

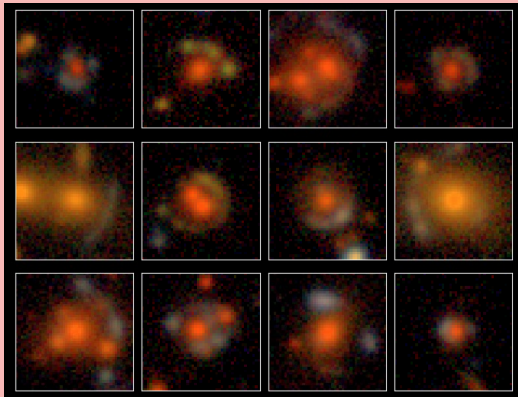


# ADDITIONAL FIGURES: HOME PAGE

## MODEL'S PERFORMANCE

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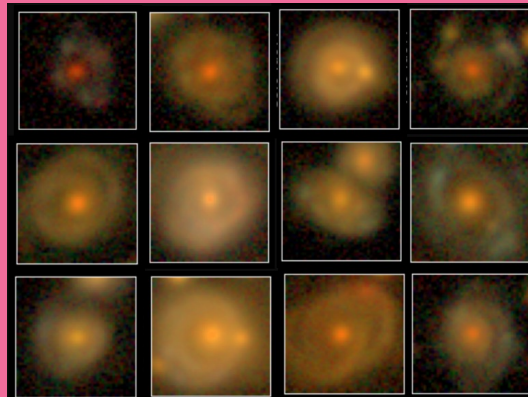
- [Test on existing lens catalogs](#)
- [Confusion matrix](#)



## DSPL SEARCH

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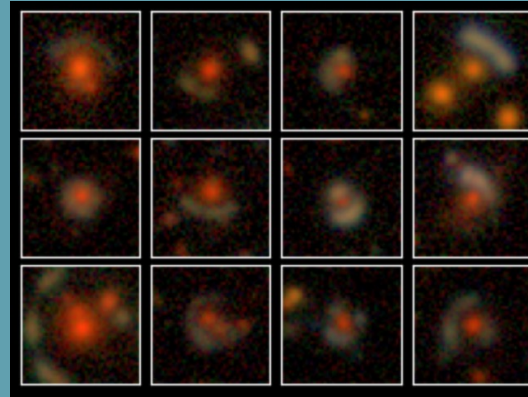
- [Training sample](#)
- [Highest ranked images](#)



## VISUAL INSPECTION

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- [Context & performance](#)
- [Highest graded candidates](#)



## MODEL'S ARCHITECTURE

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- [Vision Transformer \(ViT\)](#)
- [Attention mechanism](#)

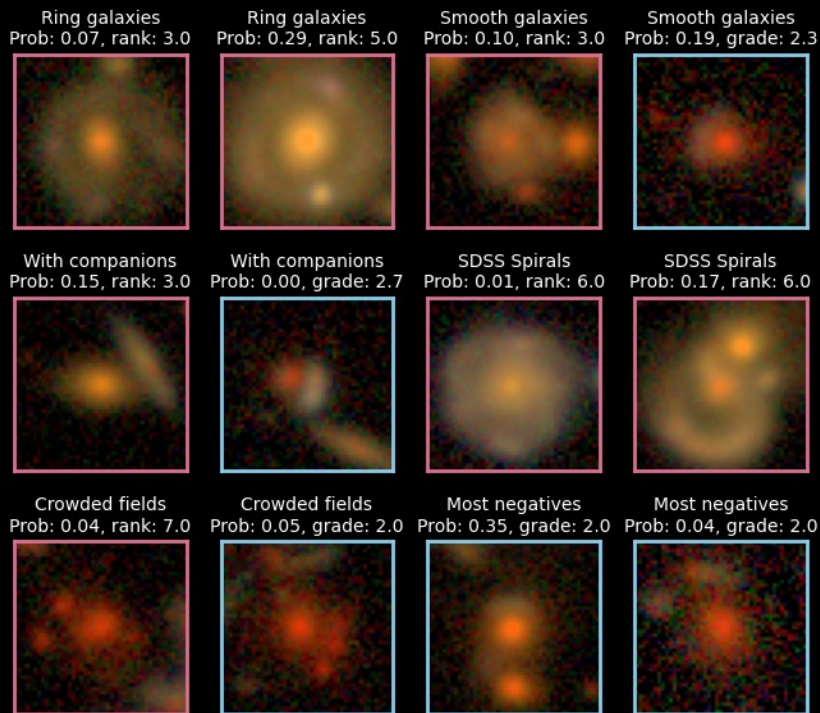


# PERFORMANCE ON EXISTING LENS CATALOGS

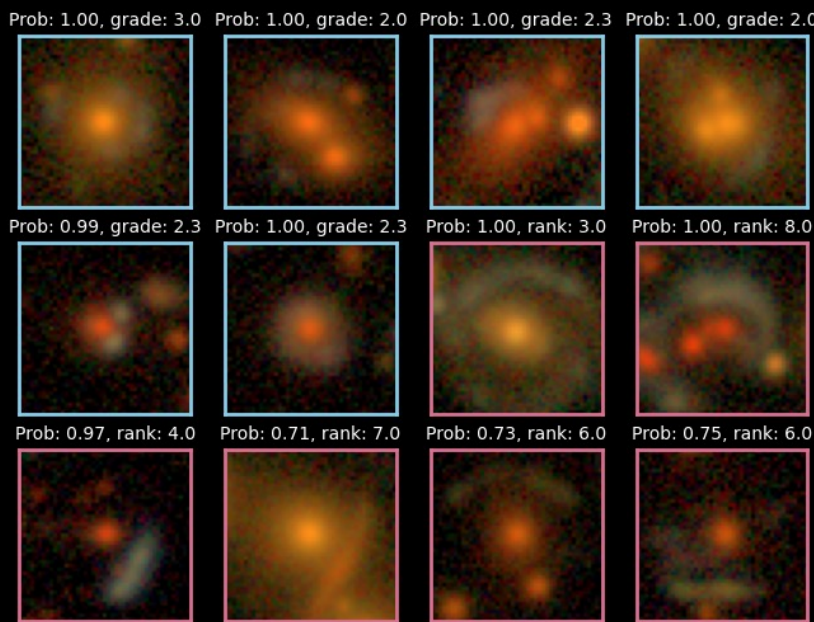


	Jacobs et al. (2019)	O'Donnell et al. (2021)
Number of candidates:	457	140
Recovered (default classification):	391 (85.6%)	98 (70%)
Recovered with 75% prob. threshold:	374 (81.9%)	94 (67.1%)

## Not Recovered:

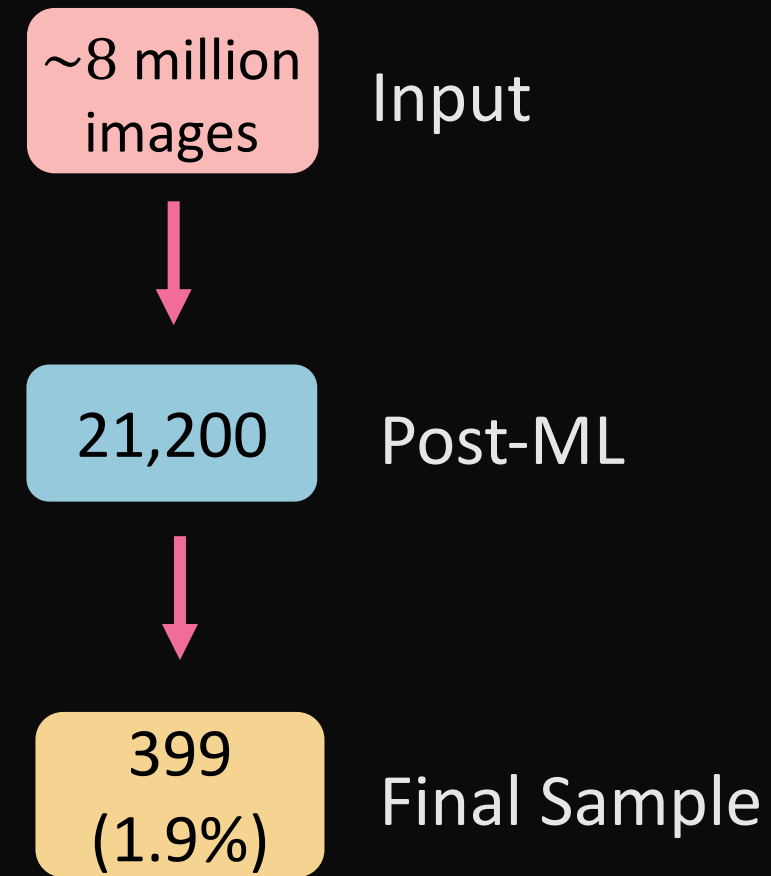


## Recovered:



Rank  $\in$  0-10, grade  $\in$  0-3

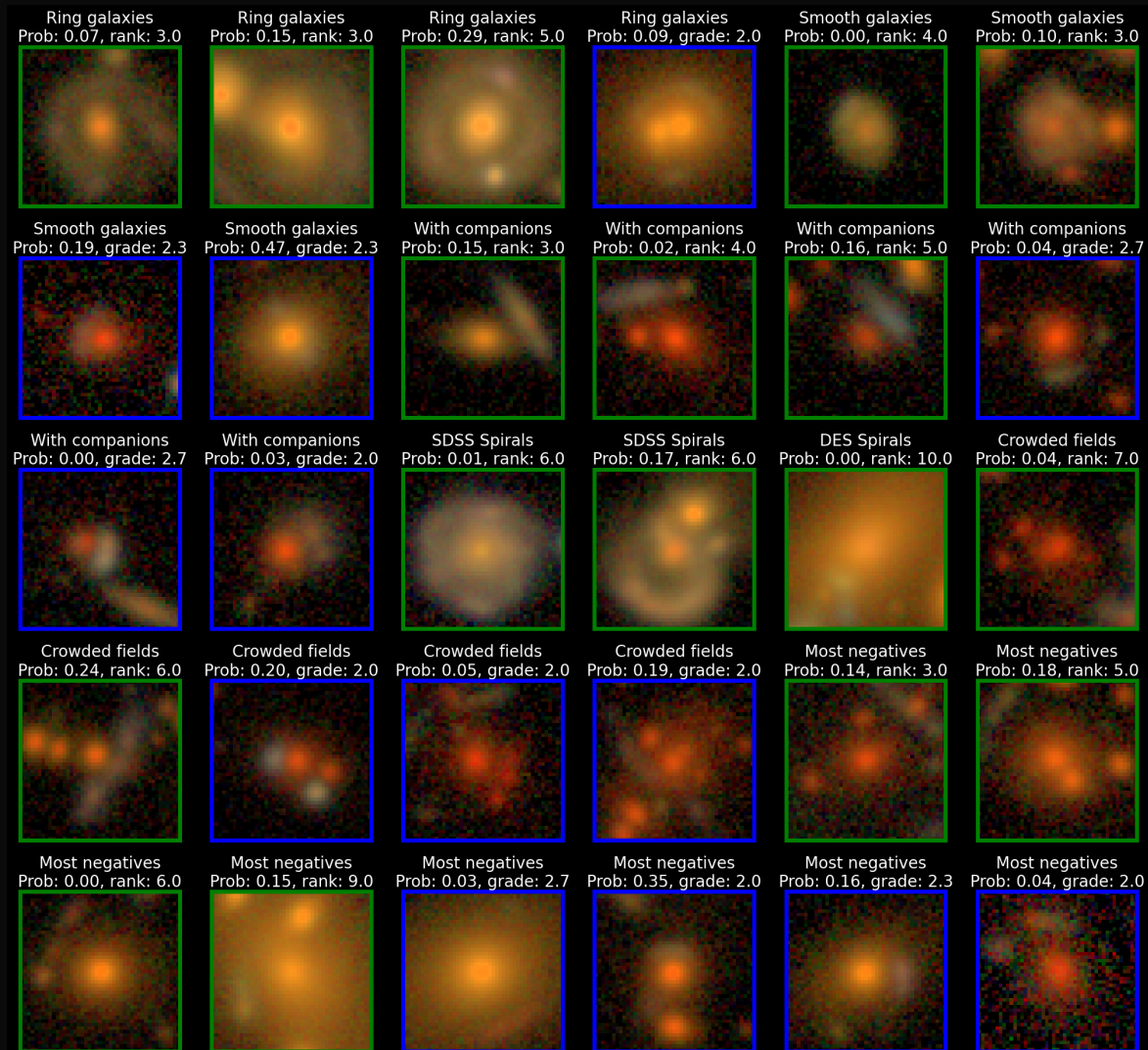
Jacobs May, 2019



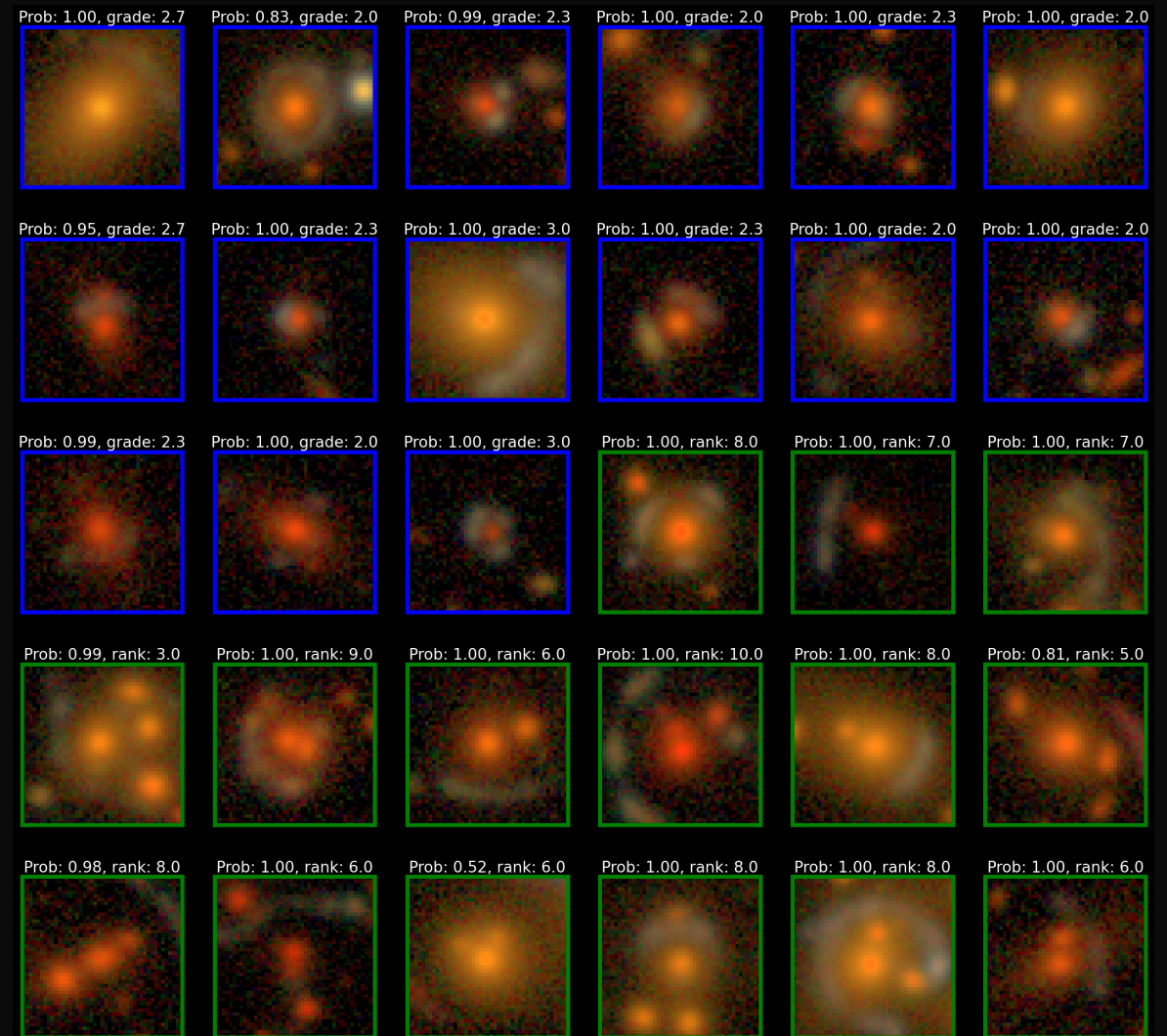


# PERFORMANCE ON EXISTING LENS CATALOGS

Not Recovered:



Recovered:



Rank  $\in$  0-10, grade  $\in$  0-3





# CONFUSION MATRIX

Complete dataset:

Class	#
Single	14000
Ring galaxies	1700
Smooth galaxies	1500
SDSS Spirals	1500
DES Spirals	2000
With companions	1000
Crowded fields	1400
Artifacts	2090
Most negatives	15000
Total	40190

Training	70%
Validation	15%
Testing	15%

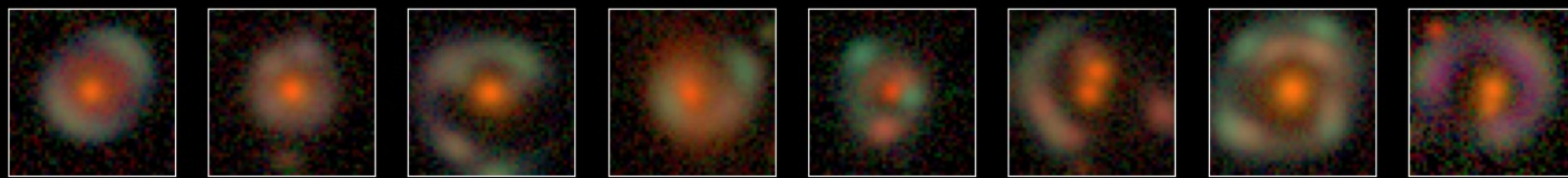
True label	Single	Ring galaxies	Smooth galaxies	With Companions	SDDS Spirals	DES Spirals	Crowded Fields	Artifacts	Most negatives
	0.99	0.011	0.005	0.014	0	0	0.005	0	0.003
	0.001	0.87	0.051	0	0.025	0	0	0	0
	0.001	0.086	0.91	0	0	0	0	0	0.002
	0.001	0	0	0.90	0	0	0.015	0	0.005
	0	0	0.005	0	0.77	0.046	0	0	0.013
	0	0.011	0	0	0.17	0.91	0	0	0.016
	0.001	0	0	0.048	0	0	0.95	0	0.007
	0.001	0	0	0.014	0	0	0	0.99	0.005
	0	0.033	0.033	0.02	0.038	0.046	0.031	0.007	0.95
Predicted label									



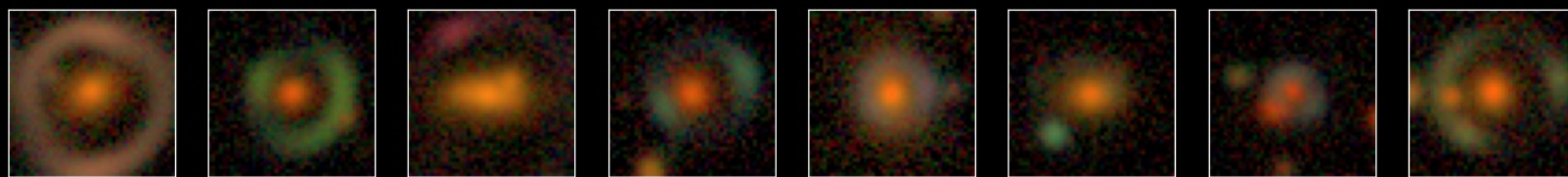
# DSPL SEARCH: TRAINING SAMPLE

New or renamed classes:

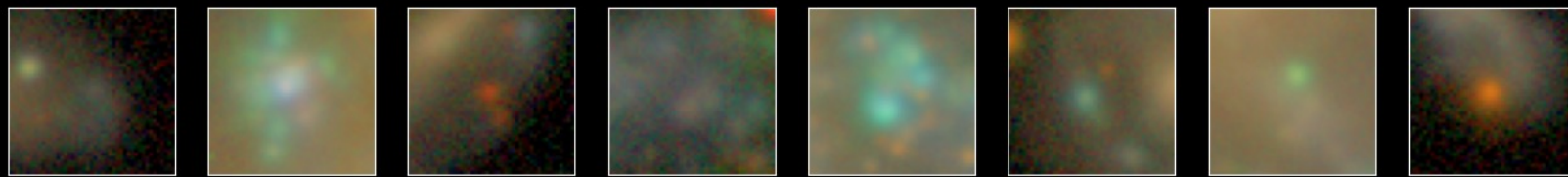
Double (Positive)



Single



Dusty Fields



Kept previous classes:

Ring galaxies

Smooth galaxies

Spiral galaxies

With companions

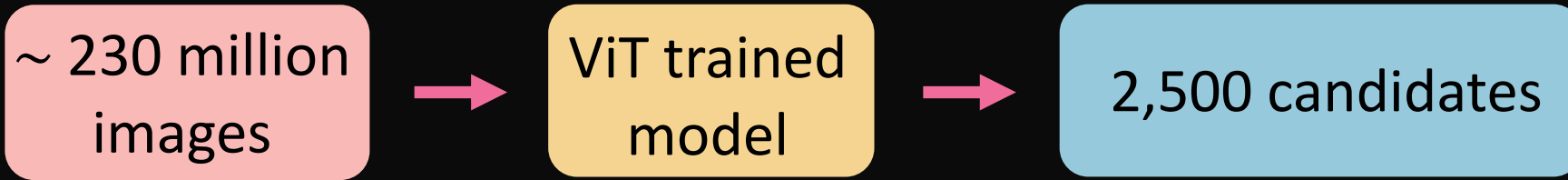
Crowded fields

Artifacts

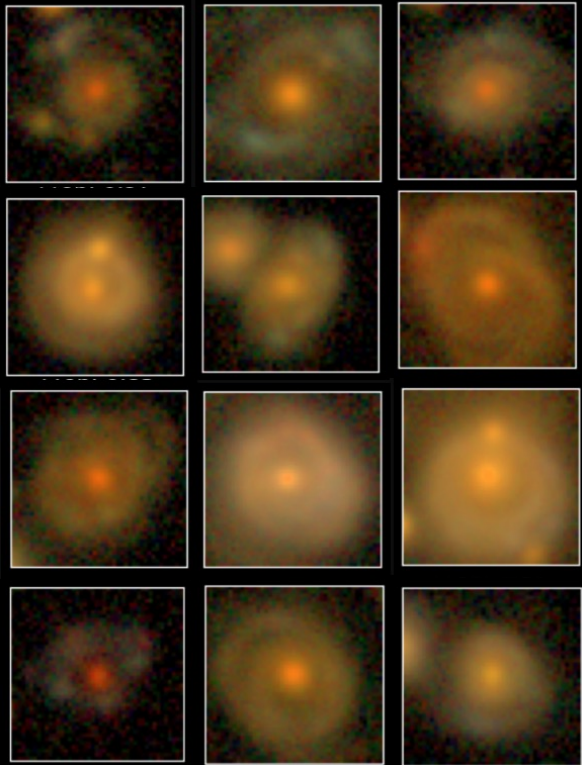
Most negatives



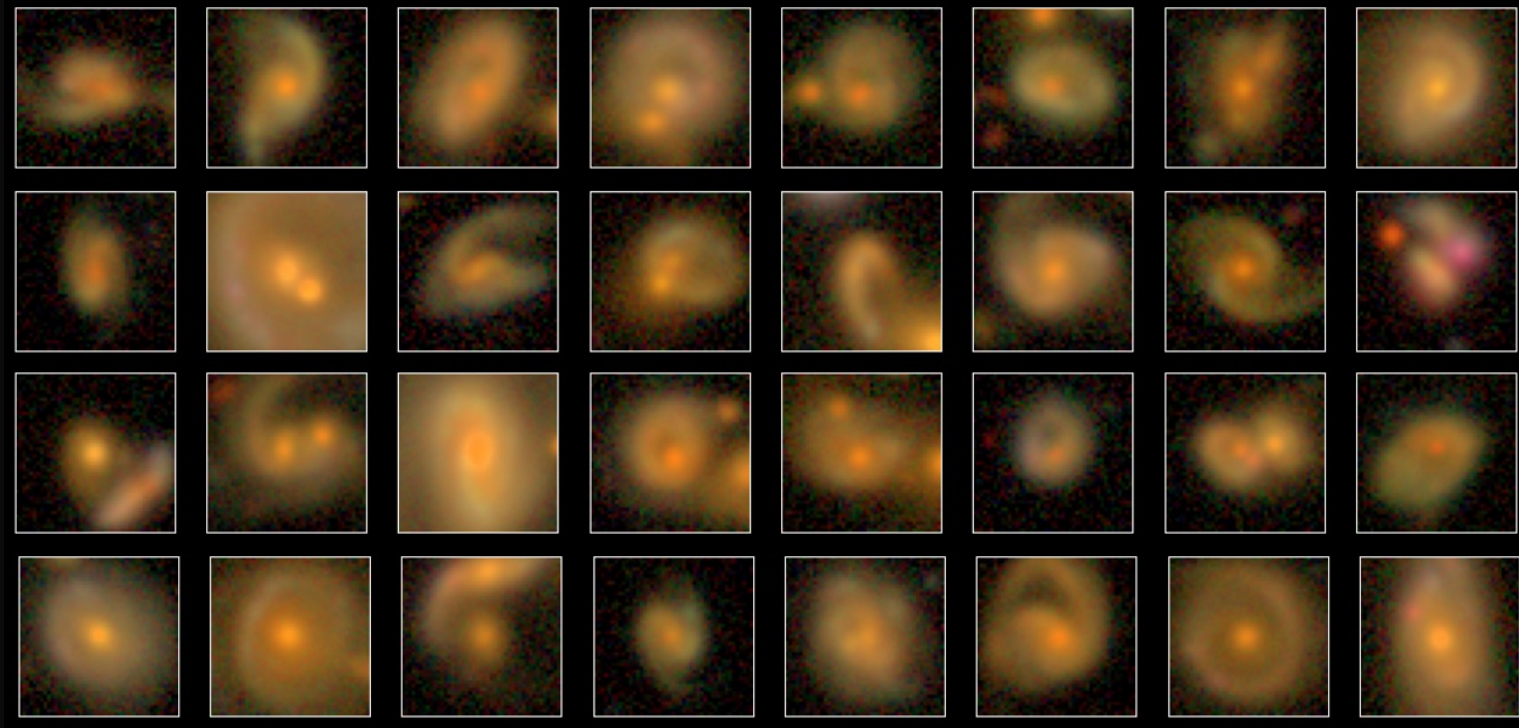
# DSPL SEARCH: HIGHEST RANKED IMAGES



Best candidates:



Random sample of candidates with probability  $\sim 1$  ( $\sim 200$ ):

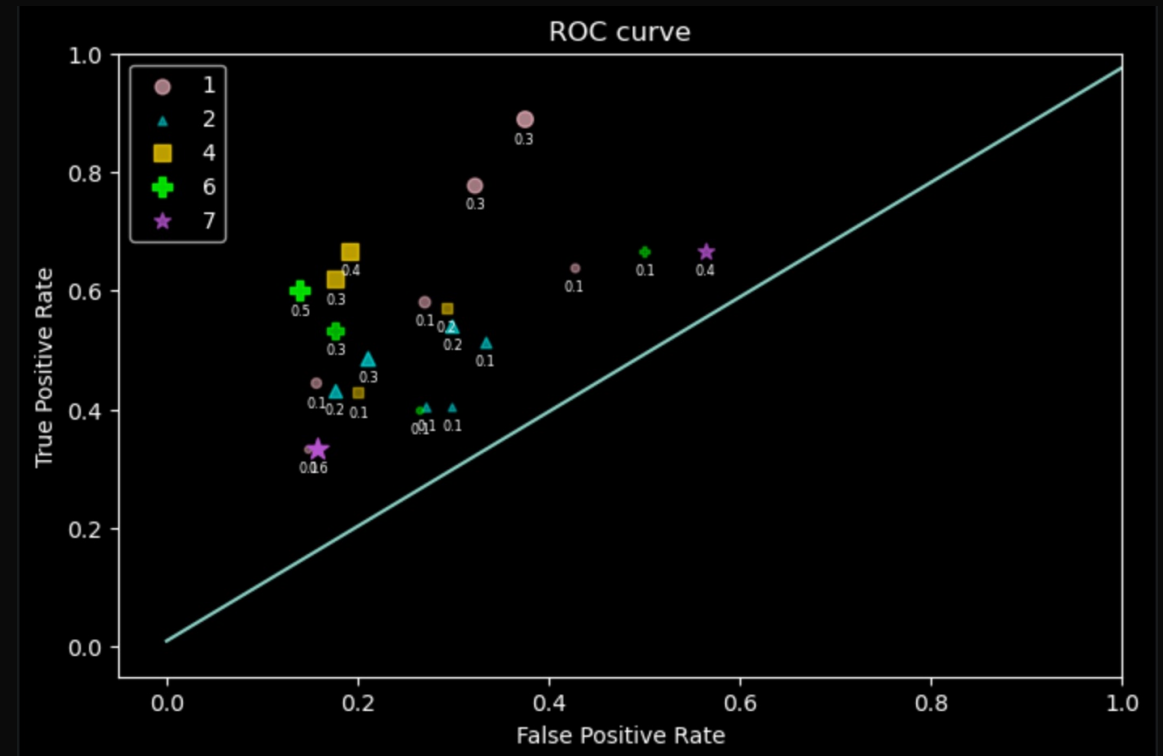
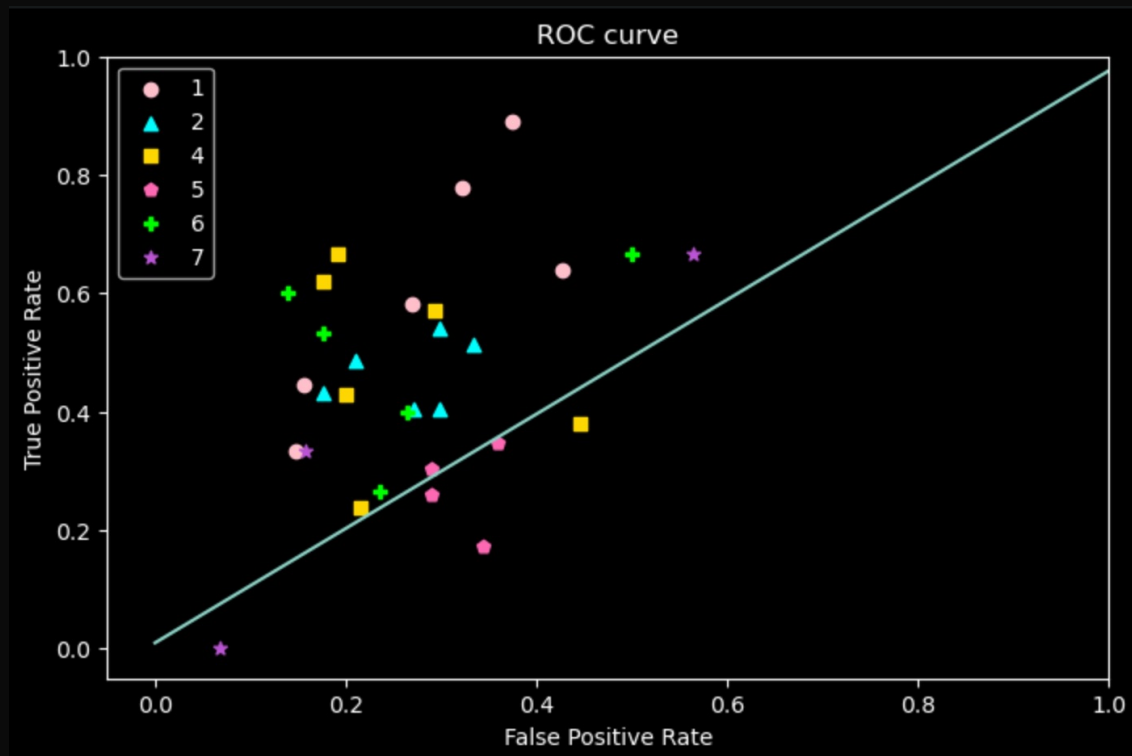




# VISUAL INSPECTION: CONTEXT

We conducted a visual inspection experiment as a project in an undergraduate course tailored for non-physics majors. Each group of students inspected 1,000 images and we had 6 groups in total.

Weights for weighted average:

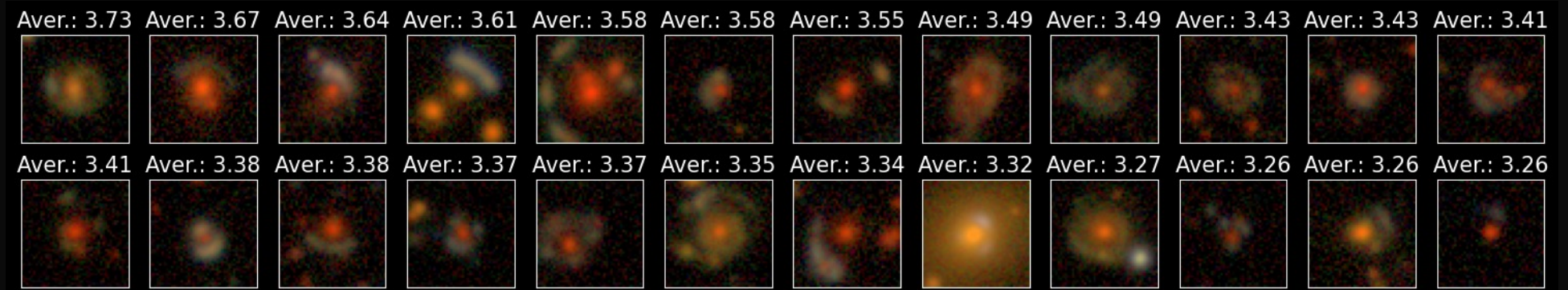




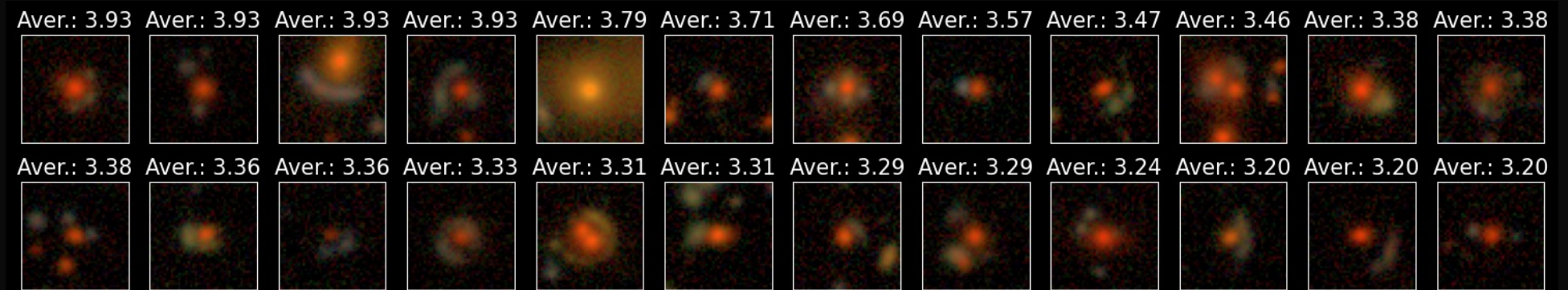


# VISUAL INSPECTION: HIGHEST GRADED IMAGES

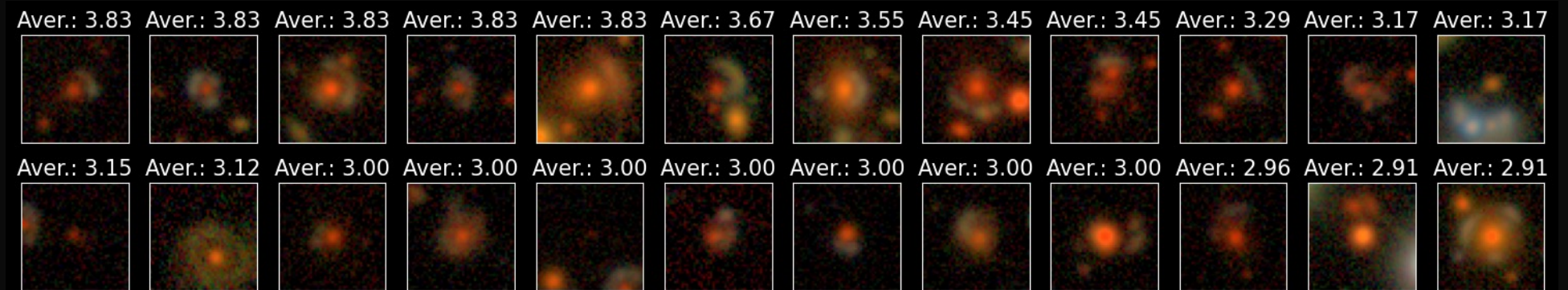
Group 1



Group 2



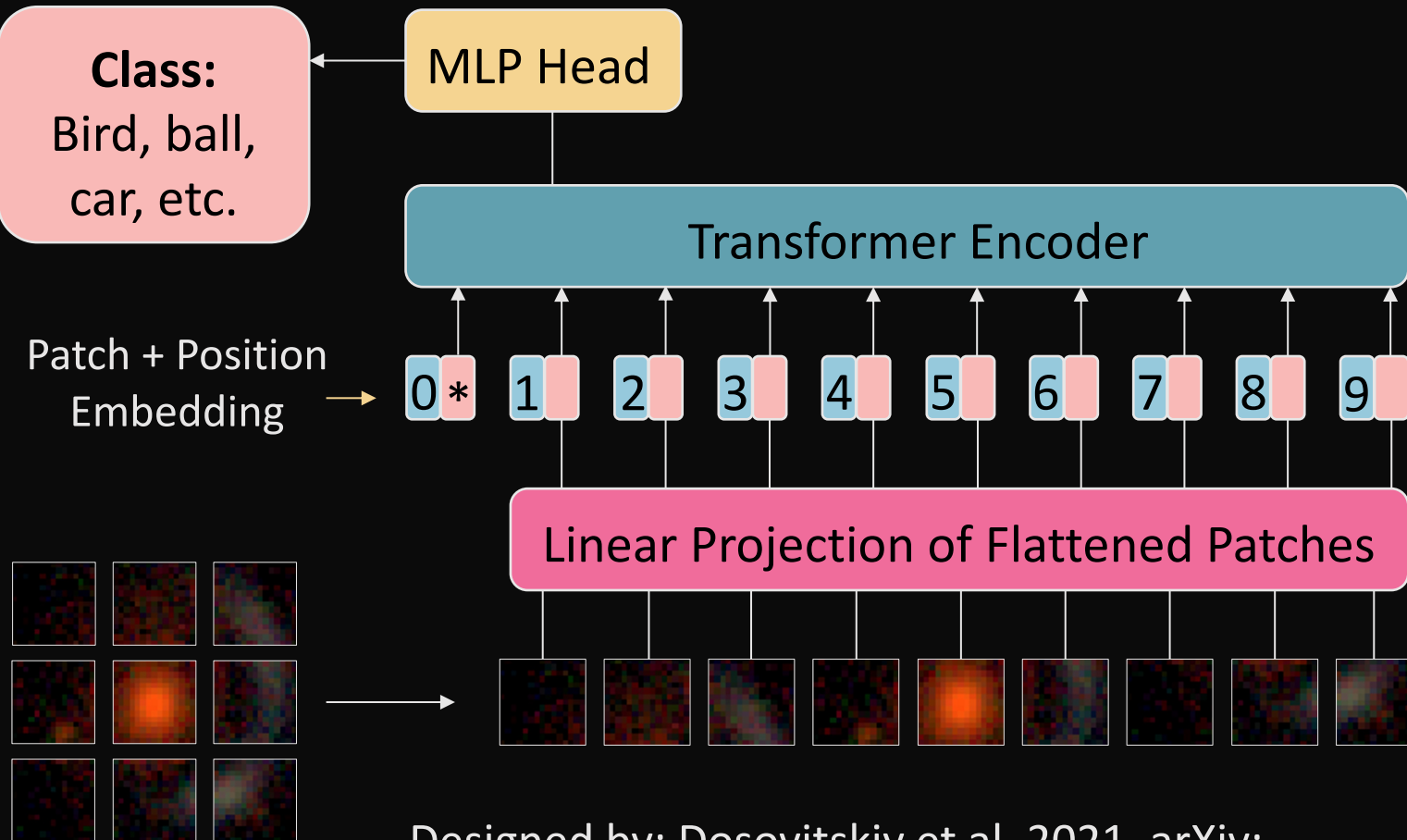
Group 4







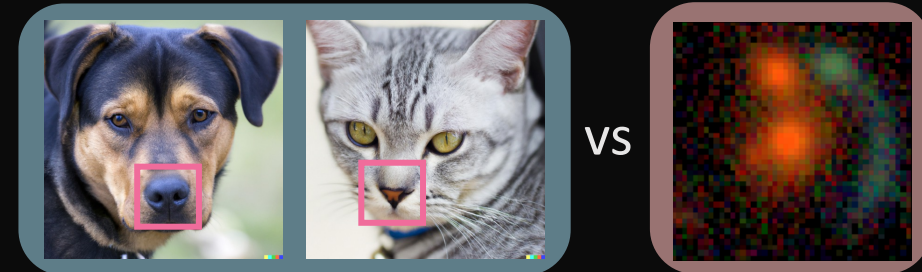
# THE VISION TRANSFORMER (ViT)



Designed by: Dosovitskiy et al. 2021. arXiv: 2010.11929

## CHARACTERISTICS:

Larger receptive field  
→ Better for global features

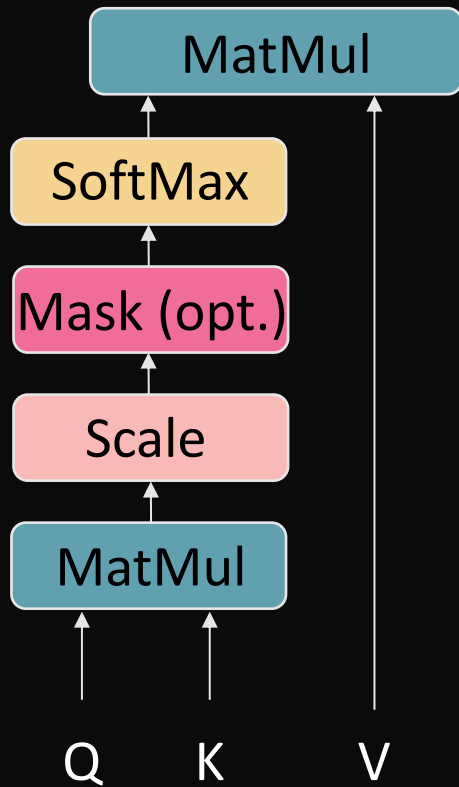


Performs the **same or better** than state of the art CNN models when **pre-trained** on large datasets.

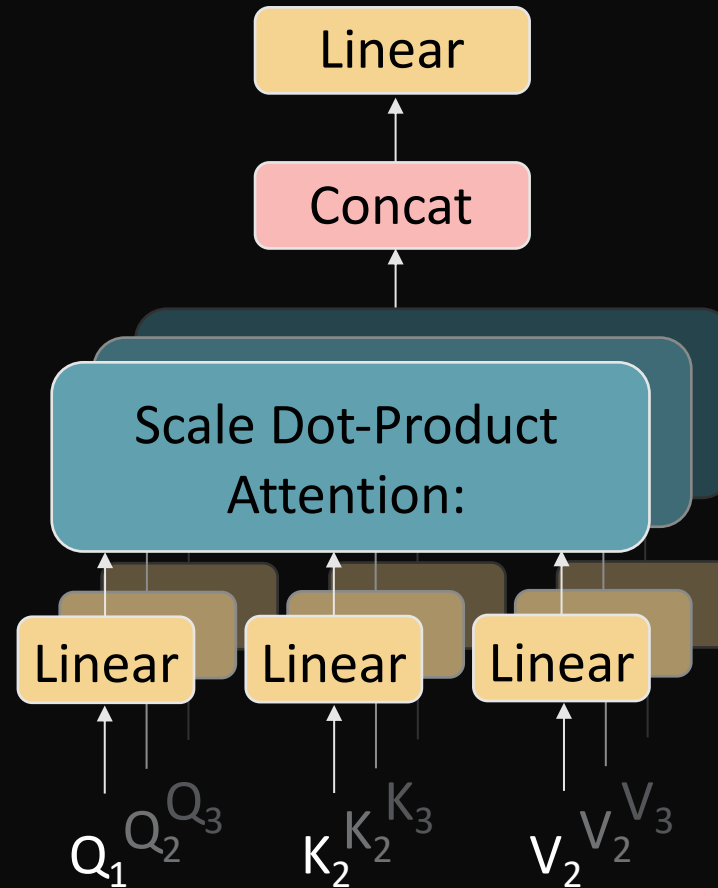


# ATTENTION MECHANISM

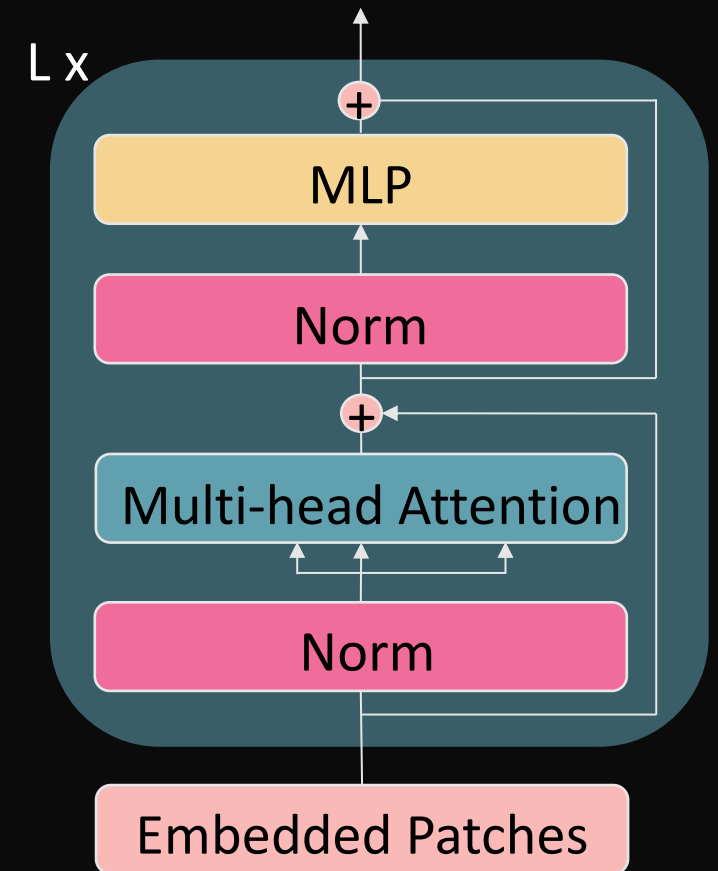
## Scale Dot-Product Attention:



## Multi-Head Attention:



## Transformer Encoder:



# SEARCH RESULTS

Some beautiful lenses:

~ 230 million

ViT trained

20,600 candidates

Random sample

