



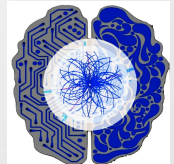
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INGENIERÍA

Muon Detection Using Deep Learning, Applied to CONNIE Events

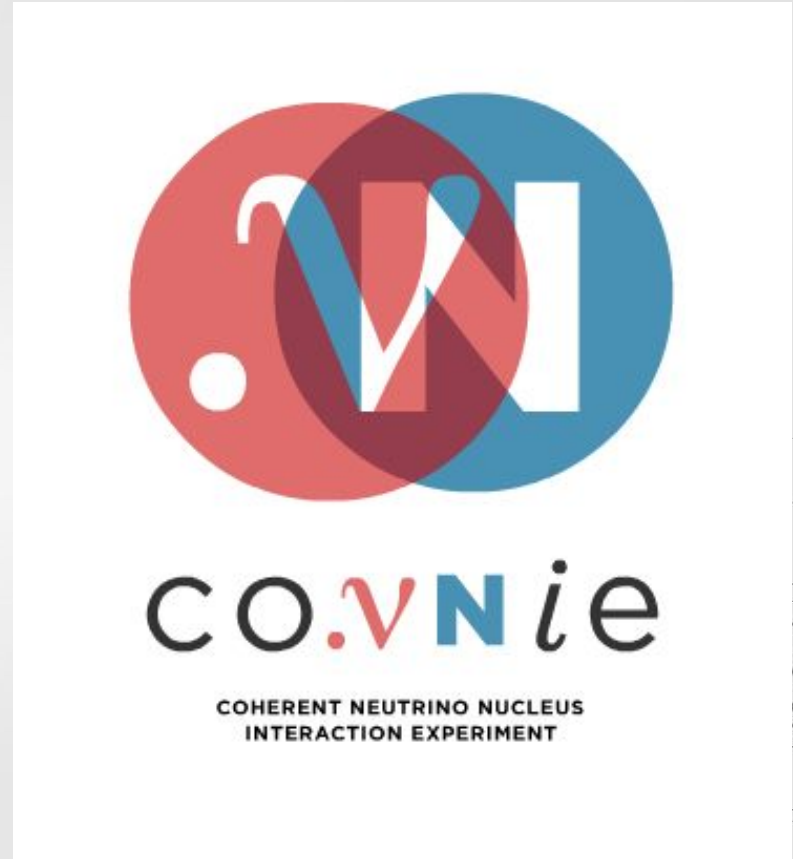
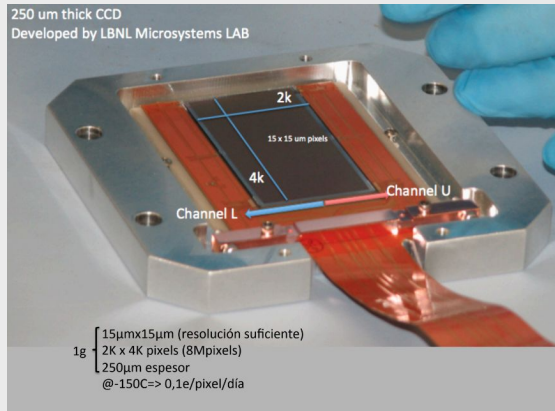
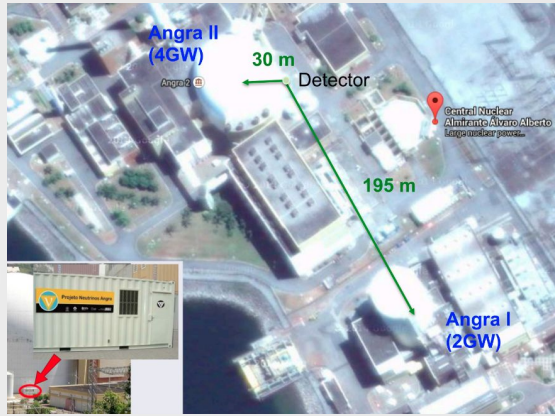
Javier Bernal, Dr. Diego Stalder, Jorge Molina

Facultad De Ingeniería
Universidad Nacional De Asunción
Laboratorio de Mecánica y Energía

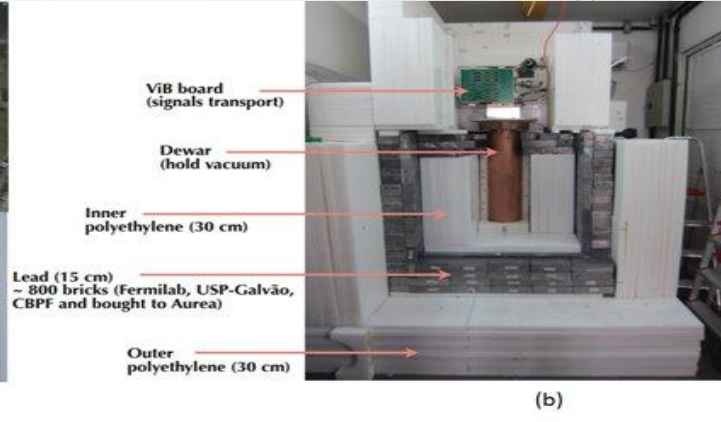
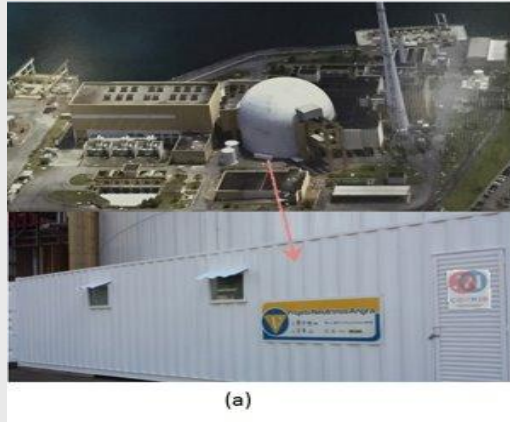
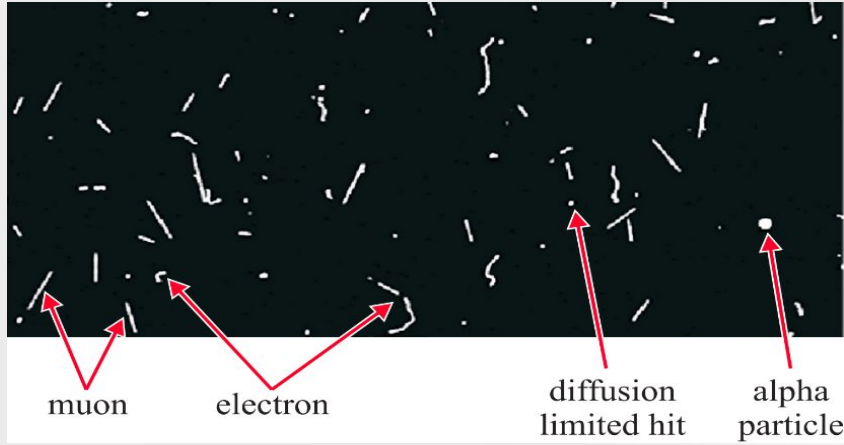
Fast Machine Learning for Science Workshop, Dec. 2020



CONNIE (COherent Neutrino Nucleus Interaction Experiment)



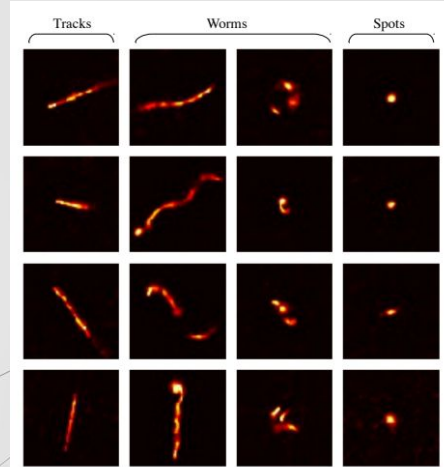
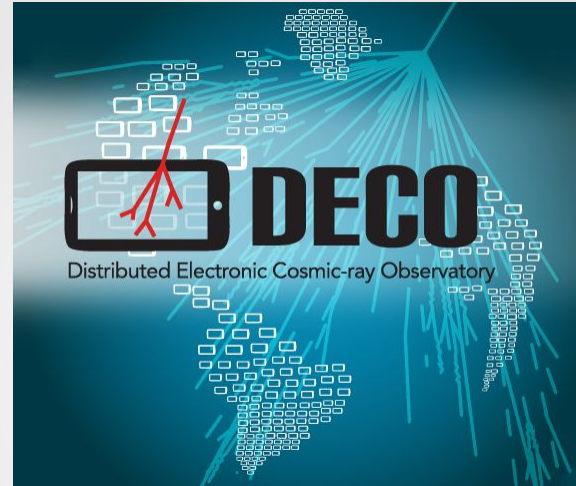
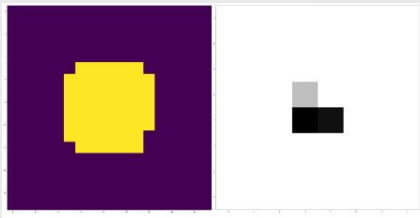
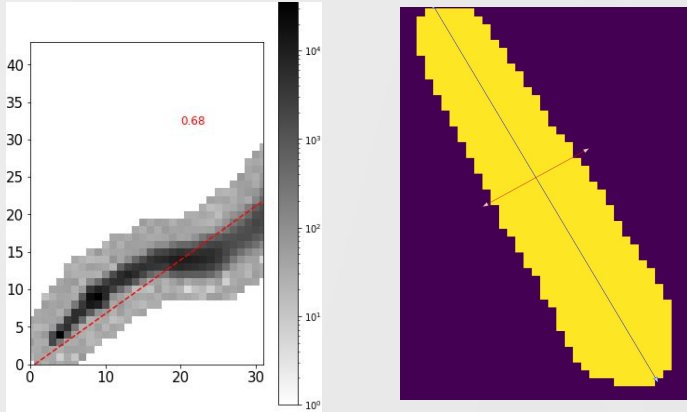
Muons



Previous Muon classification Attempts

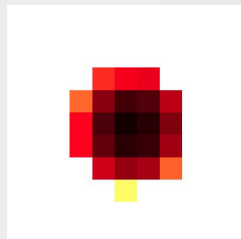
- DECO experiment

- CONNIE classical cuts

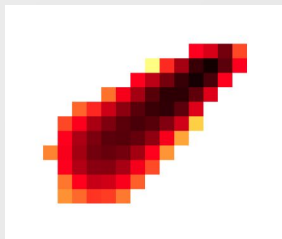


Particle Identification In Camera Image Sensors
Using Computer Vision

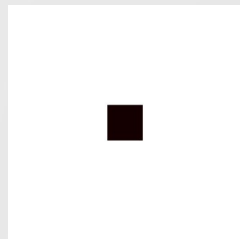
Dataset



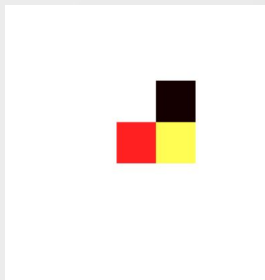
Spot



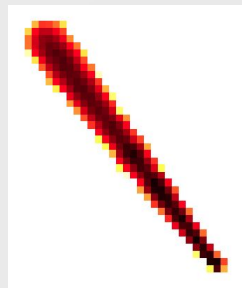
Muon Unsure



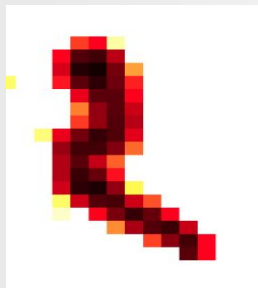
Bad Pixel



Undefined



Muon Sure

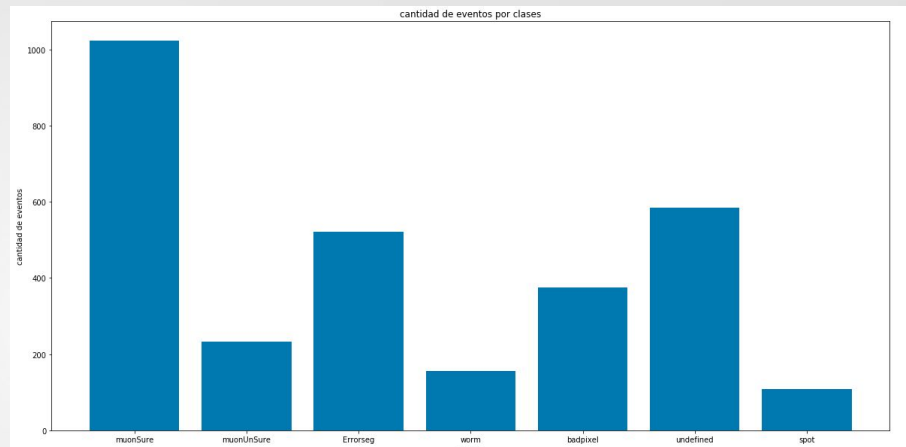


worms



Segmentation errors

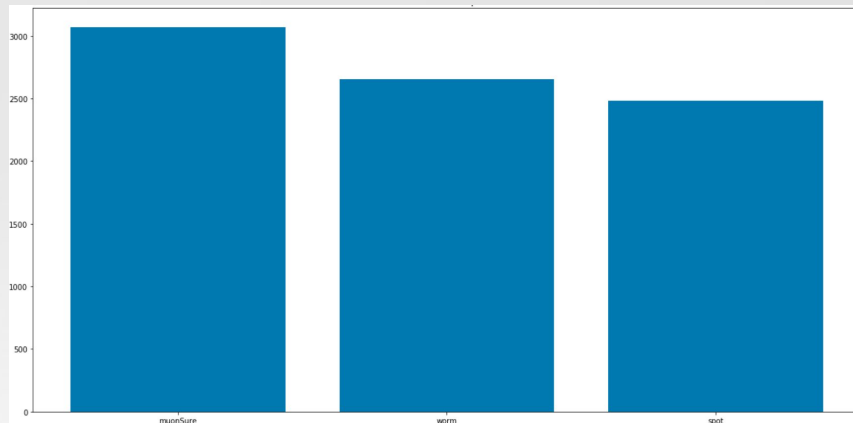
Datasets distribution



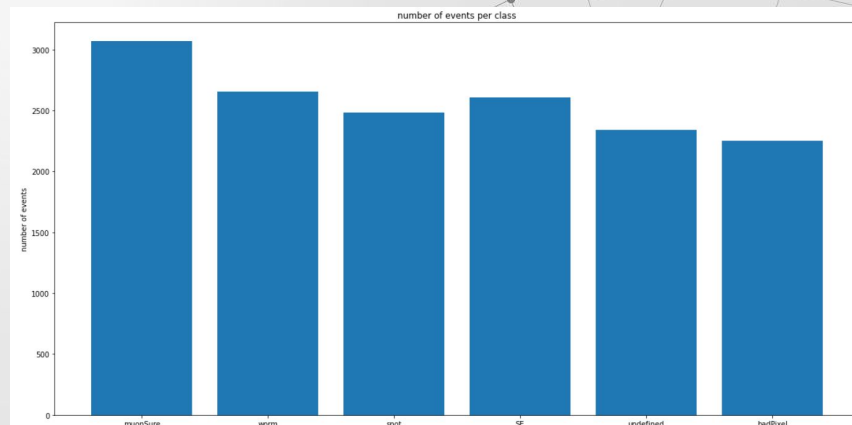
Dataset Preprocessing

- read the .fits
- remove the negative values
- resize
 - 64x64 3 classes
- logarithmic scale
 - 64x64 6 classes
 - 64x64 padd 3 classes
 - 64x64 3 classes
 - 128 x 128 3 classes
- normalize it to 0-255
- data augmentation

3 classes data distribution

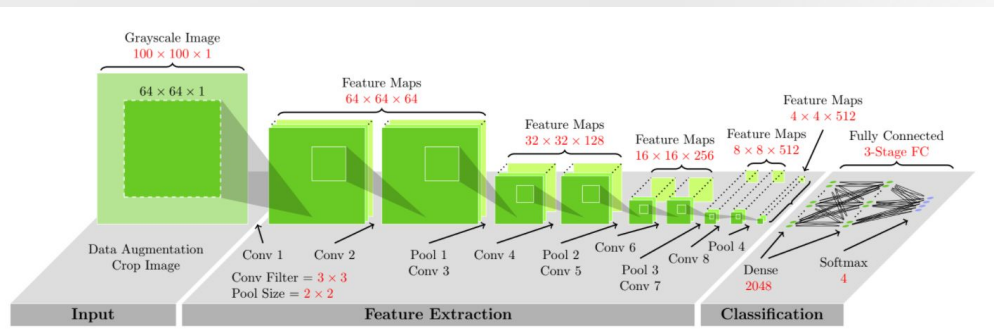


6 classes data distribution



DL model

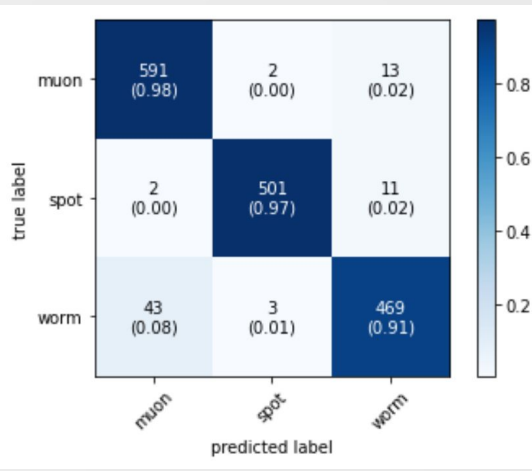
- optimizer: adam
- loss: categorical_crossentropy
- epochs: 200
- batch size: 64



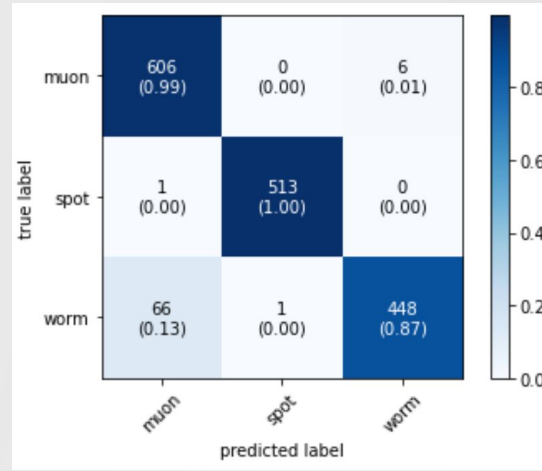
	Layer	Features	Size	Activation	Dropout
1	Convolution	64	3×3	Leaky ReLU	-
2	Convolution	64	3×3	Leaky ReLU	-
3	Max Pooling	-	2×2	-	0.2
4	Convolution	128	3×3	Leaky ReLU	-
5	Convolution	128	3×3	Leaky ReLU	-
6	Max Pooling	-	2×2	-	0.2
7	Convolution	256	3×3	Leaky ReLU	-
8	Convolution	256	3×3	Leaky ReLU	-
9	Max Pooling	-	2×2	-	0.2
10	Convolution	512	3×3	Leaky ReLU	-
11	Convolution	512	3×3	Leaky ReLU	-
12	Max Pooling	-	2×2	-	0.2
9	Dense	2048	-	Leaky ReLU	0.4
10	Dense	2048	-	Leaky ReLU	0.4
11	Dense	4	-	softmax	-

Winter et al (2018)arXiv:1803.04493v2 (DECO collaboration)

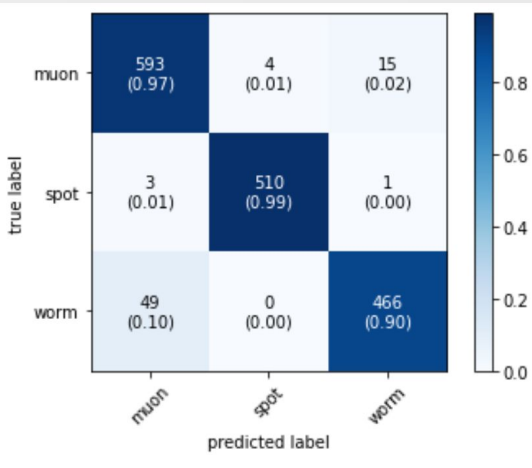
Training results



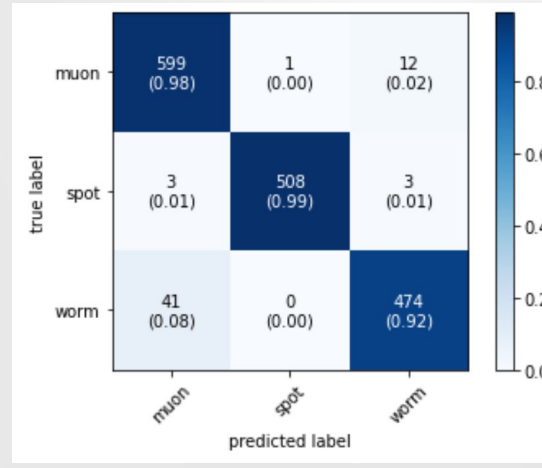
64x64 without padding



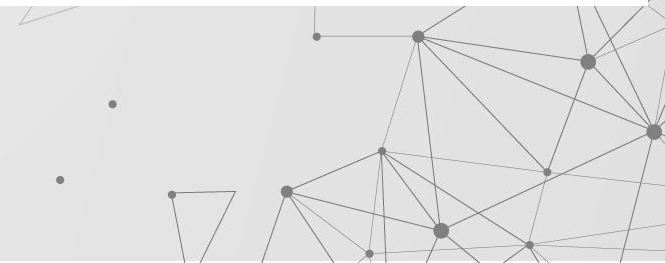
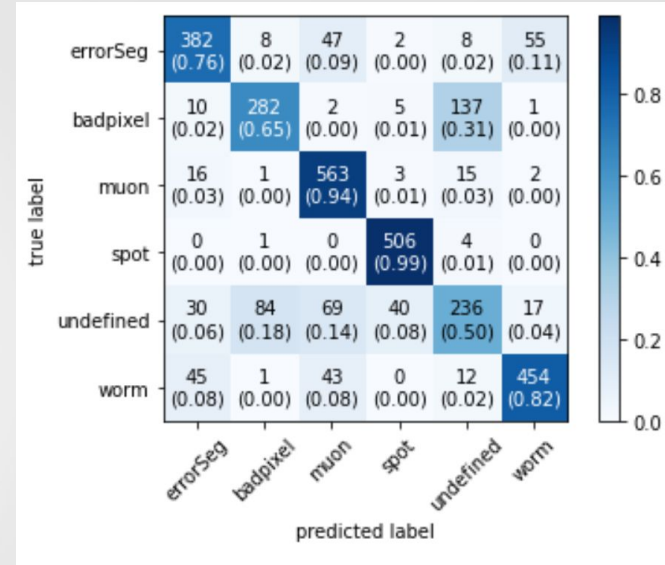
64x64 with padding



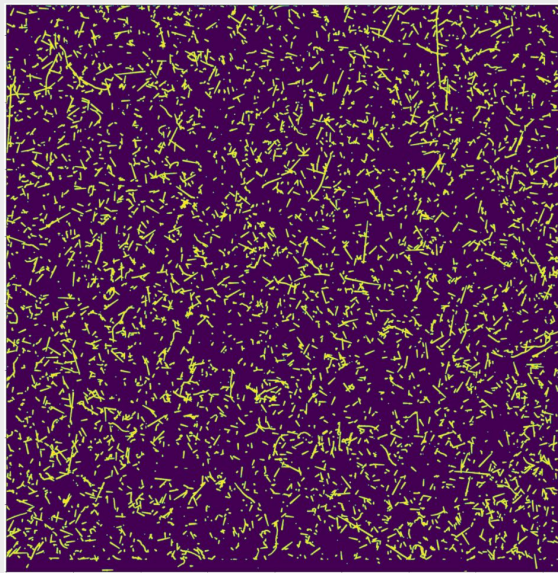
64x64 not logarithmic



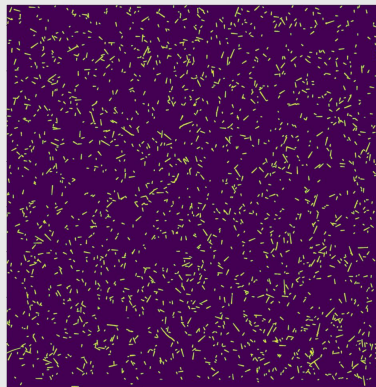
128x128



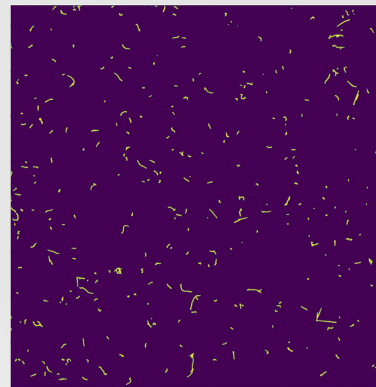
DL classification



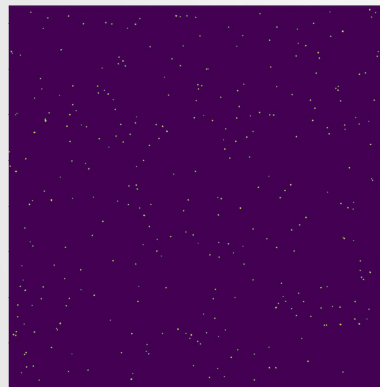
full image
run ID:246
expo time: 3 hours



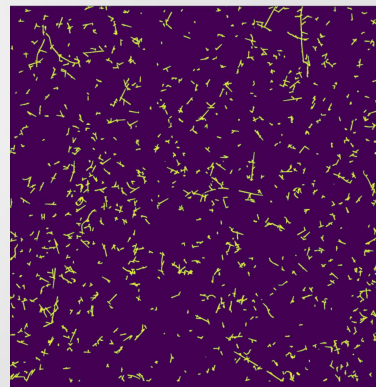
muon sure



worms



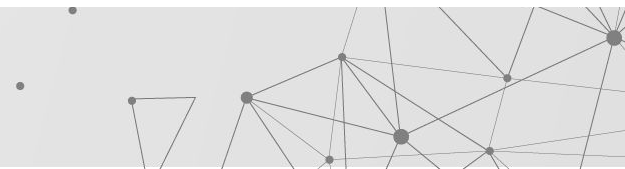
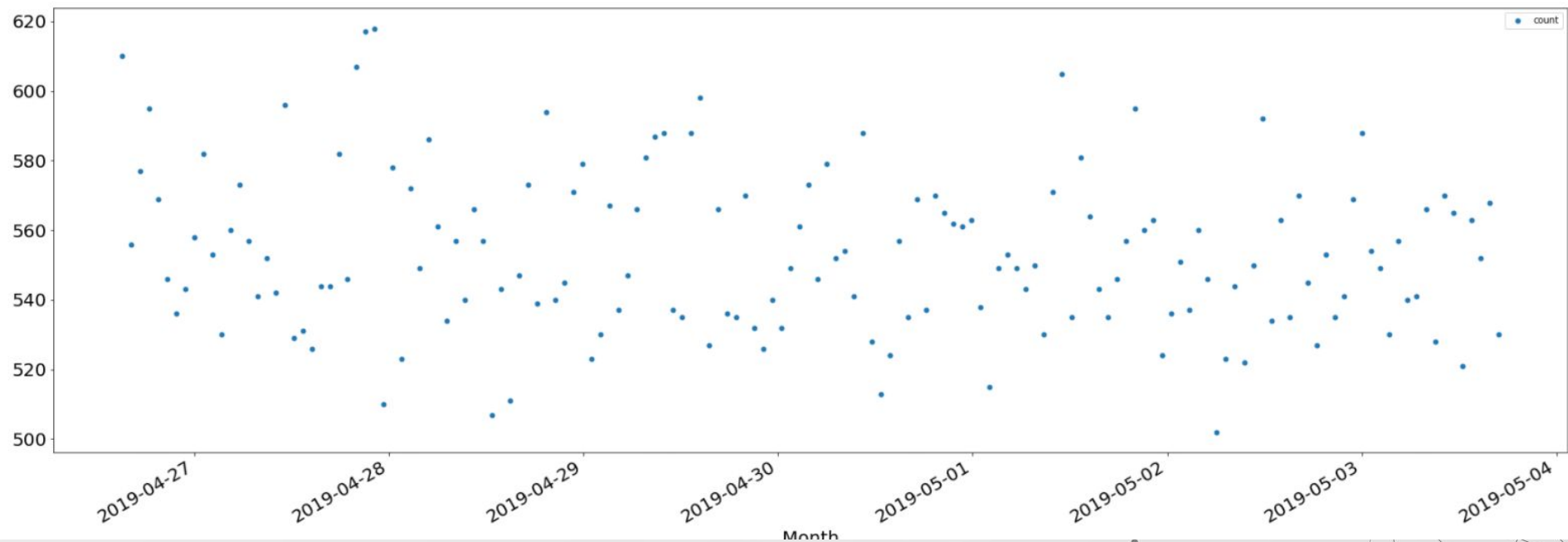
spots



badPixles, undefines,
segmentation errors



DL classification results: Preliminary time series



Technical data

all the algorithms were trained with:

Software

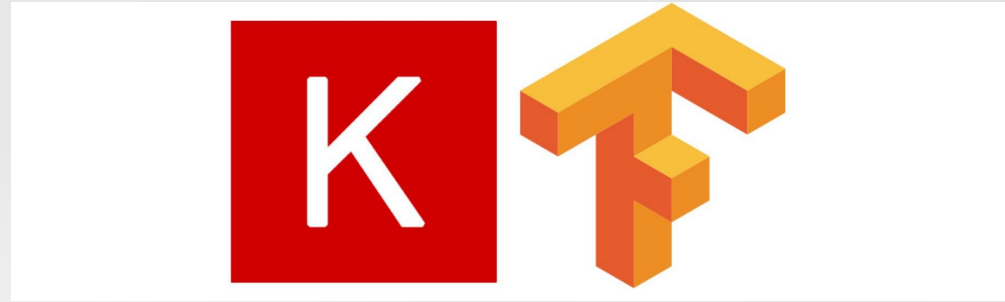
TensorFlow 2

Keras api

Python 3.6

hardware

NVIDIA GeForce RTX2080 ti (11GB RAM)





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Thanks for your Attention

Fast Machine Learning for Science Workshop, Dec. 2020

