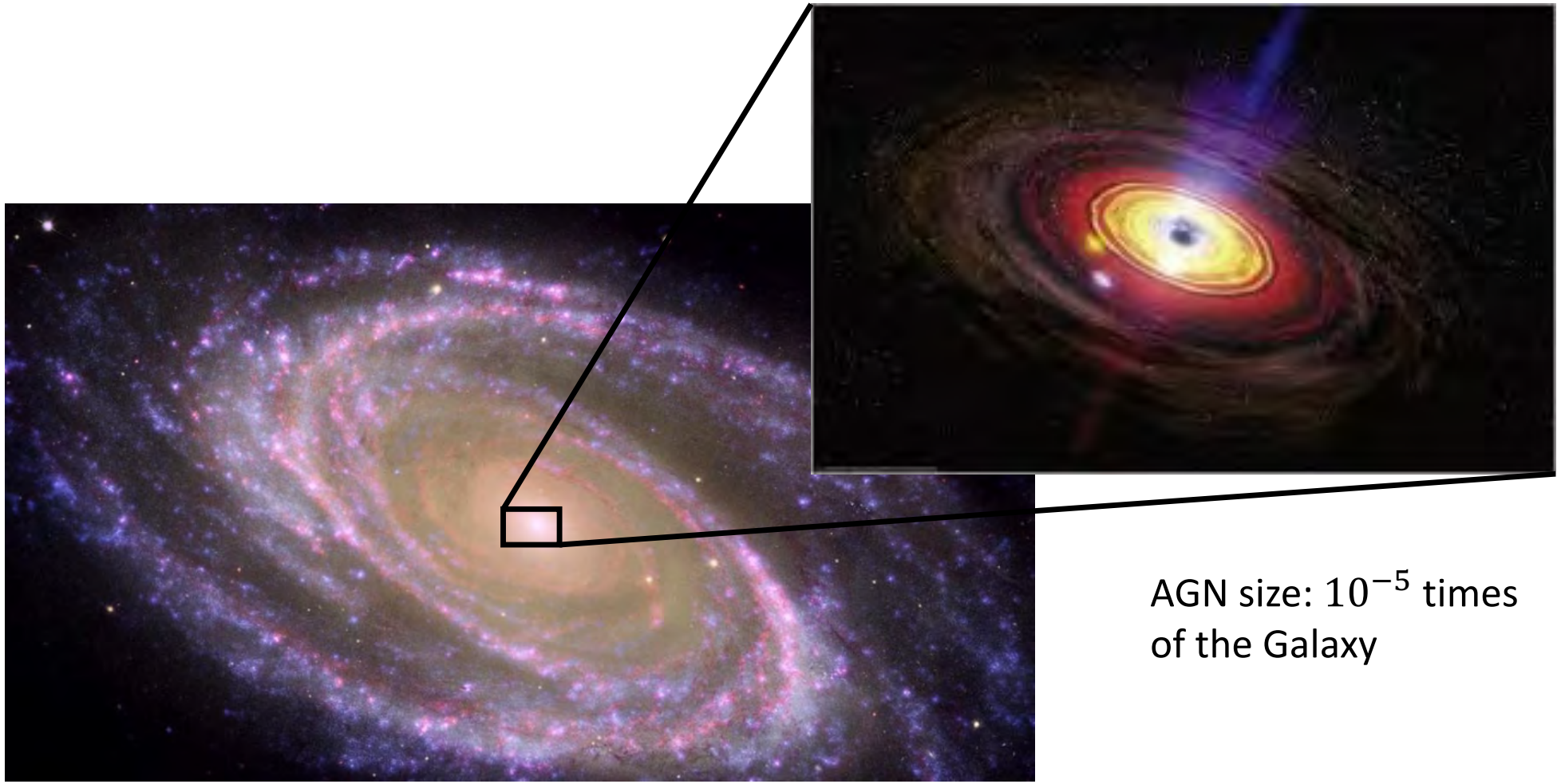
Active Galactic Nuclei





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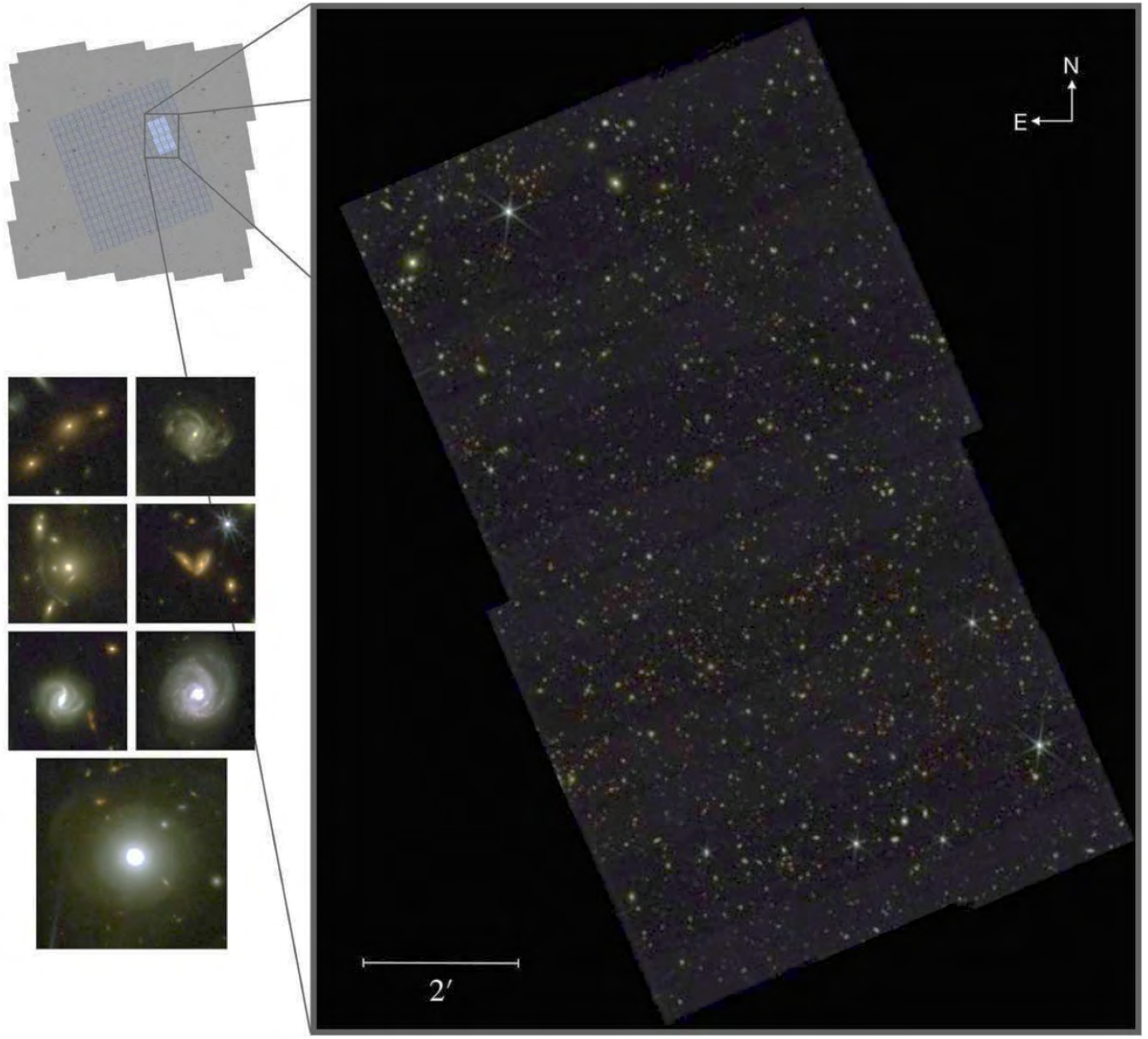
Active Galactic Nuclei



AGN size: 10^{-5} times of the Galaxy

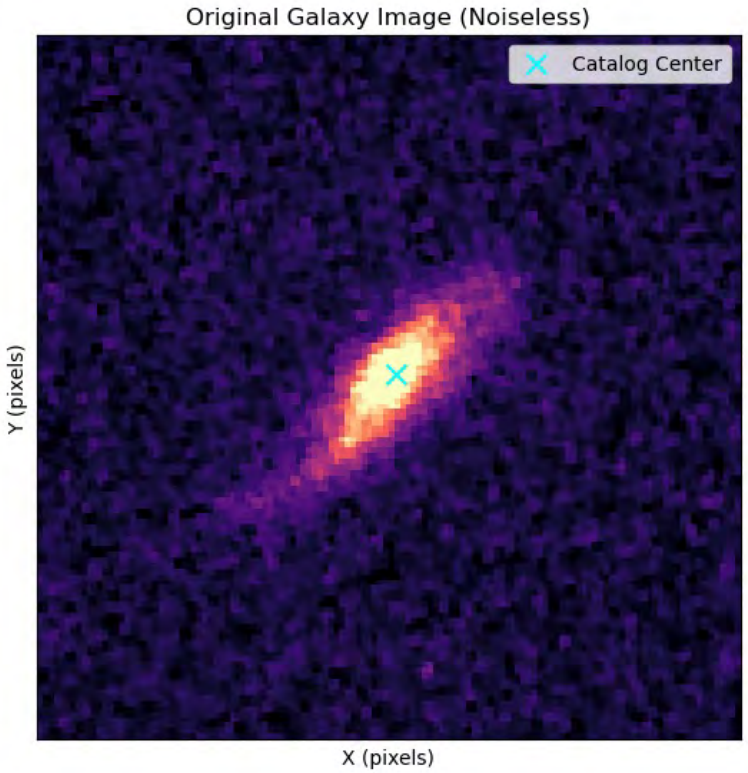
COSMOS-WEB



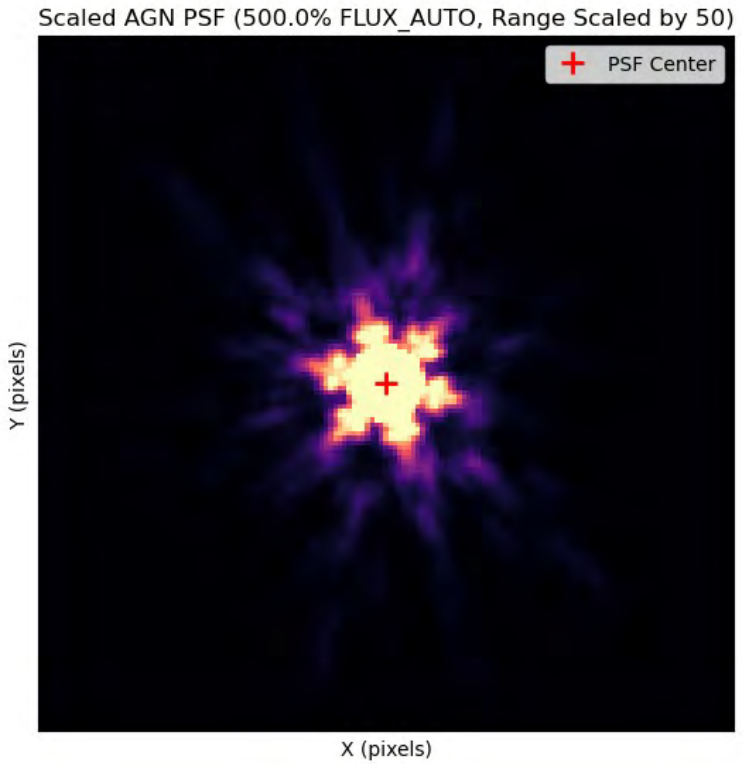


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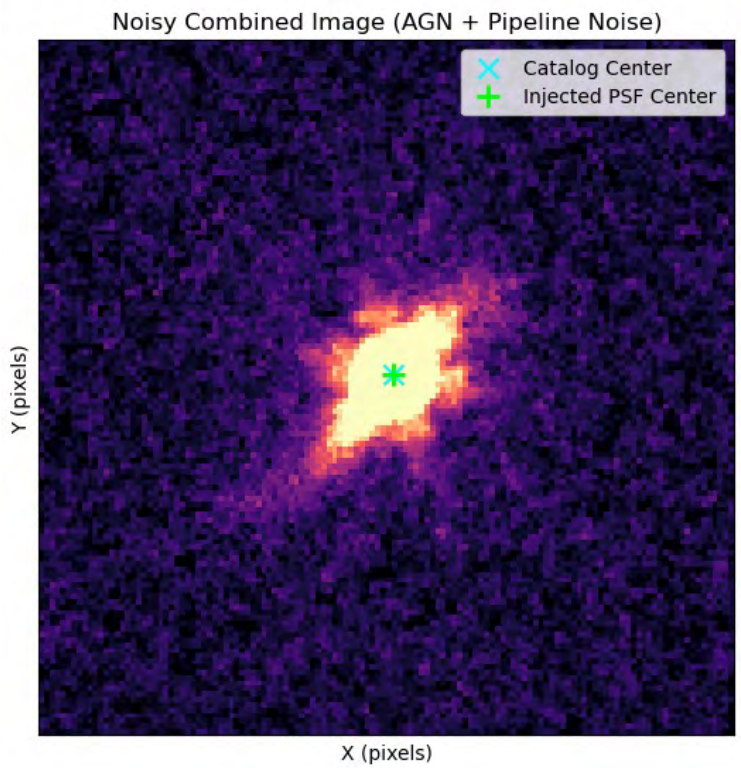
AGN Injection



Original Galaxy



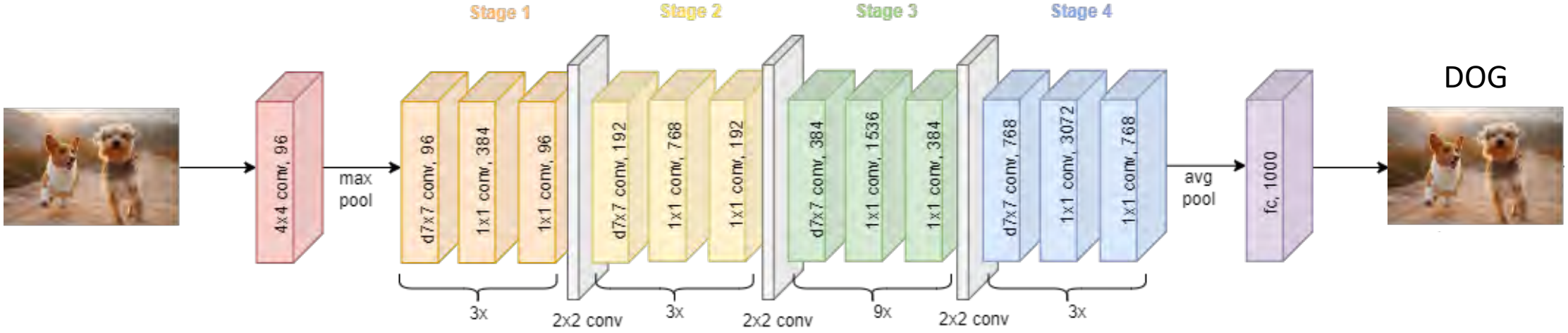
PSF



Injected AGN

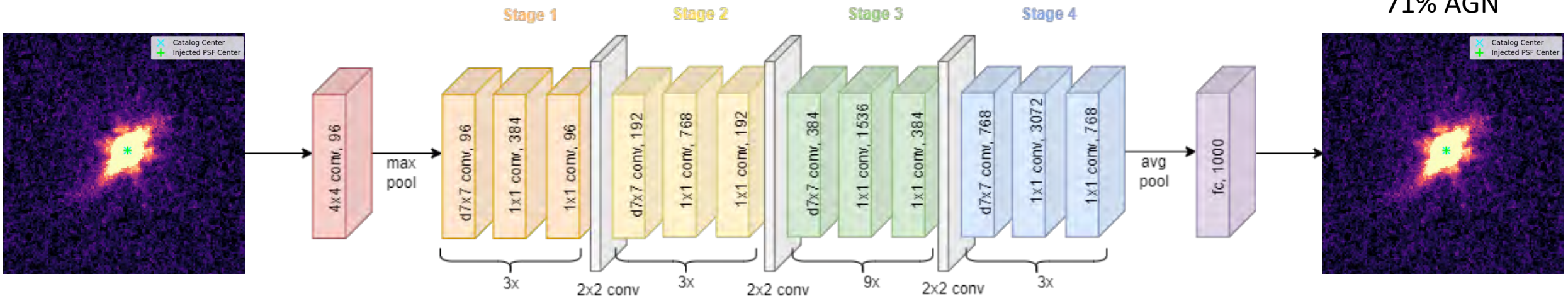
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Modified Convnext Architecture



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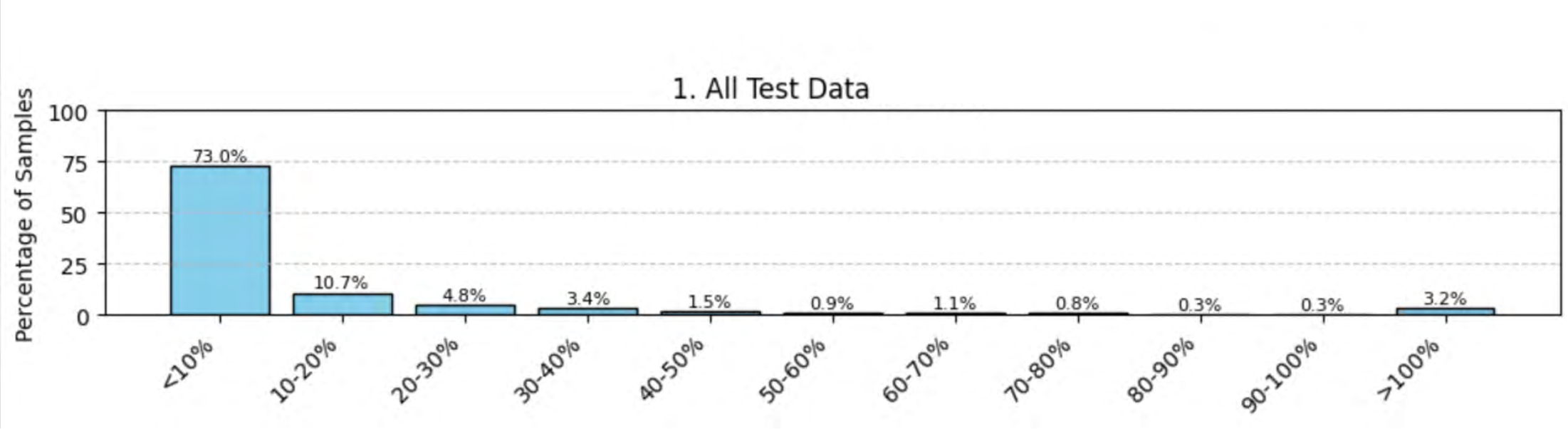
Modified Convnext Architecture



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Accuracy of the ConvNext Model

Training with about 100,000 images: 60,000 Training 20,000 Validation 20,000 Test

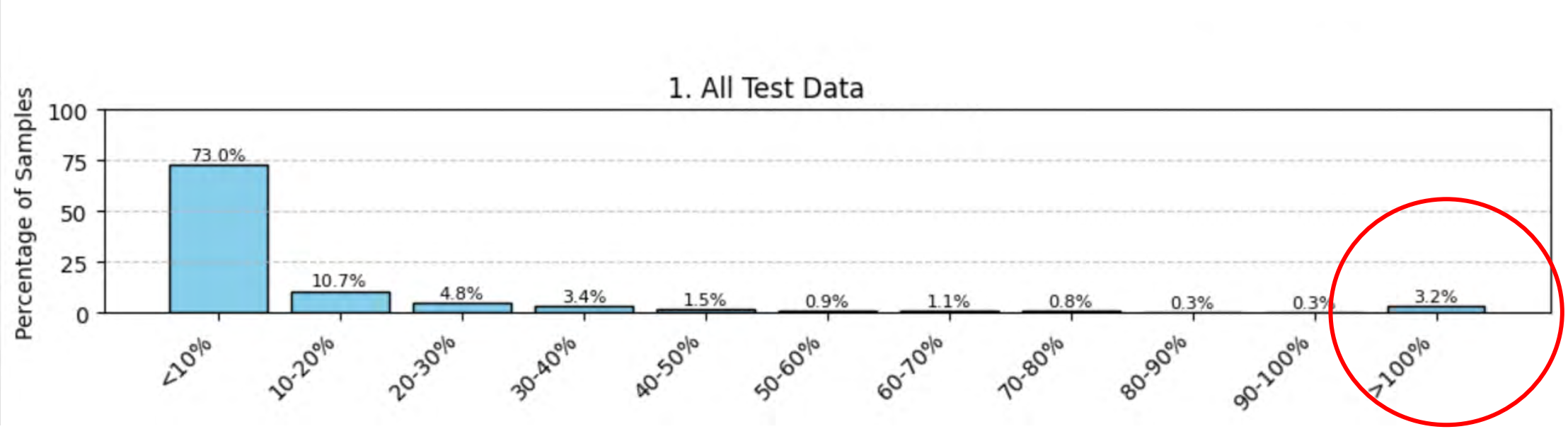


Prediction Percentage Error: $\frac{|Pred - True|}{True + \varepsilon} \times 100$

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Accuracy of the ConvNext Model

Training with about 100,000 images: 60,000 Training 20,000 Validation 20,000 Test

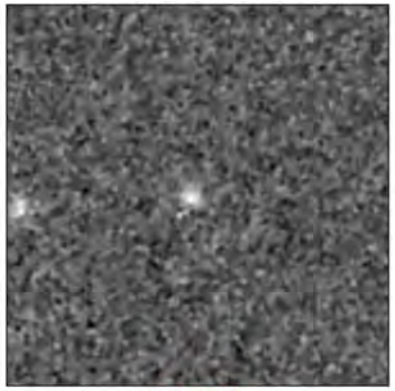


Prediction Percentage Error: $\frac{|Pred - True|}{True + \varepsilon} \times 100$

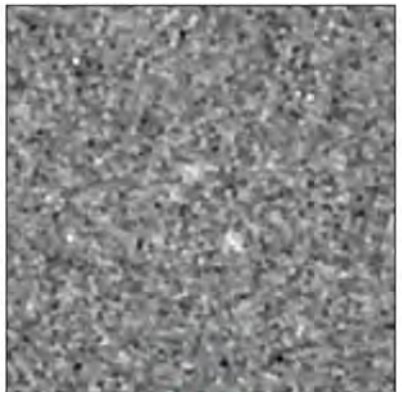
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Sources of Large Error

Low S/N



True: 0.04
Pred: 0.45
Error: 1094%



True: 0.06
Pred: 0.45
Error: 683%

Point Source



True: 0.12
Pred: 0.81
Error: 556%



True: 0.09
Pred: 0.84
Error: 754%

Multiple sources



True: 0.07
Pred: 0.55
Error: 653%

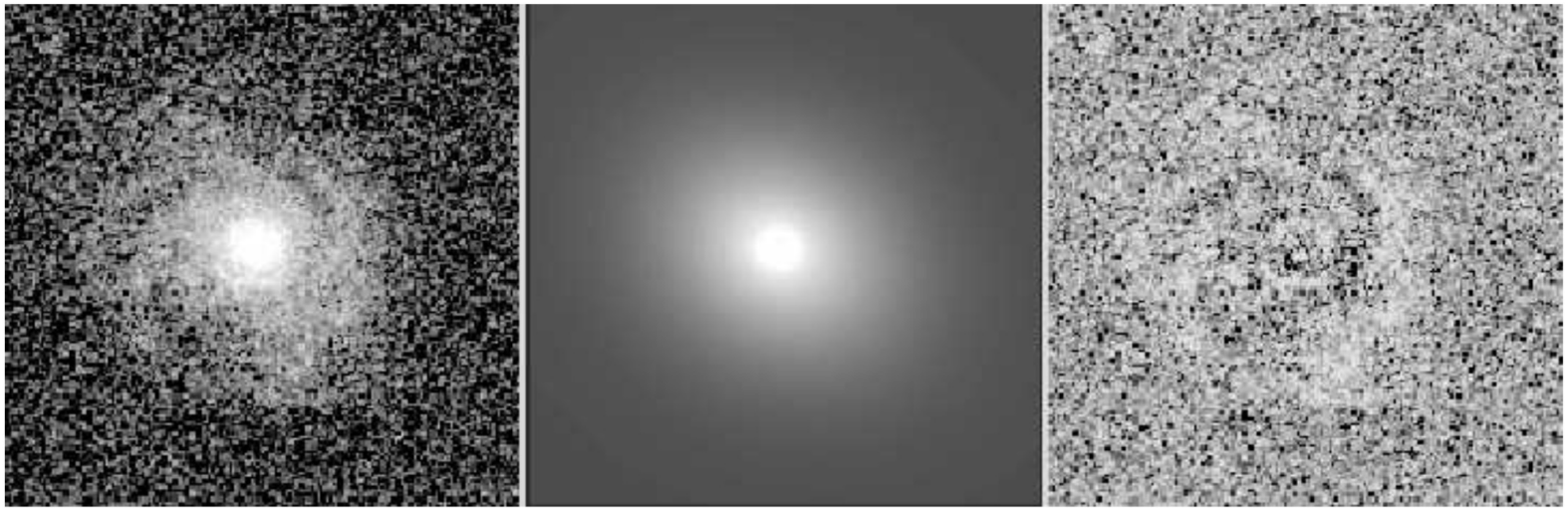


True: 0.13
Pred: 0.65
Error: 393%

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Validation of the Model

Structural Decomposition with GALFIT



Original | Sérsic + PSF | Residual

→ X% AGN (PSF)

→ Y% GALAXY (Sérsic)

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Future Work

F115W



F150W



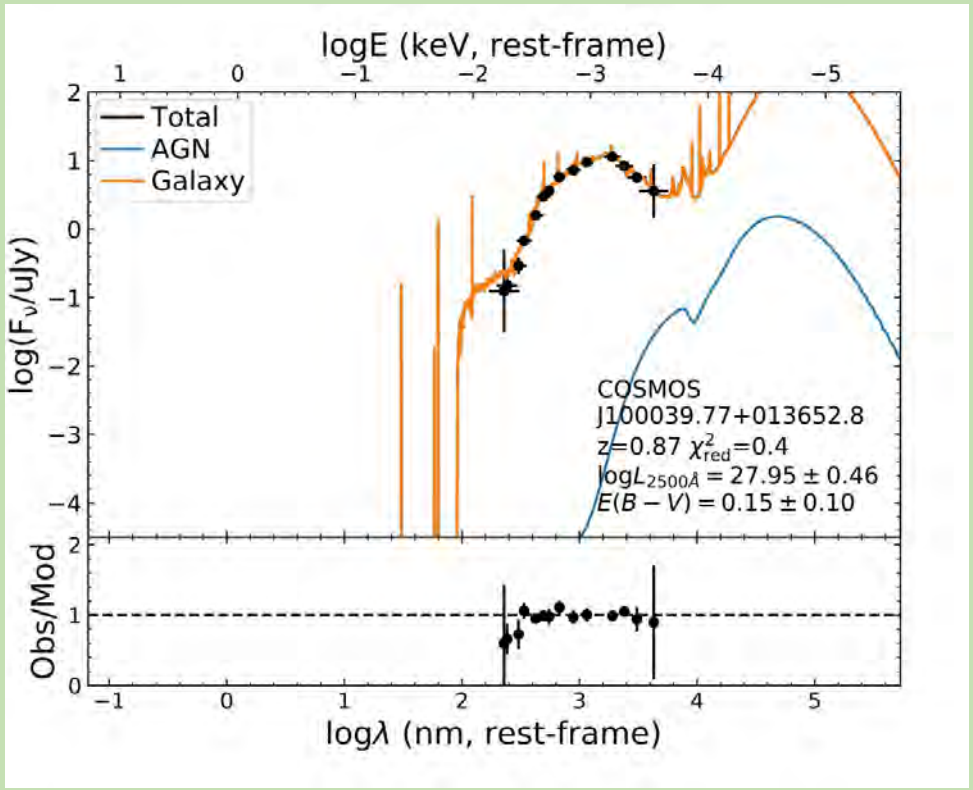
F277W



F444W



Multi-band



SED-fitting

X% AGN (blue)

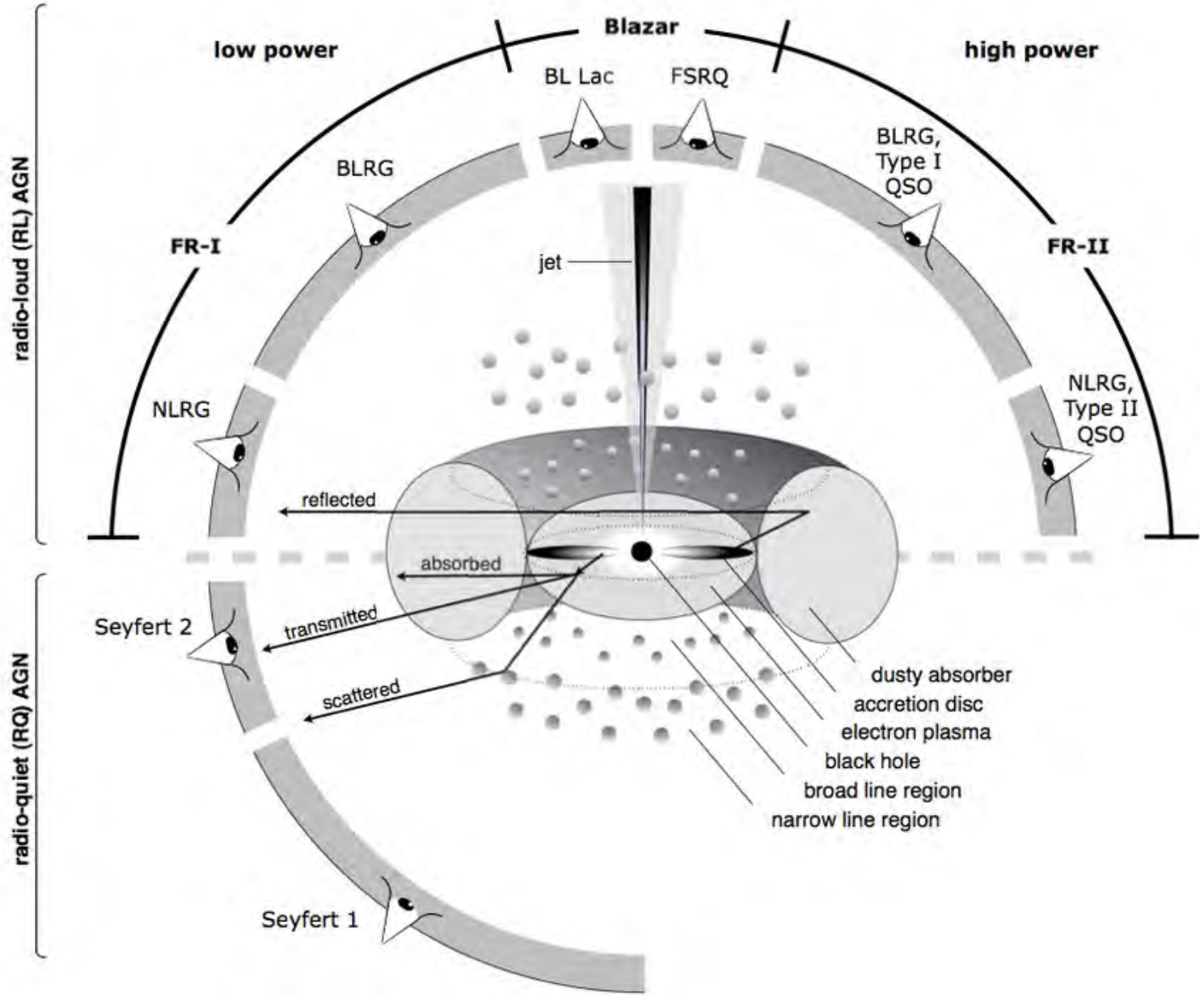
Y% GALAXY (orange)

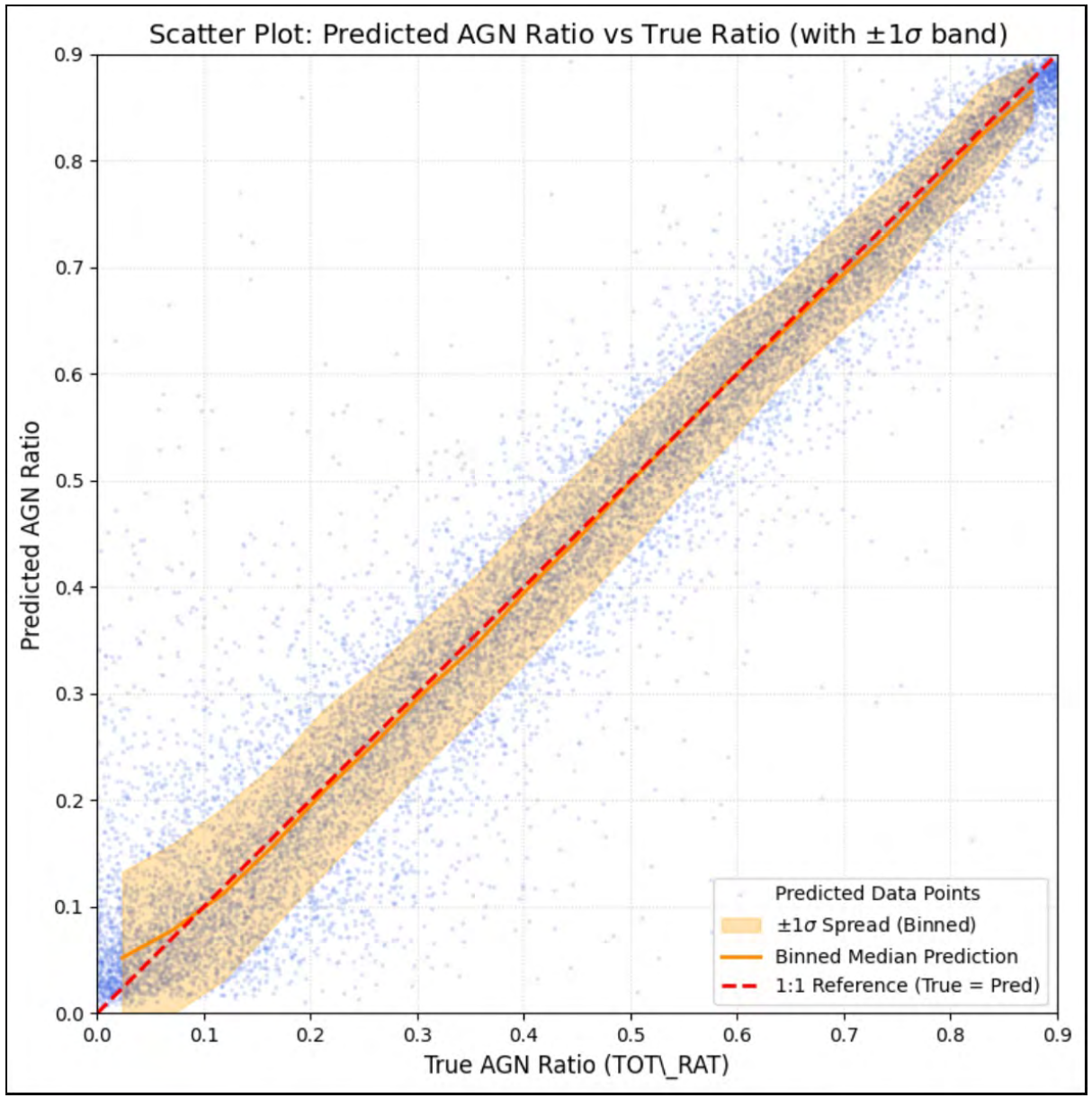
AGN-percentage

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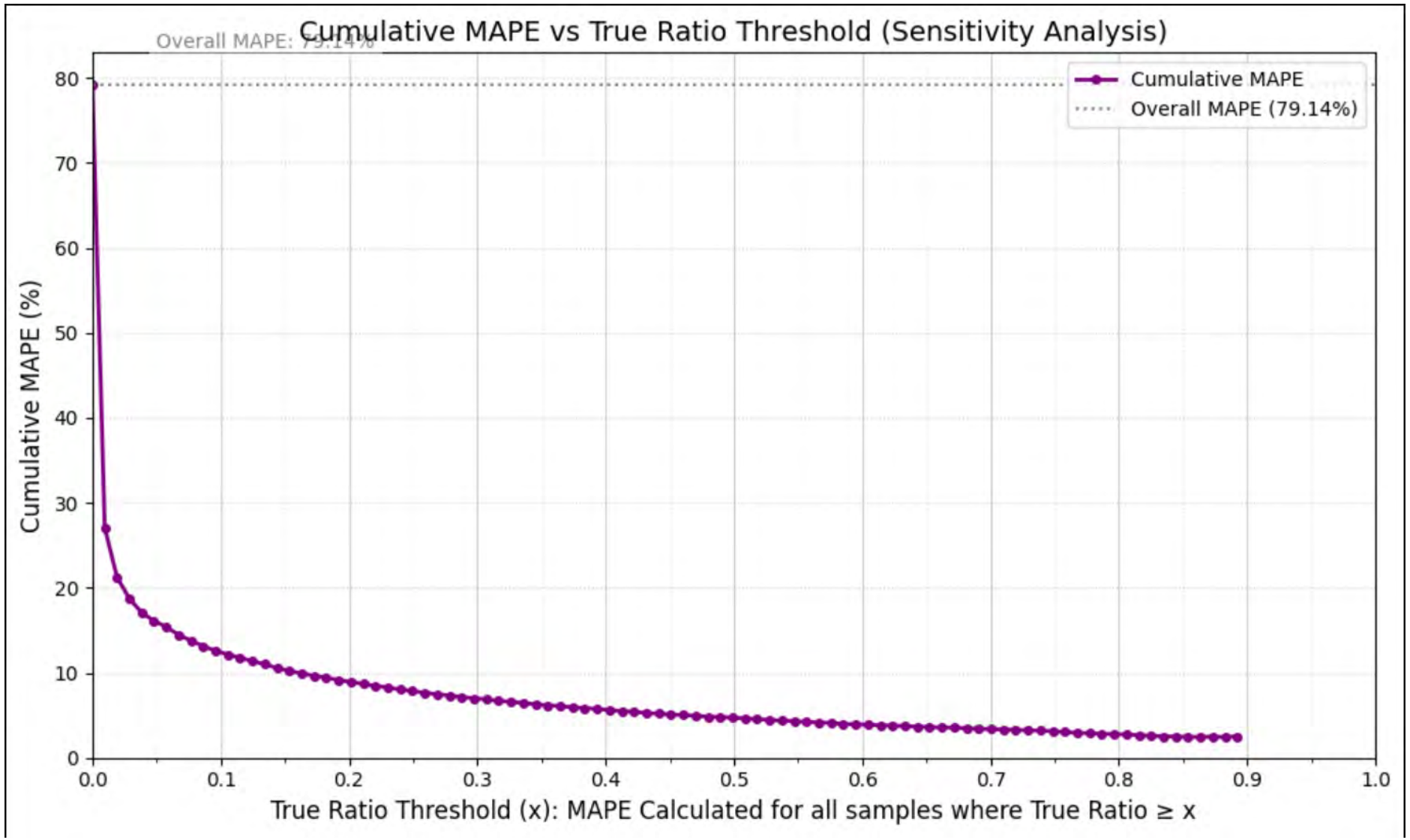
Summary

- Deep learning model can predict AGN contribution with a high accuracy
- Performance depends on the quality of the sample
- Validation on real images is required. Model needs to be tested against established metods
- Final note: DL/ML should be used with caustions. should be used as a **fast, efficient pre-selection or pre-processing tool** for AGN candidates, not as the final, definitive selection criterion.


radio-loud (RL) AGN
radio-quiet (RQ) AGN
low power
Blazar
high power
BL Lac
FSRQ
BLRG
BLRG,
Type I
QSO
FR-I
FR-II
jet
NLRG
NLRG,
Type II
QSO
reflected
absorbed
transmitted
scattered
Seyfert 2
Seyfert 1
dusty absorber
accretion disc
electron plasma
black hole
broad line region
narrow line region


Scatter Plot: Predicted AGN Ratio vs True Ratio (with ±1σ band)
Predicted AGN Ratio
True AGN Ratio (TOT_RAT)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Predicted Data Points
±1σ Spread (Binned)
Binned Median Prediction
1:1 Reference (True = Pred)

```
==================================================
      QUANTITATIVE REGRESSION METRICS
==================================================
Mean Squared Error (MSE):       0.0042
Root Mean Squared Error (RMSE): 0.0644
Mean Absolute Error (MAE):      0.0414
R-squared Score (R^2):         0.9380
Mean Absolute Percentage Error (MAPE): 79.14%
==================================================
```


Cumulative MAPE vs True Ratio Threshold (Sensitivity Analysis)
Overall MAPE: 79.14%
Cumulative MAPE
Overall MAPE (79.14%)
Cumulative MAPE (%)
0
10
20
30
40
50
60
70
80
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
True Ratio Threshold (x): MAPE Calculated for all samples where True Ratio ≥ x