



AlphaGo



Lee Sedol





# International Meteor Conference 2019



## The Radio Meteor Zoo - identifying meteor echoes using artificial intelligence

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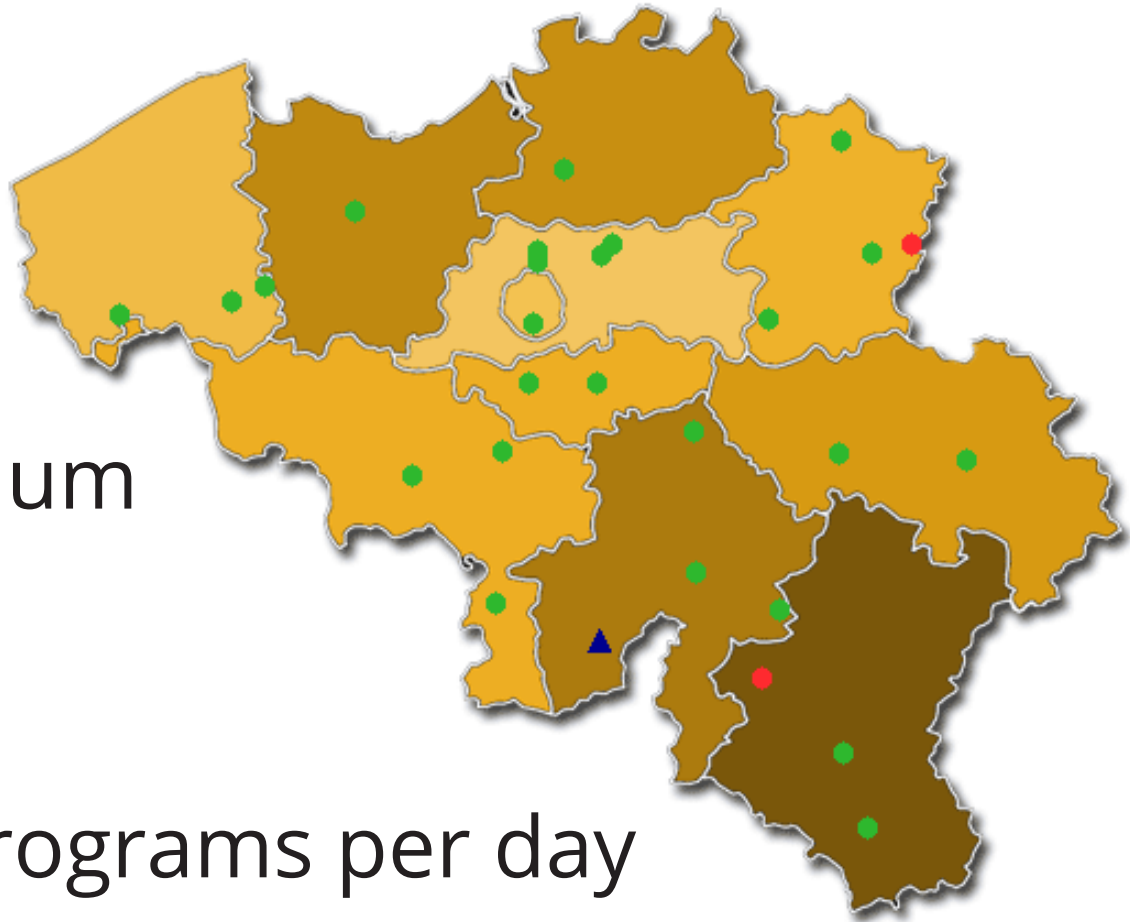


ROYAL BELGIAN INSTITUTE  
FOR SPACE AERONOMY



# BRAMS network

- ~25 stations all over Belgium



- ~8000 spectrograms per day

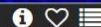
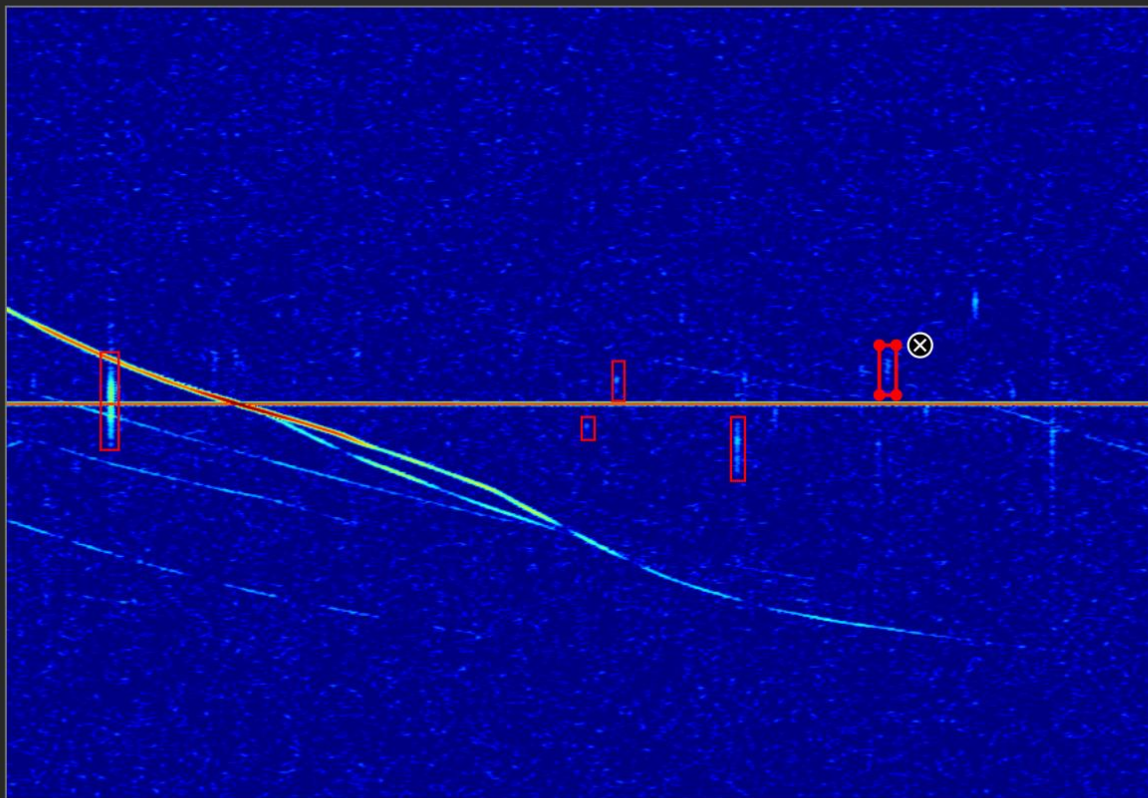




**WE  
NEED  
YOU**

<https://www.radiometeorzoo.org/>

Thank you for your constant support!



SWITCH TO LIGHT THEME

## TASK

## TUTORIAL

Draw a rectangle around each potential meteor echo.

📏 Rectangle tool

5 drawn

NEED SOME HELP WITH THIS TASK?

Done



🗑️ Demo mode:

No classifications are being recorded. [Disable](#)

FIELD GUIDE



# Agenda

- ❖ What is a neural network?
- ❖ Measuring performance
- ❖ Potential improvements





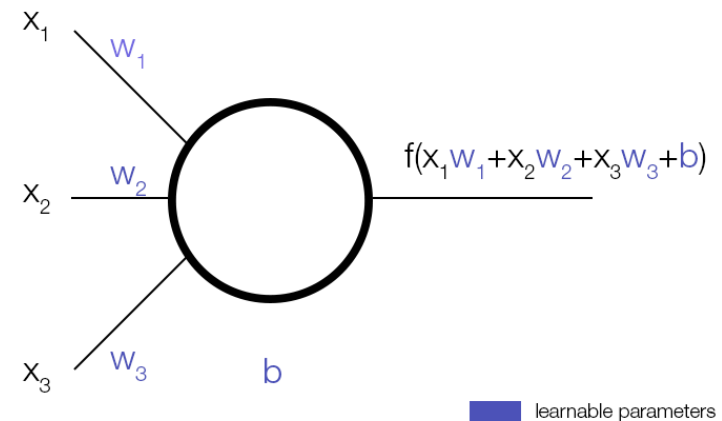
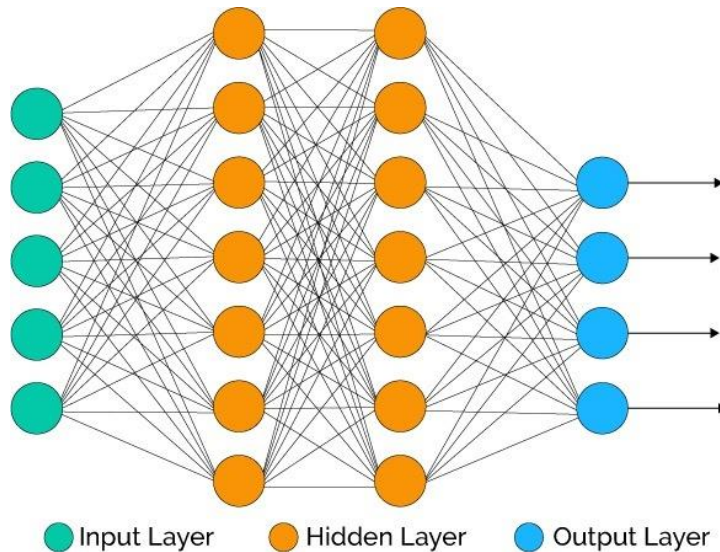
# WHAT IS A NEURAL NETWORK?





# What is a neural network?

- A convolutional neural network (CNN) is a type of supervised learning often used for image recognition.

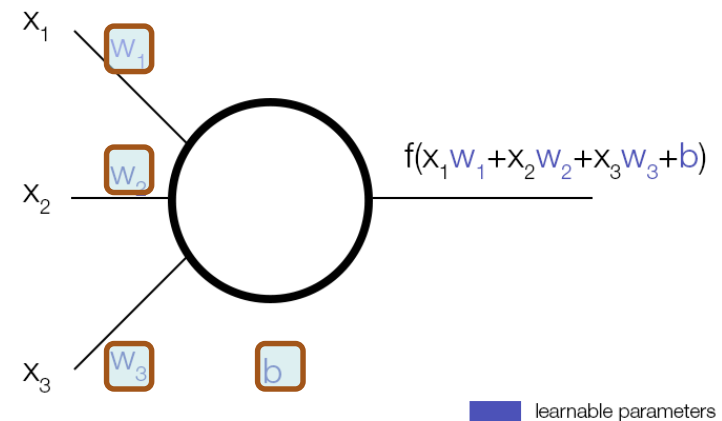
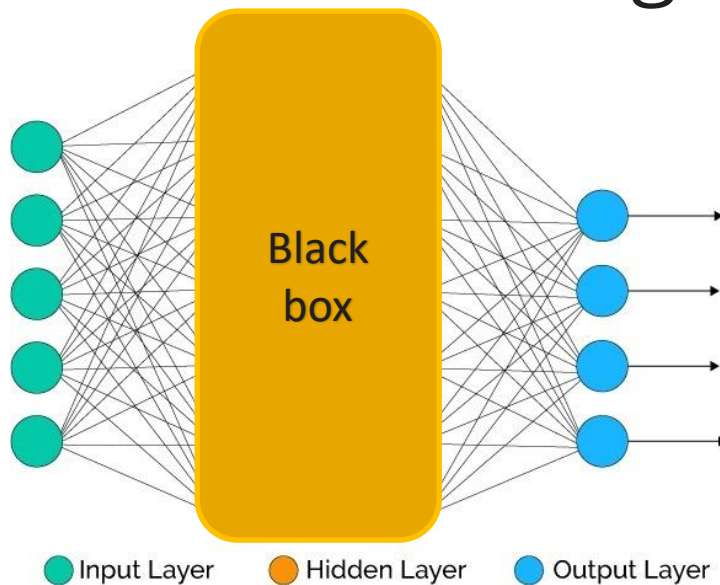






# What is a neural network?

- A convolutional neural network (CNN) is a type of supervised learning often used for image recognition.





# What is a neural network?

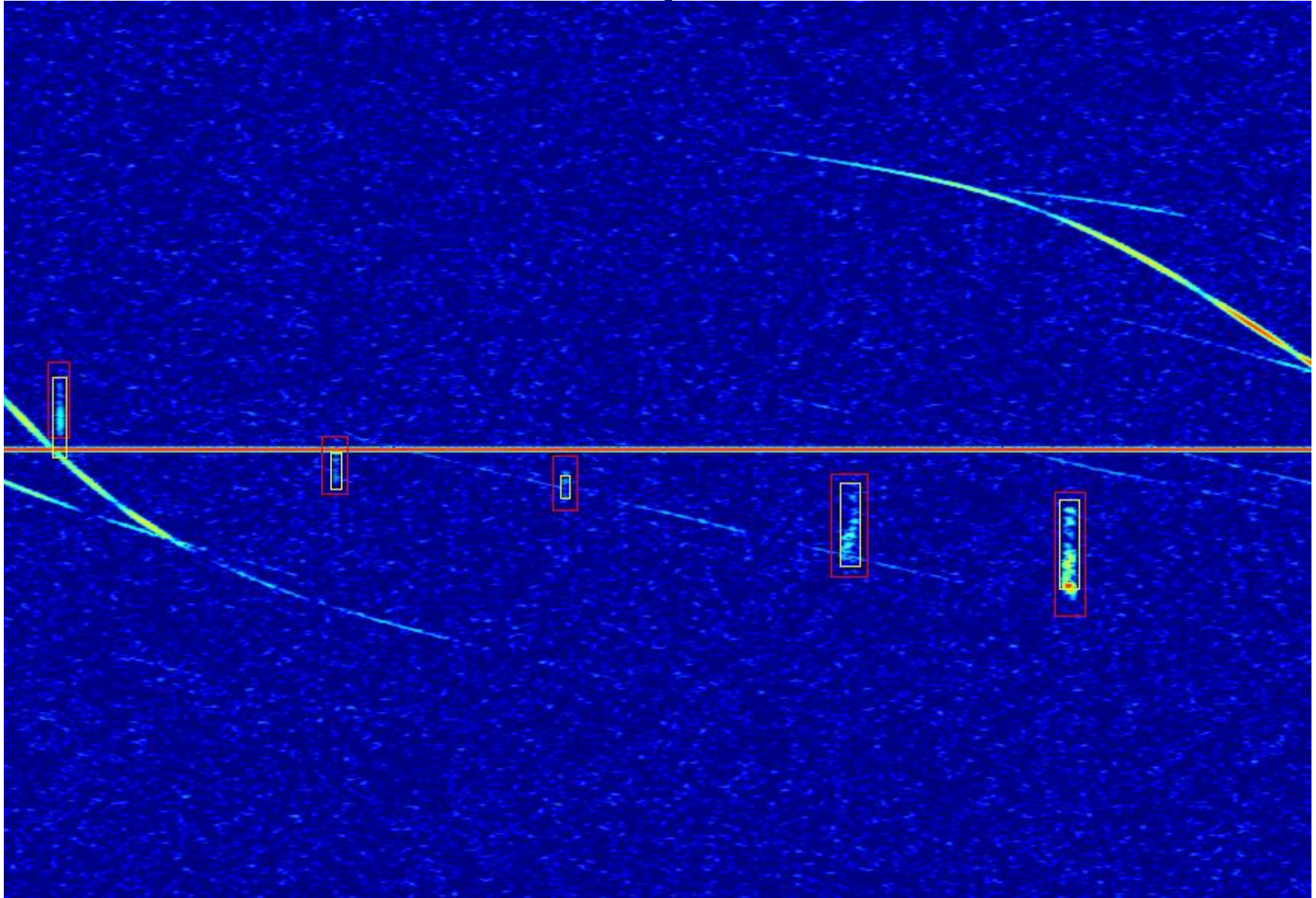
- A convolutional neural network (CNN) is a type of supervised learning often used for image recognition.
- The aggregated classifications from the RMZ volunteers are used to train the CNN.



# MEASURING PERFORMANCE

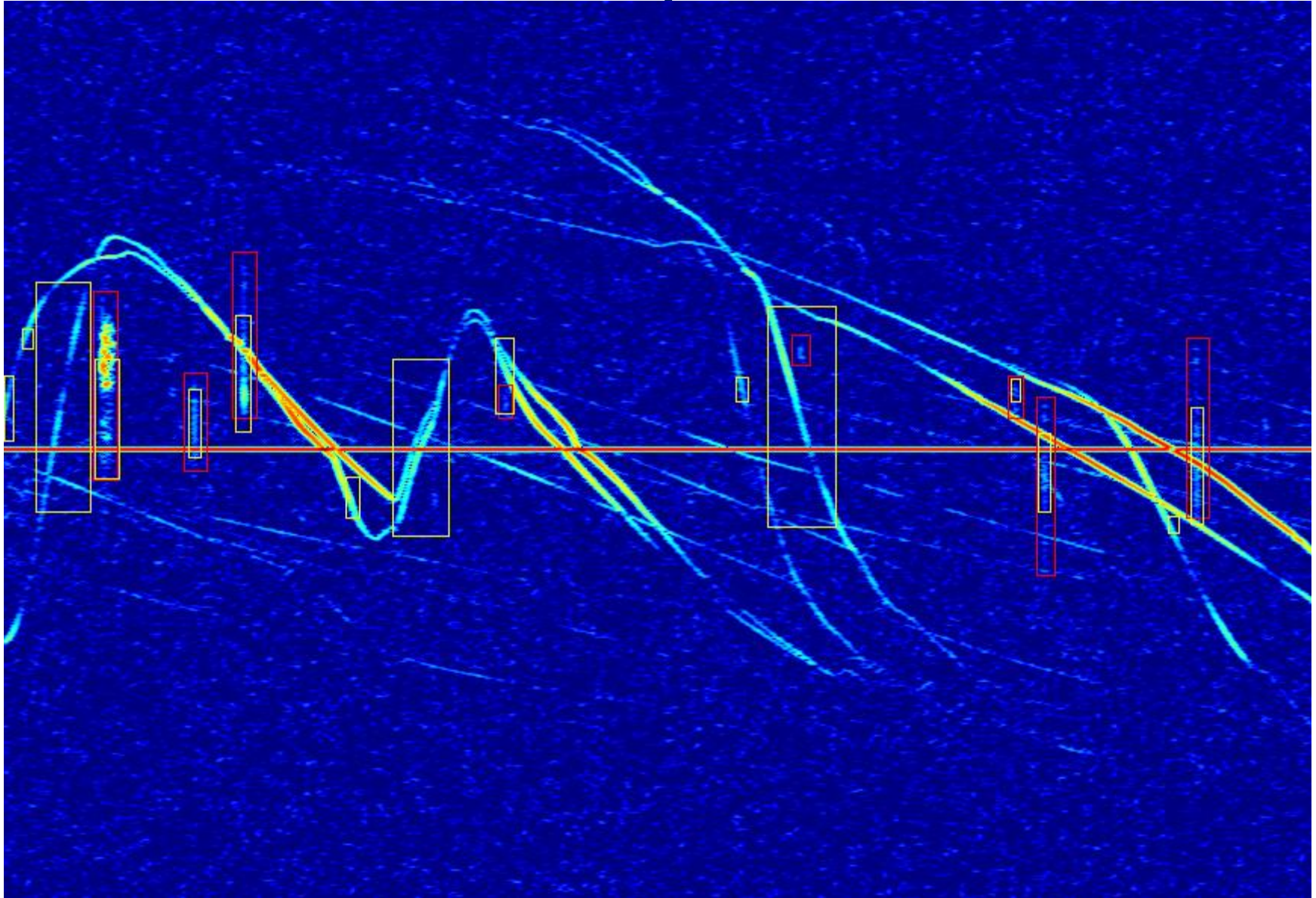


# How well does it perform?



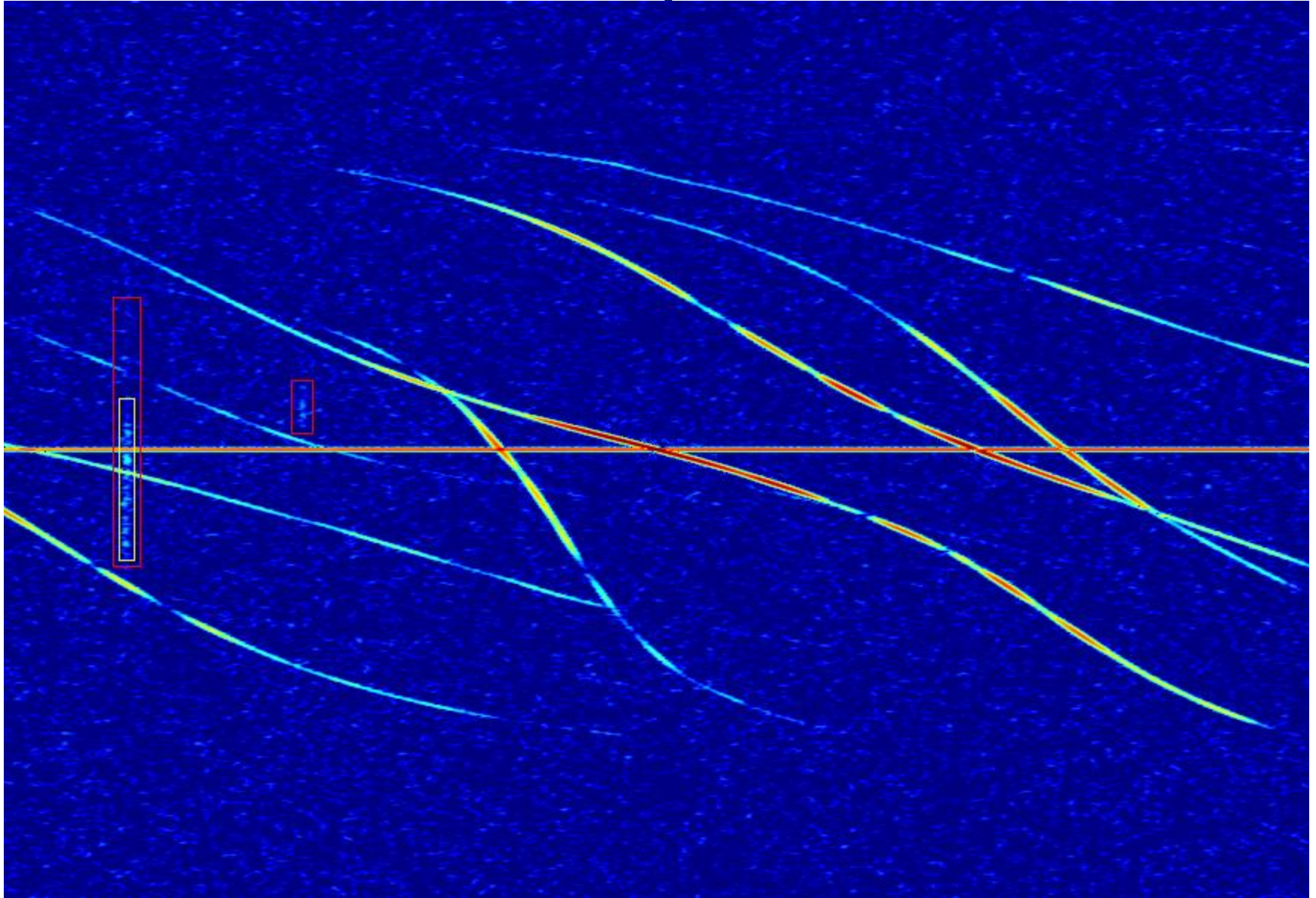


# How well does it perform?





# How well does it perform?







## How do we quantify it?

- 3 distinct data sets: training, test & validation
- We have used expert validation (on an unseen data set of Orionids & Geminids 2018)



## How do we quantify it?

$$\textit{Precision} = \frac{TP}{TP + FP} = 0,85$$

$$\textit{Recall} = \frac{TP}{TP + FN} = 0,67$$

$$\textit{F1 score} = 2 * \frac{\textit{Precision} * \textit{Recall}}{\textit{Precision} + \textit{Recall}} = 0,75$$



# POTENTIAL IMPROVEMENTS





# Potential improvements

- Replace the current threshold by a region detection algorithm.
- Additional training on difficult spectrograms: military airplanes, ...
- Narrowing the bounding boxes for the aggregated classifications.



# CONCLUSIONS



# Conclusions

- The RMZ volunteers still outperform the ML algorithm, especially in detecting fainter meteors.
- ML looks to be a promising technique that we will continue exploring.





*still*

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YOU**

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THANK YOU!  
MORE INFO?

[www.aeronomie.be](http://www.aeronomie.be)

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OUR SPECIAL  
THANKS TO

Stan Draulans  
&  
Toon Calders

The Zooniverse  
team

All citizen  
scientists

The BRAMS  
station  
hosts

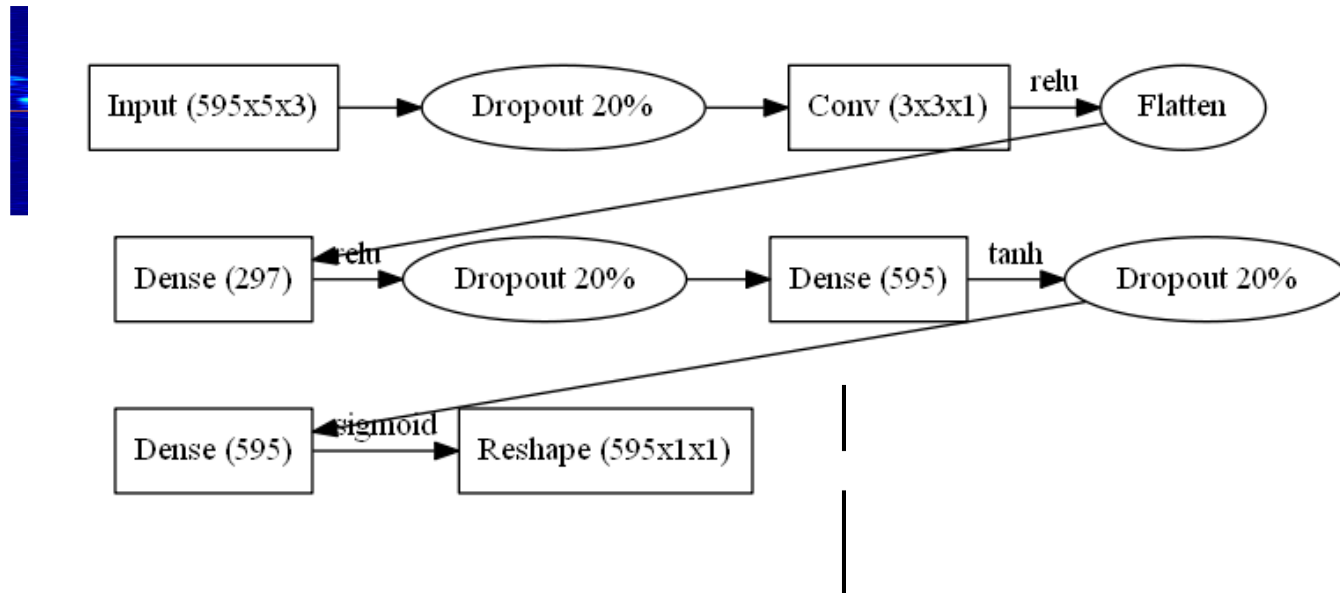


# BACKUP SLIDES

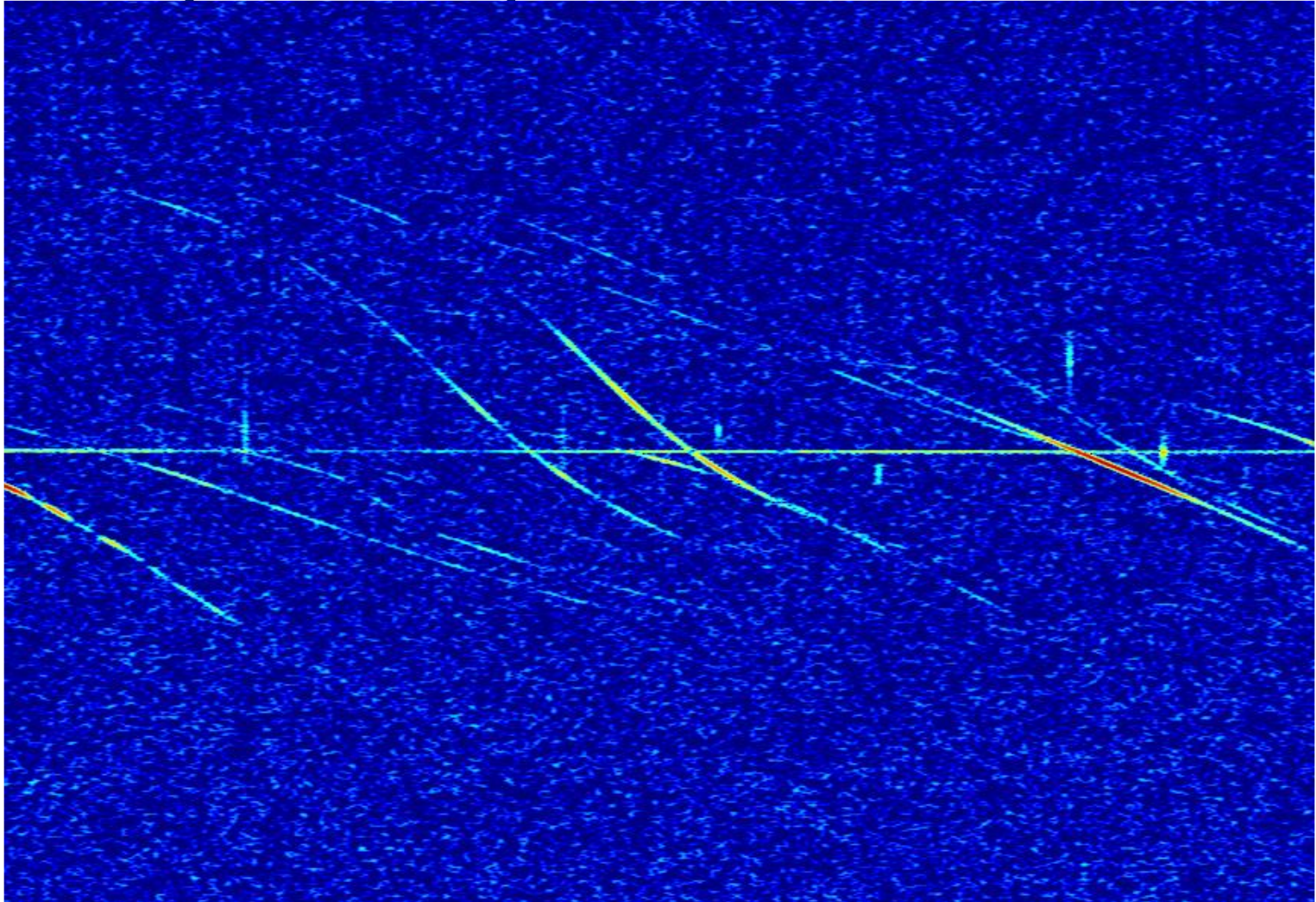




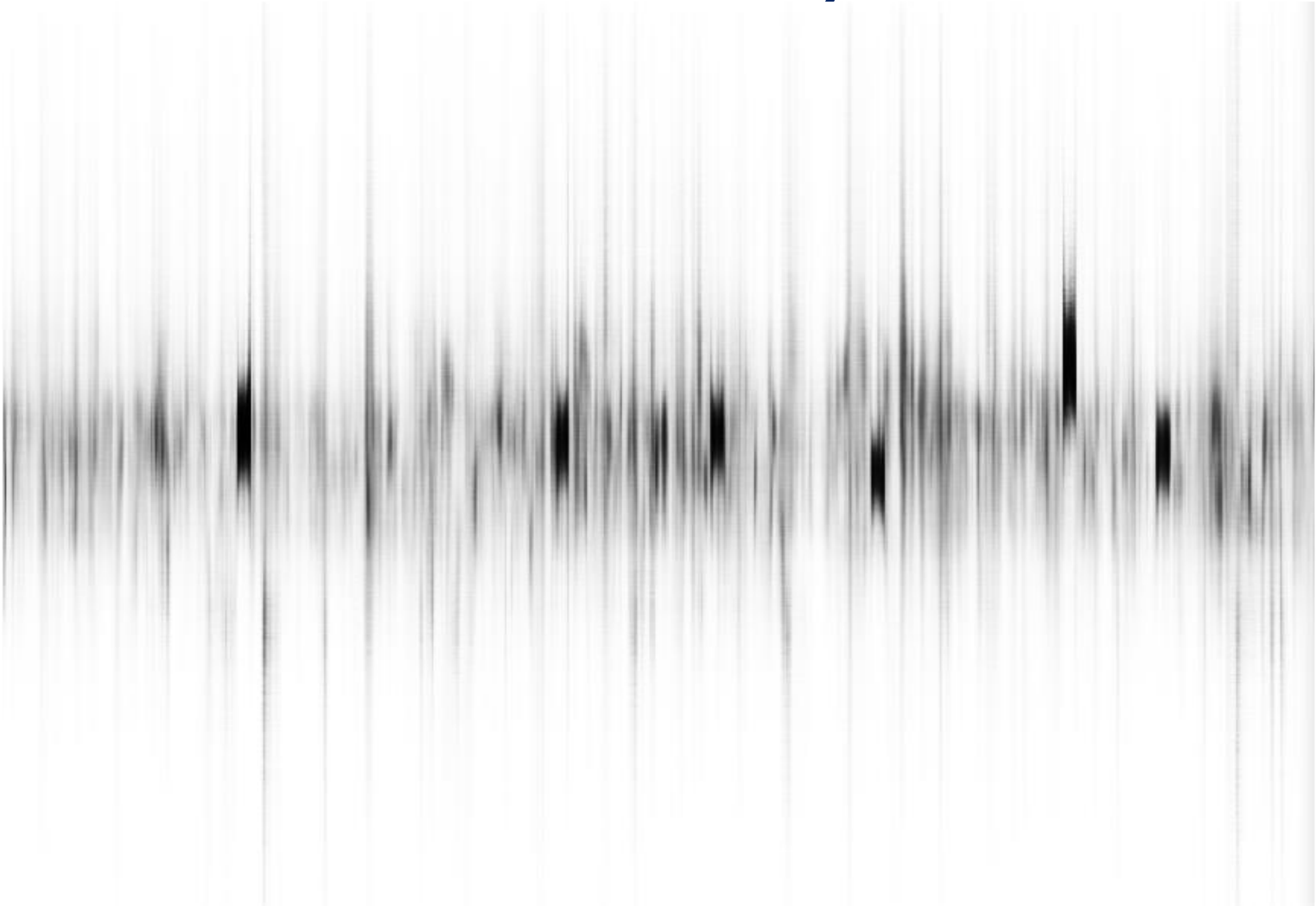
# The CNN developed by Stan Draulans



# Input spectrogram



# Pixel confidence array



After median blur





# After thresholding



# Precision-recall curve

