Filtering meteors from automatically captured images

Yuri **Galindo -** Unifesp , Dr. Ana Carolina **Lorena –** ITA

-**A Better Methodology**: test set images should come from different regions and different time periods

-**Uncertainty Estimation**: softmax is not effective, multiple stochastic predictions are used instead

-**Improved Model**: transfer learning, no fully connected layers, Monte Carlo dropout – 0.93 F1, 93 % accuracy, 95% coverage

EXOSS – Network of low cost cameras that **automatically capture** night sky images to **study meteors**.

- **Most images** are of non meteor objects such as birds, **currently filtered by hand**
- Our model must **automatically remove** non meteors and **call for expert classification** on hard cases

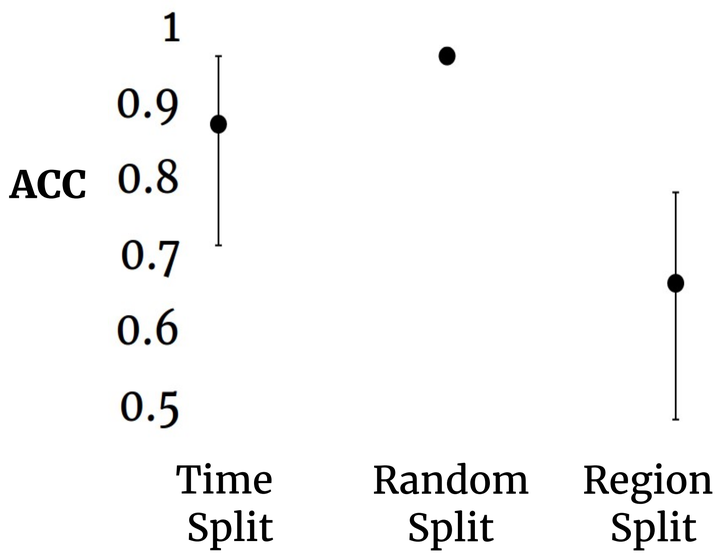
Left: non meteor, possibly a plane
Right: meteor capture

DIFFICULTIES

- Low cost cameras:
  - Glitches, noisy and grainy images
- Automatic captures:
  - Occlusion, multiple uncentered and rotated objects
- Negative class is loosely defined: **anything that isn't a meteor**

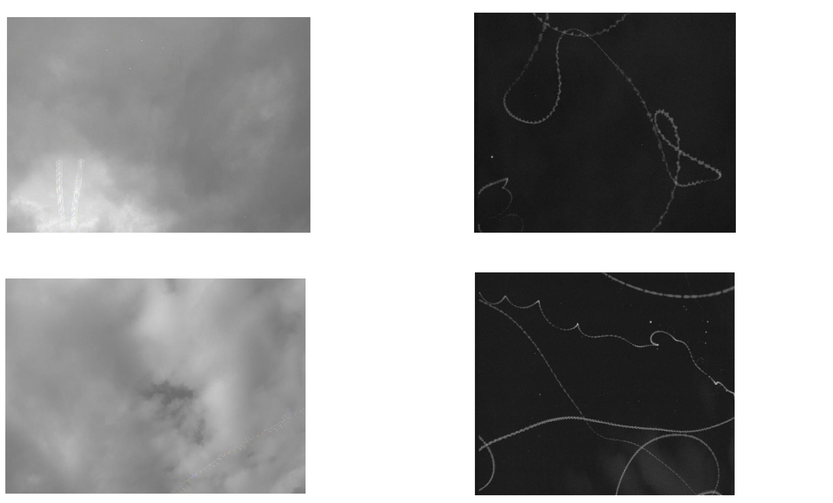
METHODOLOGY

- A single event may span multiple pictures:
  - Time split **prevents leakage**
- Different regions have different non meteor objects:
  - Region split tests **generalization**



CURRENT MODEL

- Transfer Learning – Alexnet
- No fully connected layers
  - Less parameters
  - Variable resolution
- Monte Carlo Dropout – **multiple passes instead of averaging activations**
  - Estimate uncertainty
  - Interacts well with **Convolutional Layers**
- **0.93 F1** and **93% accuracy** with **95% coverage**



Start and end of a storm (series of 97 images)

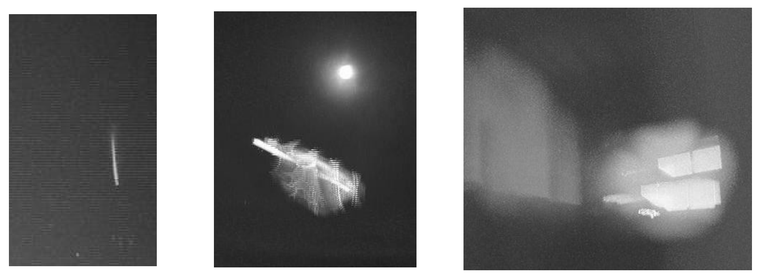
Captures of the same region (a week apart)

UNCERTAINTY ESTIMATION

Softmax outputs **aren't actual probabilities** – only squashed activations

Solution: **multiple stochastic predictions**

- Stochastic Neural Networks can approximate Gaussian Processes
- A Stochastic NN makes multiple passes through the data, making multiple predictions
- Images that have disagreeing predictions are uncertain



Left: atmospheric event similar to a meteor
Middle and right: unique captures – water reflection and fallen camera

Funded by FAPESP
São Paulo Research Foundation

Related Work

1 Deep transfer learning for meteor detection, **Y. Galindo** and **A.C. Lorena**
2 Deep learning algorithms applied to the classification of video meteor detections, **P.S. Gural**
3 Artificial intelligence techniques for automating the CAMS processing pipeline to direct the search for long-period comets, **M. De Cicco** et Al