

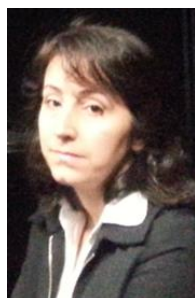


Inteligência artificial e aplicações em física

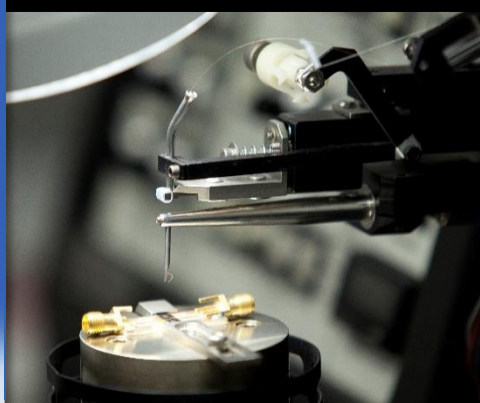
Clécio Roque De Bom – debom@cbpf.br



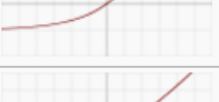
clearnightsrthebest.com



Elisangela L. Faria
(CBPF)



Activation Functions

Name	Plot	Equation	Derivative
Identity		$f(x) = x$	$f'(x) = 1$
Binary step		$f(x) = \begin{cases} 0 & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} 0 & \text{for } x \neq 0 \\ ? & \text{for } x = 0 \end{cases}$
Logistic (a.k.a Soft step)		$f(x) = \frac{1}{1 + e^{-x}}$	$f'(x) = f(x)(1 - f(x))$
TanH		$f(x) = \tanh(x) = \frac{2}{1 + e^{-2x}} - 1$	$f'(x) = 1 - f(x)^2$
ArcTan		$f(x) = \tan^{-1}(x)$	$f'(x) = \frac{1}{x^2 + 1}$
Rectified Linear Unit (ReLU)		$f(x) = \begin{cases} 0 & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} 0 & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$
Parametric Rectified Linear Unit (PReLU) [2]		$f(x) = \begin{cases} \alpha x & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} \alpha & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$
Exponential Linear Unit (ELU) [3]		$f(x) = \begin{cases} \alpha(e^x - 1) & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} f(x) + \alpha & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$
SoftPlus		$f(x) = \log_e(1 + e^x)$	$f'(x) = \frac{1}{1 + e^{-x}}$

Do not take advantage of Neural Nets for non linearities estimation. Useful in regression problems since is unbounded.

Hard to train, derivative vanishes.

Easily differentiable. In the last layers can be associated with probability.

Similar results as in sigmoid activations in intermediate layers. However, is numerically faster.

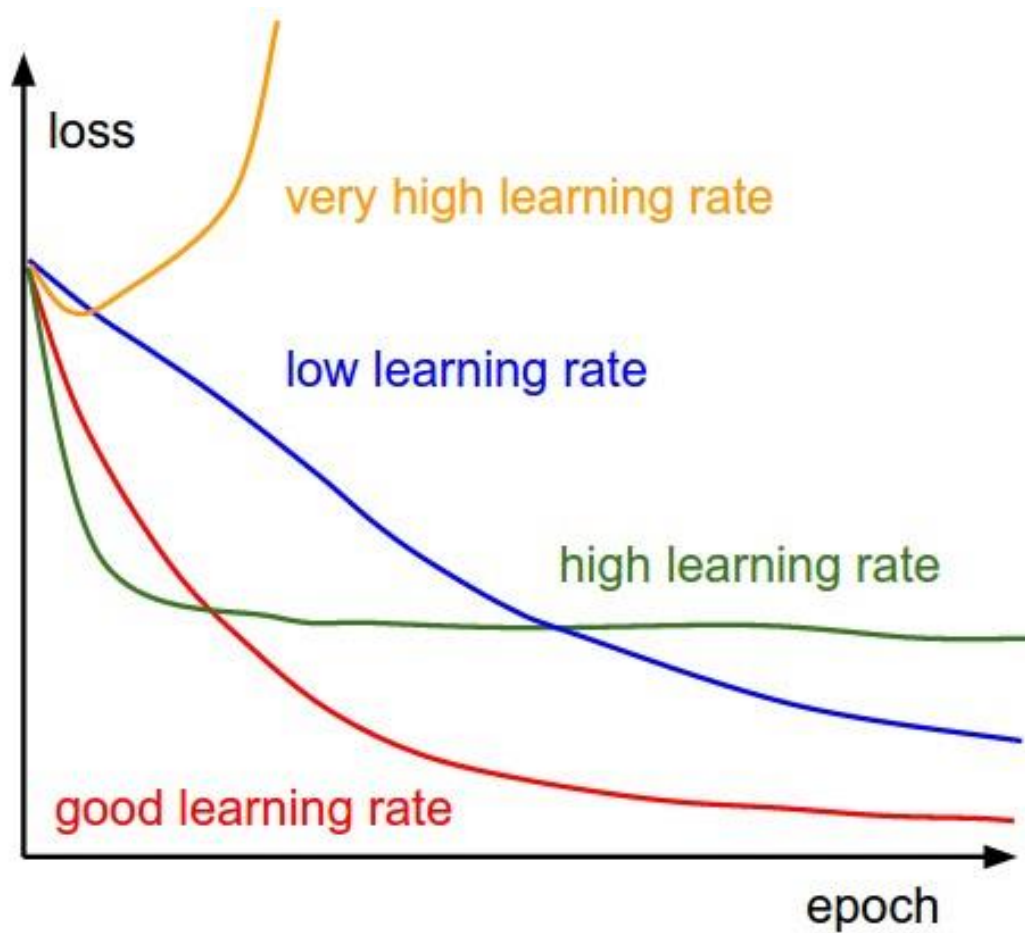
Tentative to avoid the vanishing of the ReLU derivative.

Adapted from

<https://towardsdatascience.com/>

activation-functions-neural-networks-1cbd9f8d91d6

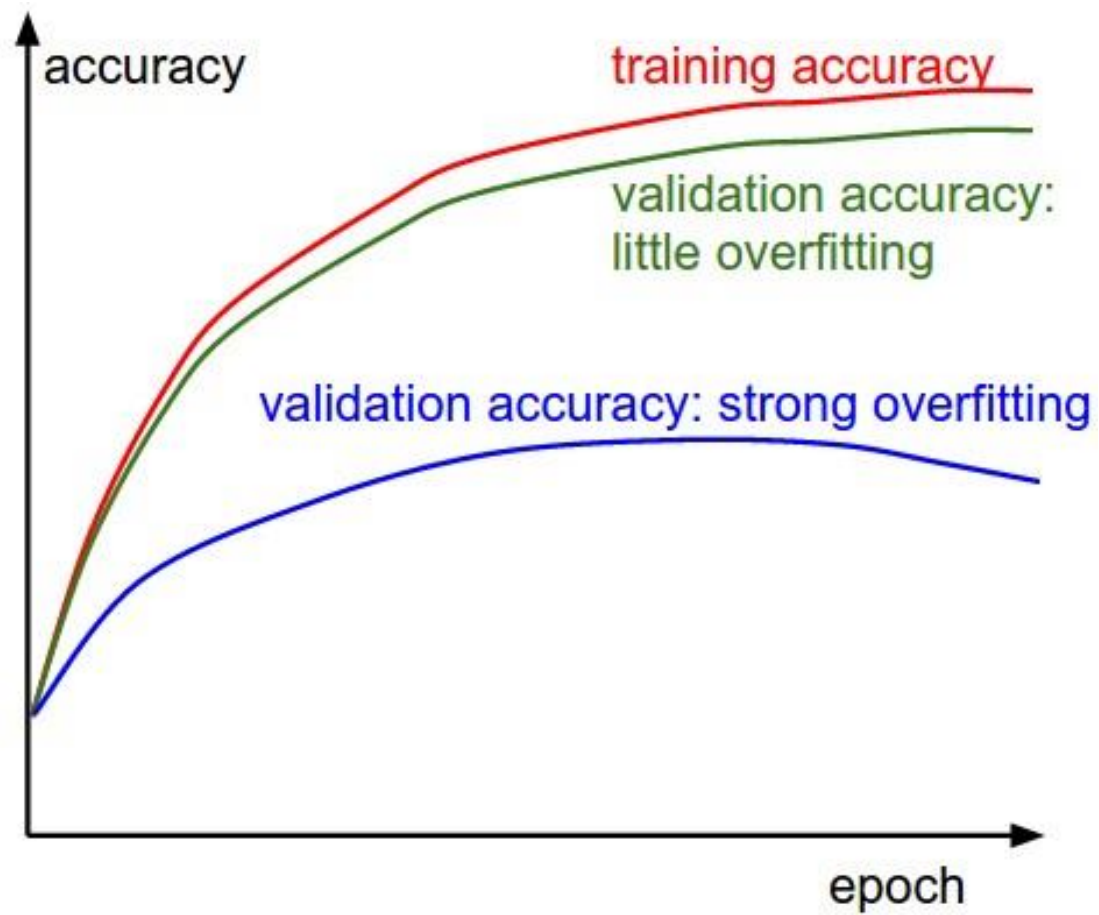
Some intuitions on your LOSS



Source: [http://cs231n.github.io/neural-networks-](http://cs231n.github.io/neural-networks-3/#baby)

[3/#baby](http://cs231n.github.io/neural-networks-3/#baby)

Overfitting



Receiver Operating Characteristic

True positive = correctly identified

False positive = incorrectly identified

True negative = correctly rejected

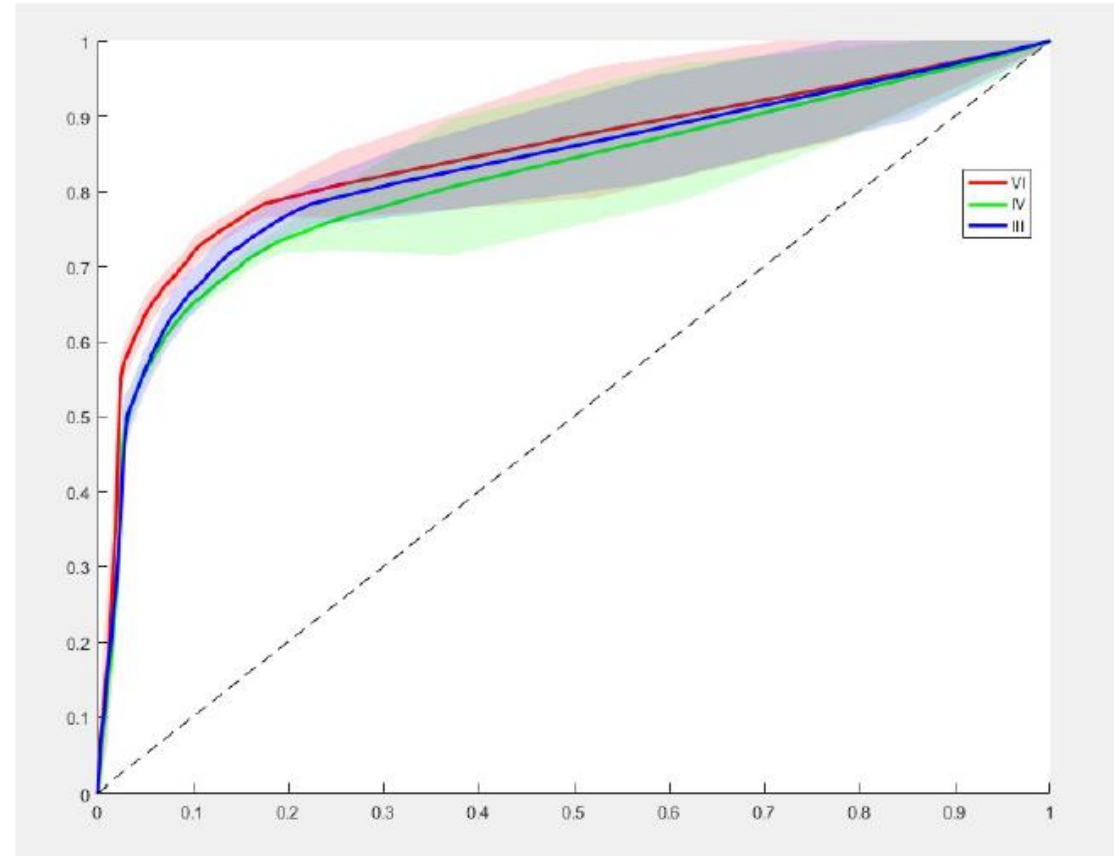
False negative = incorrectly rejected

E.g. 3 Classes

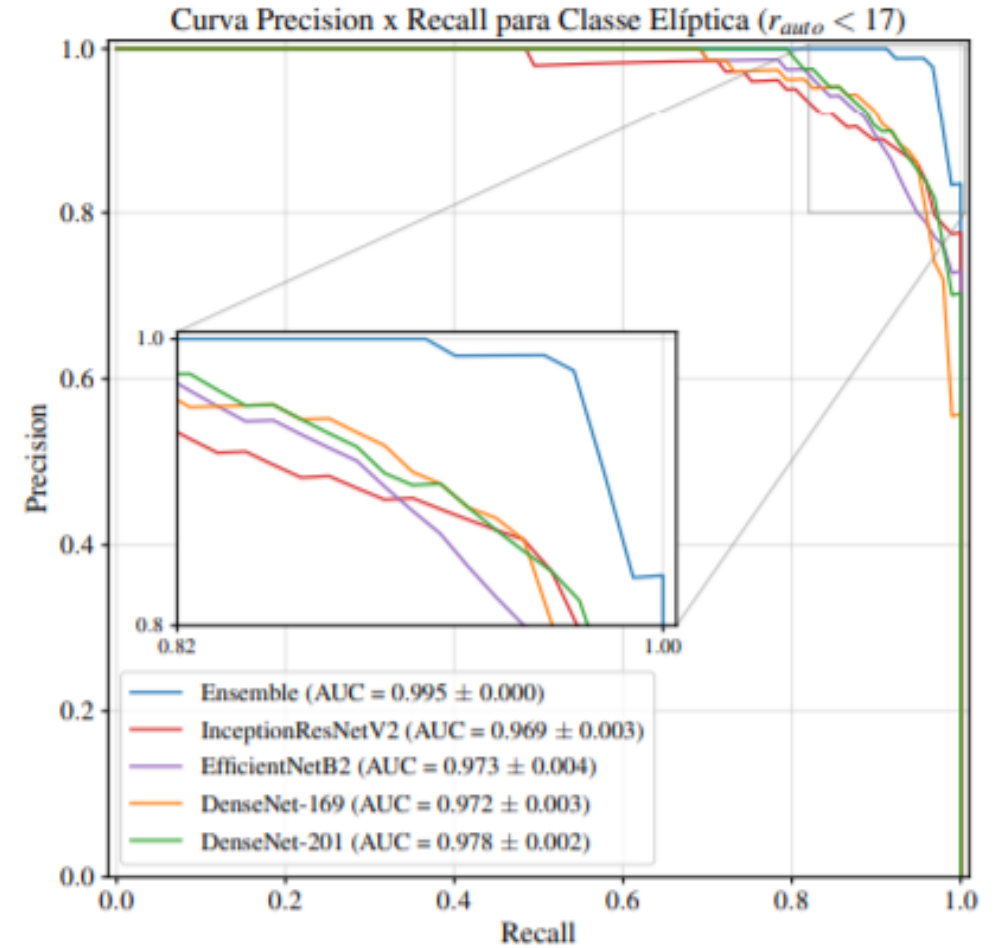
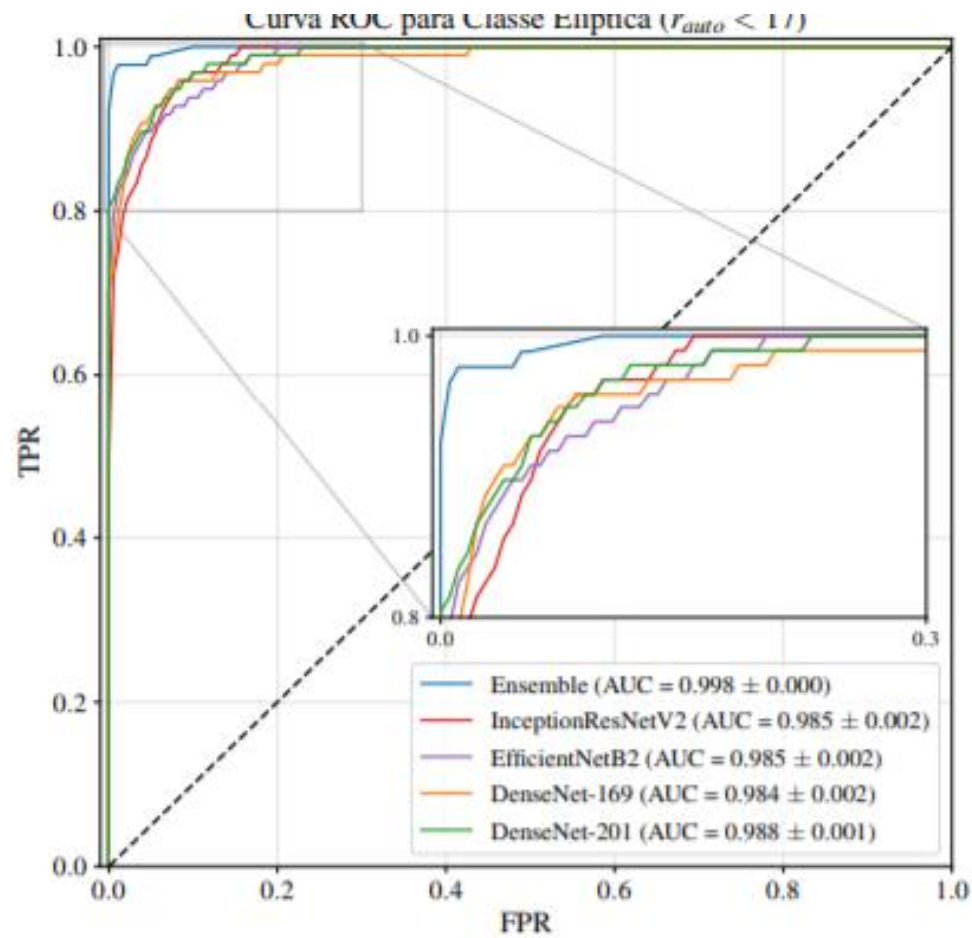
Class 1 vs classes 2&3

Class 2 vs classes 1&3

Class 3 vs classes 1&2

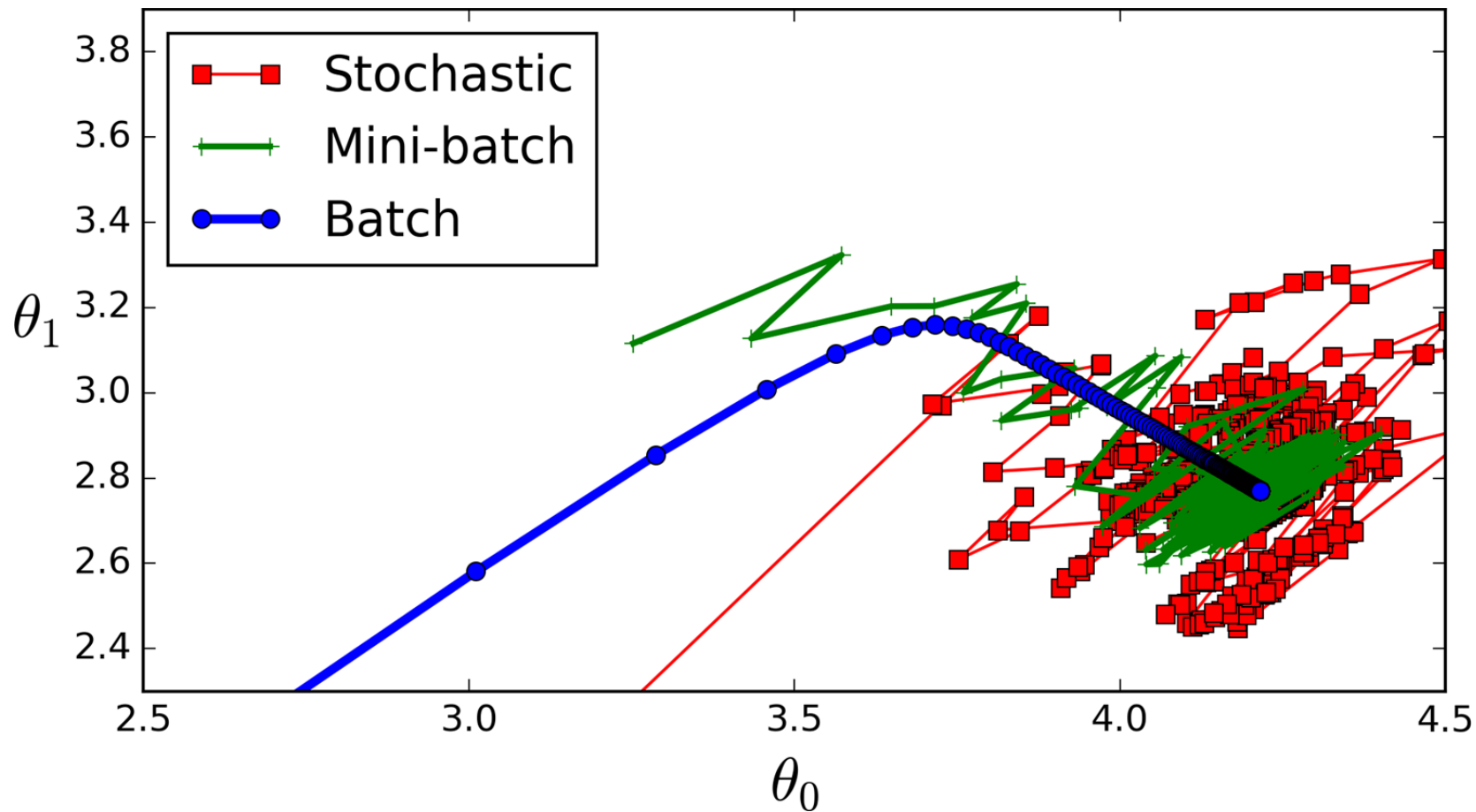


ROC and Precision X Recall



Batch Size

Computational speed X Speed of convergence. Consider two parameters



Cross- validation – K-fold validation

That is the gold standard!

Shuffle the dataset randomly.

Split the dataset into k sets

For each k set:

- Take the group as a hold out or test data set

- Take the remaining groups as a training data set

- Fit a model on the training set and evaluate it on the test set

- Save the evaluation scores in the test set

Summarize the results by defining average (or median and std on each threshold.

Conjunto Base



Fold 1



Fold 2



Fold 3



Fold 4



Fold 5



Strong Lensing Challenge 2.0

The Challenge:

Classify 100k images using up to four channels (VIS, NISP J, Y and H – Euclid-like).

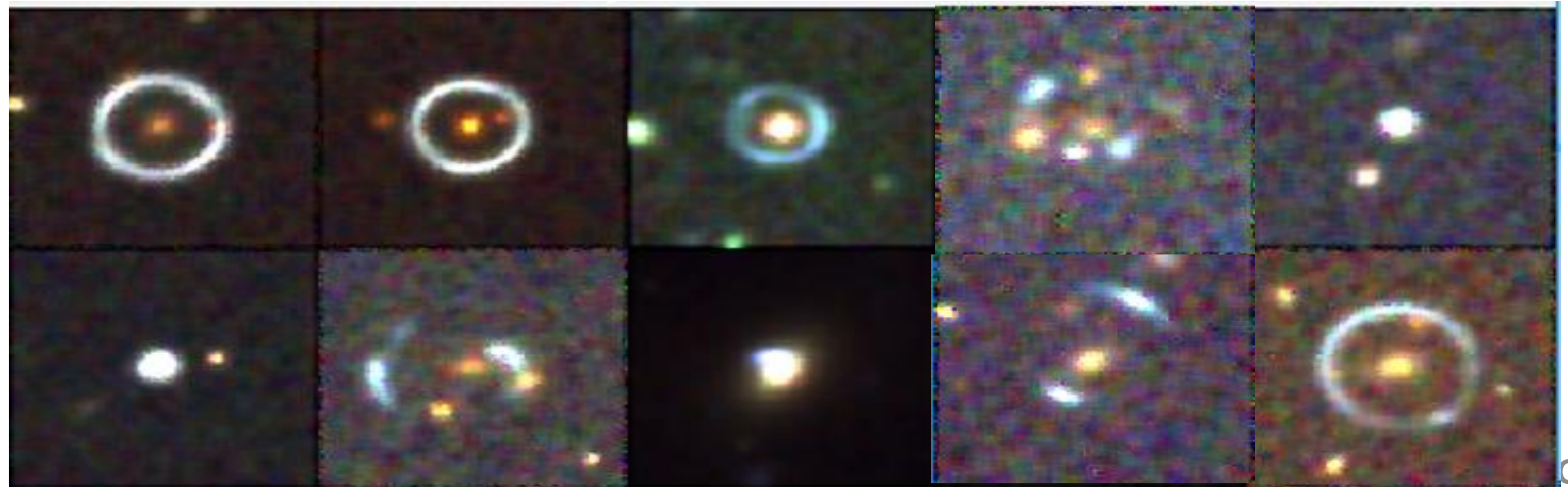
To test the algorithm we have 100k simulated images which contains all sorts of problems in the imaging system.

There was no information on how the images were simulated.

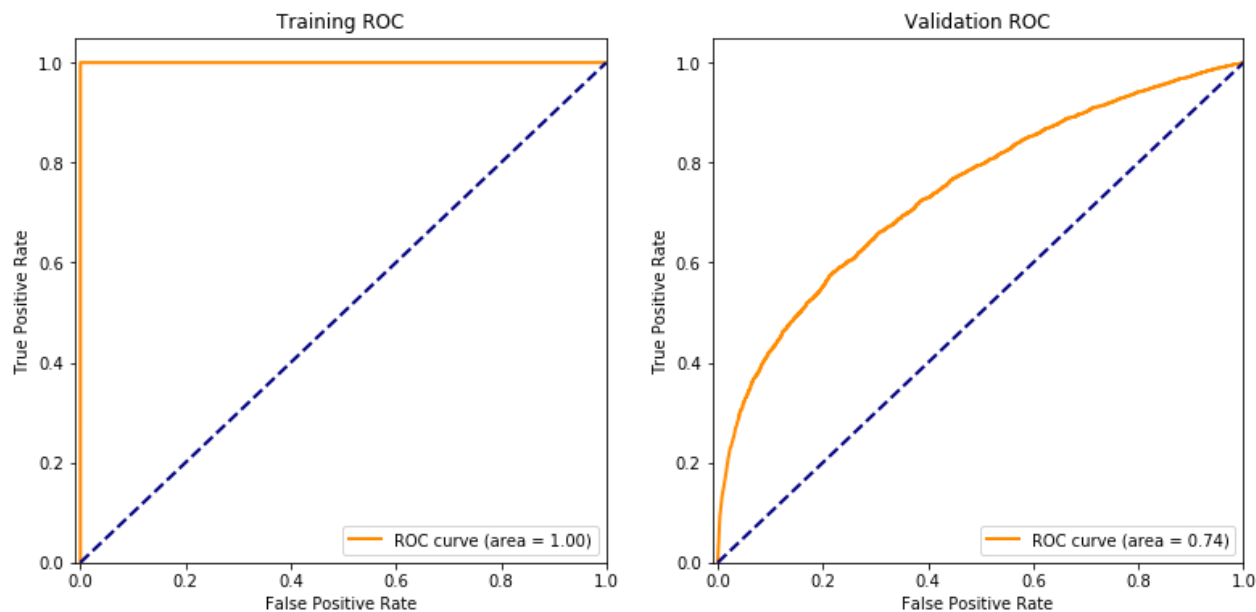
Each team developed different algorithms, mostly based in Deep Learning.

Challenge 1.0 paper : Metcalf et al.

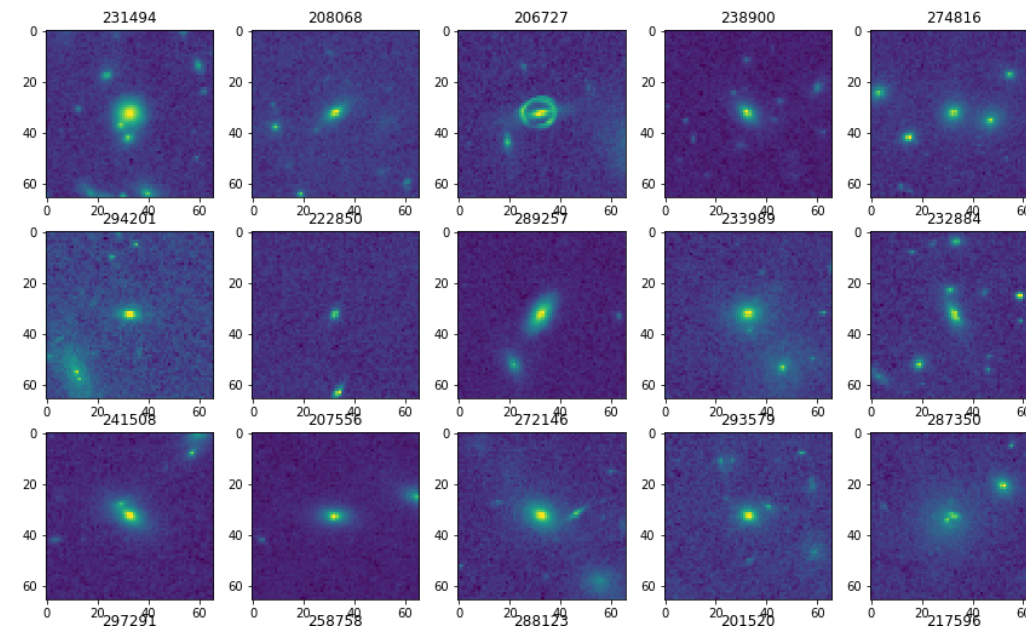
2019 arXiv:1802.03609



Some Issues found



Strong Overfitting in traditional models, like resnet50



Some Lenses are very hard to spot even to human eyes!

Some Lensed images have 20 pixels only!

	F	Precision	Recall	names
1	0.993468	0.997855	0.168824	Cast_efficient_auc Clecio Bom. et al.
2	0.993456	0.996666	0.216973	CNN-napoli-groningen Gentile F., et al.
3	0.993415	0.997041	0.197052	Cast_custom_res_auc Clecio Bom. et al.
4	0.992514	0.997135	0.161404	Cast_efficient_f Clecio Bom, et al.
5	0.992502	0.997300	0.156404	cnnLF Rui Li et al.
6	0.992460	0.996276	0.188806	Cast_custom_res_f Clecio Bom, et al.
7	0.992210	0.997031	0.155718	GAMOCCLASS2 Diego Tuccillo et al.
8	0.990452	0.996228	0.133105	manchester1 Neal Jackson
9	0.989814	0.995895	0.127168	OU-VIS-JYH-200 Joshua Wilde et al.
10	0.987513	0.992573	0.148197	GAMOCCLASS Diego Tuccillo, at al.
11	0.985876	0.990229	0.167554	i-L-Finding-Challenge-2 Joshua Wilde et al.
12	0.985229	0.994180	0.089544	BarSanCNN-N1 Iberto Manjón García, et al.
13	0.984689	0.991219	0.118356	OU-JYH-VIS-66 Joshua Wilde et al.
14	0.982051	0.991908	0.081559	BarSanCNN-N2 Iberto Manjón García, et al.
15	0.981997	0.989571	0.103315	LASTRO_FINDER Elodie Savary, et al.
16	0.981912	0.988461	0.117437	UIUC_ML_Lens_folks Joshua Yao-Yu Lin, Zehao Jin
17	0.975971	0.989837	0.058916	DeepForkLens-elu Anna Niemiec, Jonathan Vacher
18	0.975971	0.989837	0.058916	DeepForkLens-maxpool Anna Niemiec, Jonathan Vacher
19	0.974475	0.988605	0.057726	DeepForkLens Anna Niemiec, Jonathan Vacher
20	0.956939	0.958788	0.304440	LASTRO_Andrei_Daniel Elodie Savary, et al.
21	0.942402	0.944213	0.300992	OU-T-SNE Joshua Wilde et al.
22	0.561878	0.574694	0.021796	NOTCH Nan Li, et al.
23	0.561878	0.574694	0.021796	NJUPTDeeplens Nan Li, et al.
24	0.559905	0.559986	0.482188	UIUC_ML_lensing_group Joshua Yao-Yu Lin, Zehao Jin
25	0.558057	0.557835	1.000000	Cast_cdropout_aug Clecio Bom, et al.
26	0.558057	0.557835	1.000000	Cast_cdropout Clecio Bom, et al.
27	0.558044	0.557823	1.000000	NOTCH2 Nan Li, et al.

e



	F	Precision
1	0.993468	0.997855
2	0.993456	0.996666
3	0.993415	0.997041
4	0.992514	0.997135
5	0.992502	0.997300
6	0.992460	0.996276
7	0.992210	0.997031
8	0.990452	0.996228
9	0.989814	0.995895
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13	0.984689	0.991219
14	0.982051	0.991908
15	0.981997	0.989571
16	0.981912	0.988461
17	0.975971	0.989837
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19	0.974475	0.988605
20	0.956939	0.958788
21	0.942402	0.944213
22	0.561878	0.574694
23	0.561878	0.574694
24	0.559905	0.559986
25	0.558057	0.557835
26	0.558057	0.557835
27	0.558044	0.557823

Lens Finding Challenge 2.0 results

Caixa de entrada x

Ben Metcalf <RobertBenton.Metcalf@unibo.it>

para Clécio ▾

🌐 inglês ▾ > português ▾ [Traduzir mensagem](#)

Dear Clecio,

You won! Congratulations!

I am attaching a presentation I am about to give to the Euclid strong lensing group on it. There are a few complications. In particular I think two of you entries were meant just for the Einstein radius contest? Also I'm interested in how your method that trained on the AUC does better than the one you trained on the F score.

There were other entries in the Einstein radius competition that I think are not in the right units or are areas instead of radii. I haven't been able to figure them out yet.

I'll be compiling a more complete report and will get in touch with you about that.

Yours

Ben

R. Ben Metcalf

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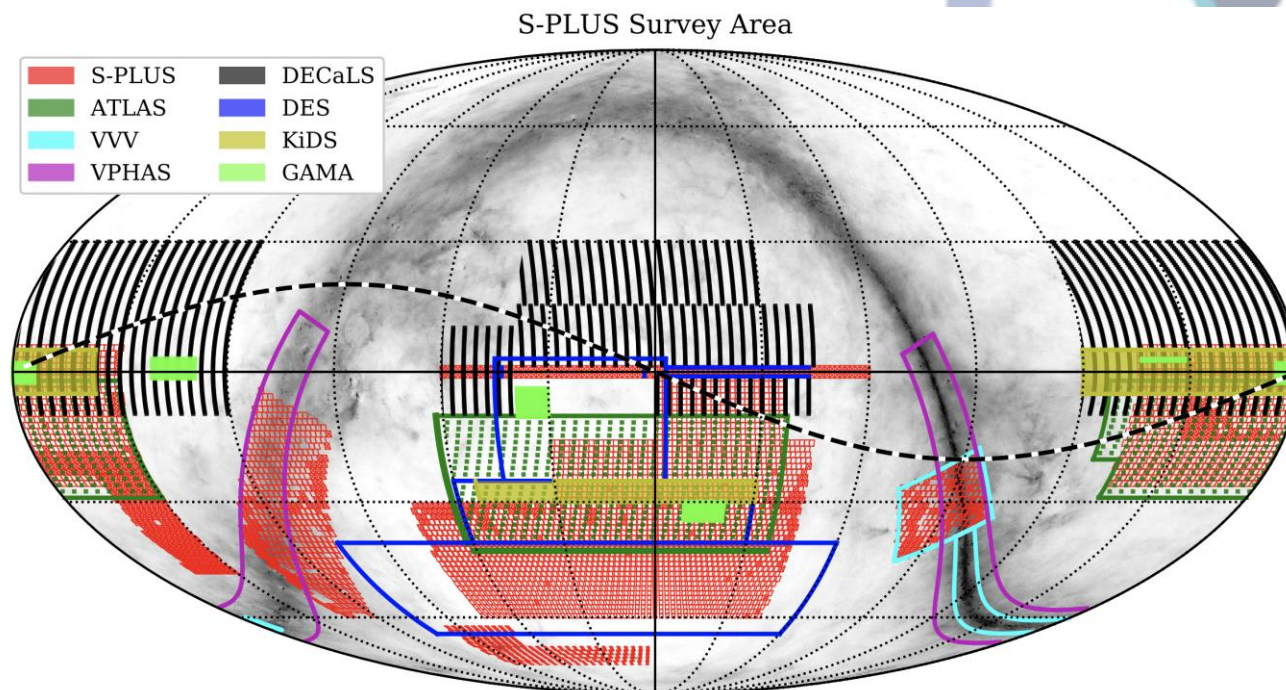


Galaxy Morphology Classification

S-PLUS is an ongoing $\sim 9,300$ sqdeg, 12 filter (8 narrow band) survey to investigate the local Universe in the Southern hemisphere.

The data was later matched with Galaxy Zoo database.

In S-PLUS DR1 we have $\sim 8k$ have galaxy Zoo classification (from the 14k in our original sample)



Some GalaxyZoo examples in S-Plus



Spirals



Some GalaxyZoo examples in S-Plus



Ellipticals

SPLUS.STRIPE82-0002.12730 : 1.0



SPLUS.STRIPE82-0002.14076 : 1.0



SPLUS.STRIPE82-0002.14560 : 1.0



SPLUS.STRIPE82-0002.14565 : 1.0



SPLUS.STRIPE82-0002.14682 : 1.0



SPLUS.STRIPE82-0002.15179 : 1.0



SPLUS.STRIPE82-0002.15375 : 1.0



SPLUS.STRIPE82-0002.15847 : 1.0



SPLUS.STRIPE82-0002.16038 : 1.0



SPLUS.STRIPE82-0002.16265 : 1.0



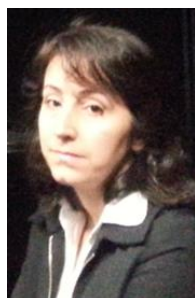


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