Finding an Elephant in the Aurora

Using machine learning to classify Northern lights images and predict phenomena

Pascal Sado – University of Oslo
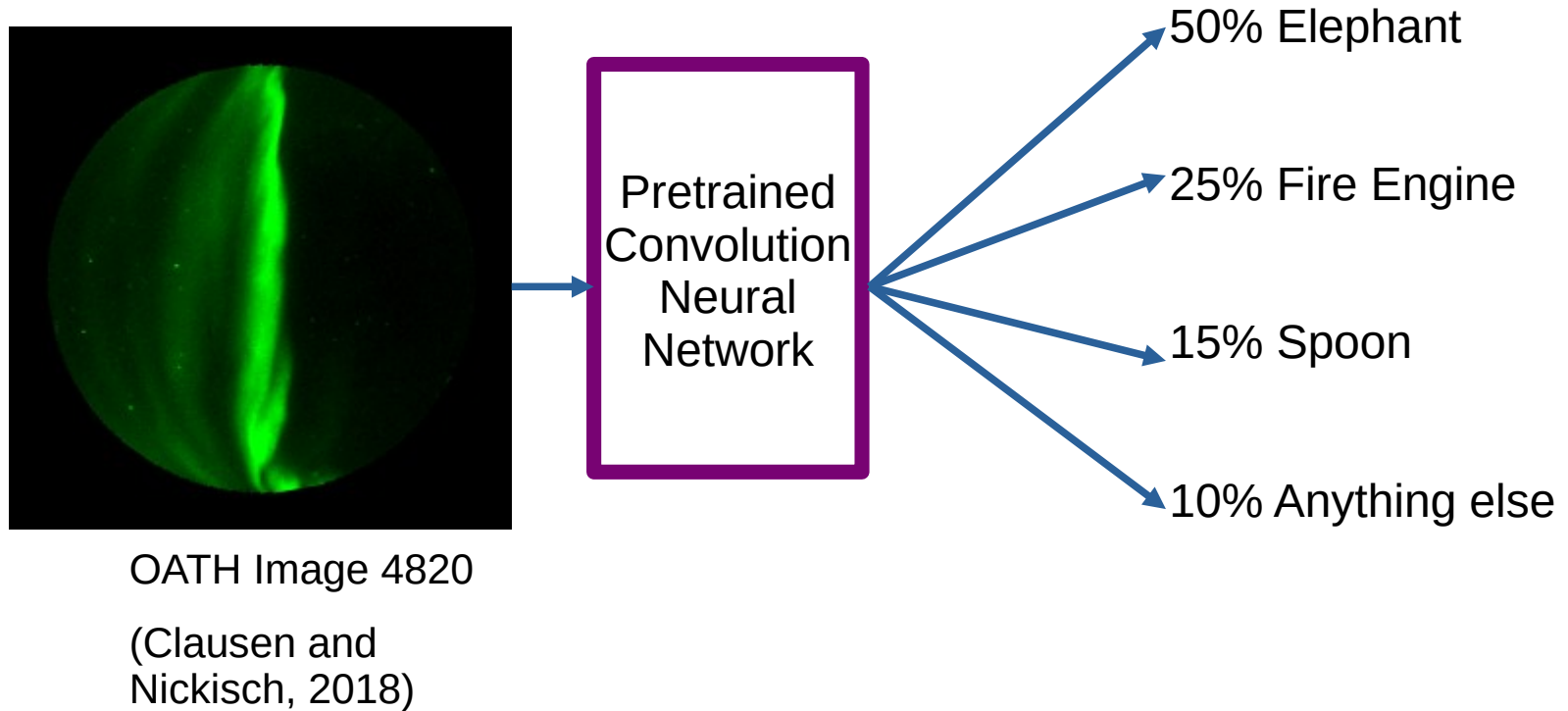
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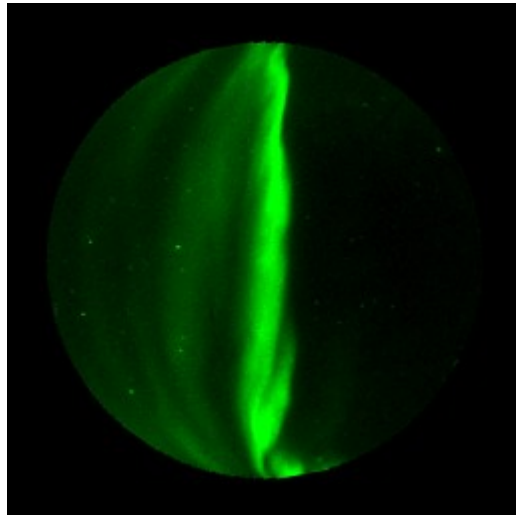   – Prediction of magnetic field disturbance

Problem

- 100s of Millions of Images of the night sky

  – Analysis of single events -> time intensive

  – Algorithms for automated classification -> Complex, expensive

- Transfer Learning:

  – established methods applied to similar problems
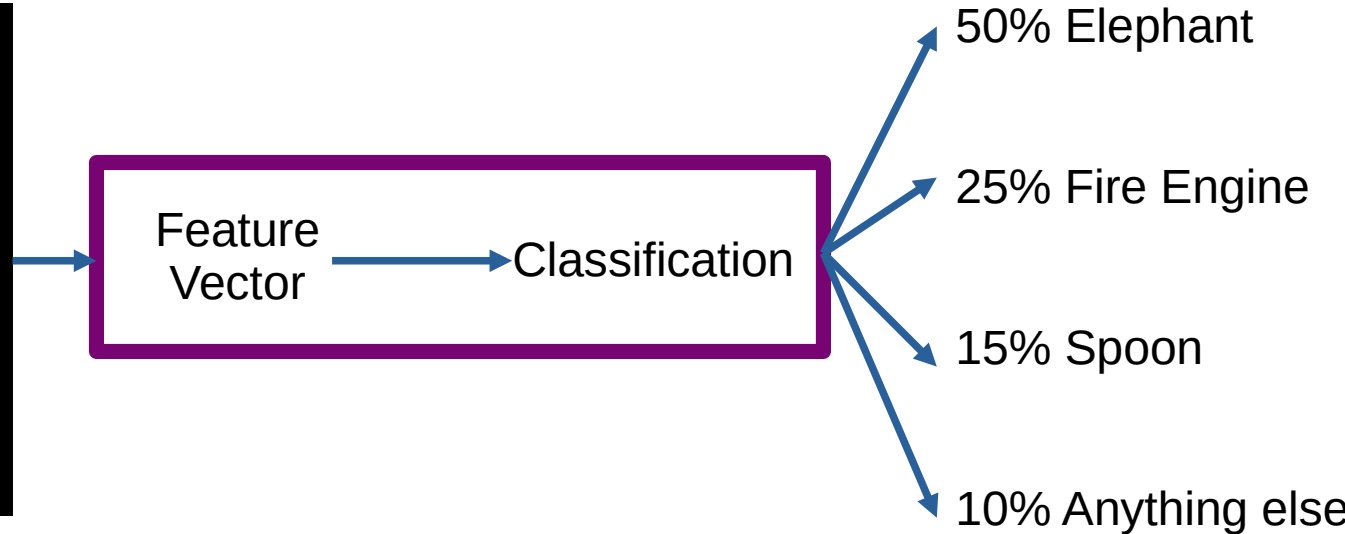
  – No / minimal training necesary

Methods: Feature Extraction
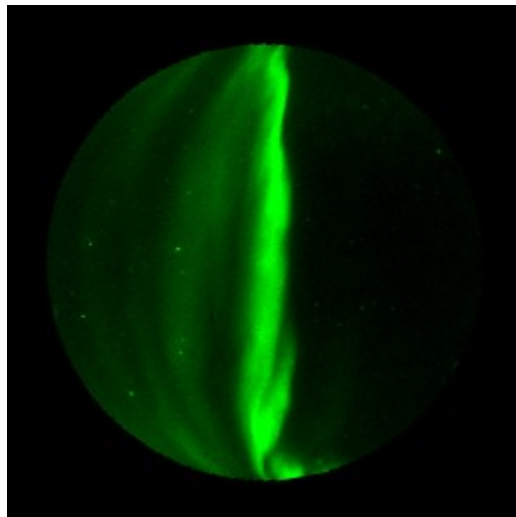

OATH Image 4820

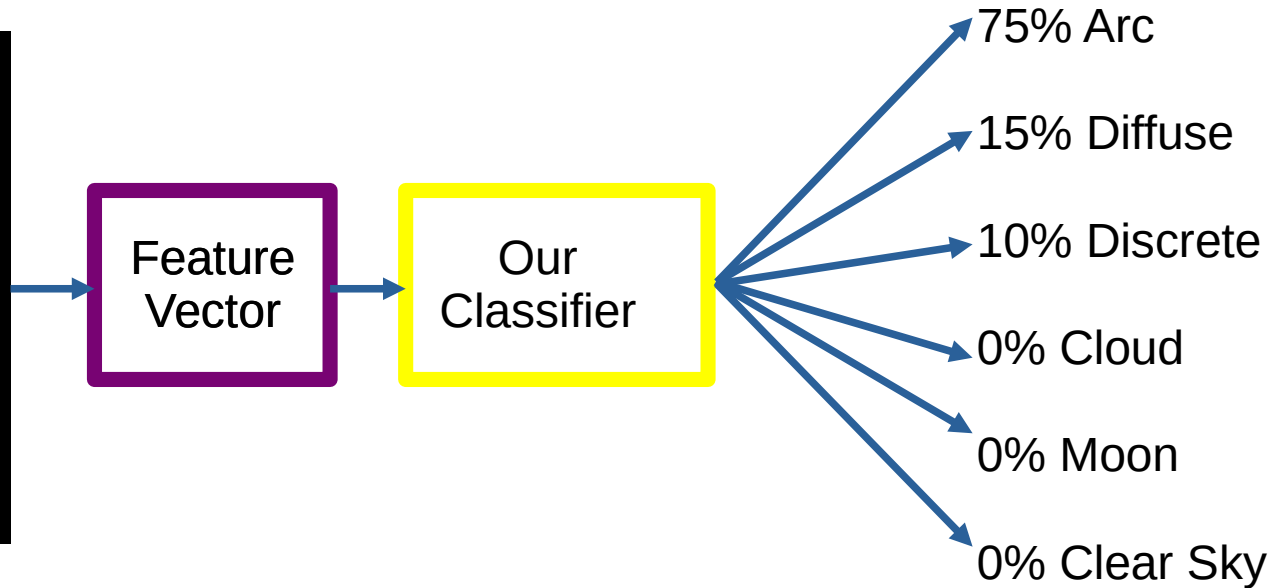(Clausen and
Nickisch, 2018)

Pretrained
Convolution
Neural
Network

50% Elephant

25% Fire Engine

15% Spoon

10% Anything else

Methods: Feature Extraction

OATH Image 4820

50% Elephant

25% Fire Engine

15% Spoon

10% Anything else

Feature Vector → Classification

Methods: Feature Extraction

OATH Image 4820

Feature Vector → Our Classifier →

- 75% Arc
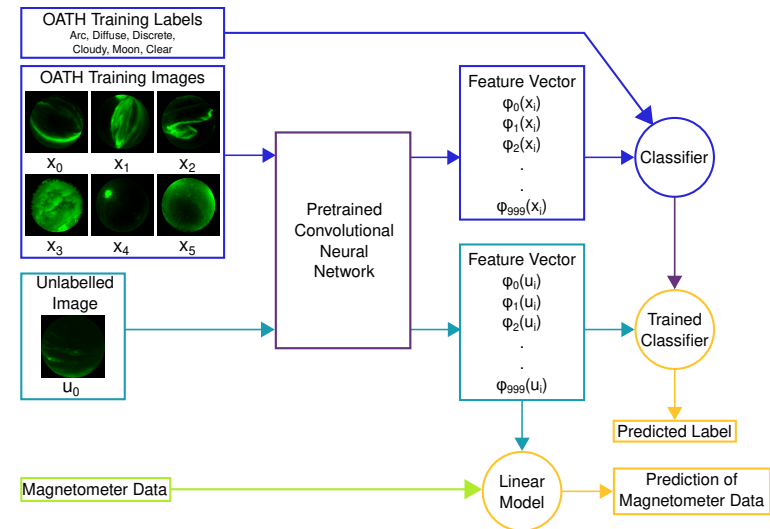- 15% Diffuse
- 10% Discrete
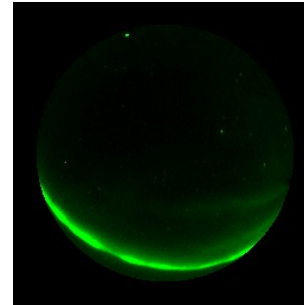- 0% Cloud
- 0% Moon
- 0% Clear Sky

Method

- Pretrained CNN for feature extraction

- Train SVM on extracted features

- Predict unseen images' labels

- Advantages:

  - Computationally inexpensive

  - Libraries for extraction and classification already exist

  - Features can be "reused"

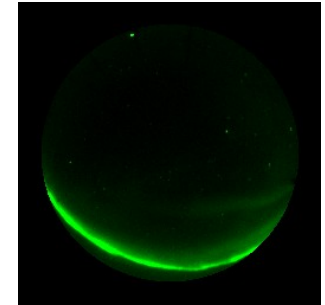|	arc	diffuse	discrete	cloud	moon	clear
arc	166	13	28	0	0	4
diffuse	15	277	39	0	0	8
discrete	22	23	383	1	1	5
cloud	0	2	1	249	4	0
moon	0	0	0	2	178	2
clear	7	12	4	0	1	300

Performance on Training Data

- 90% accuracy for six classes

- 98% accuracy for aggregated 2 classes

- Largest confusion between auroral classes and "clear sky"
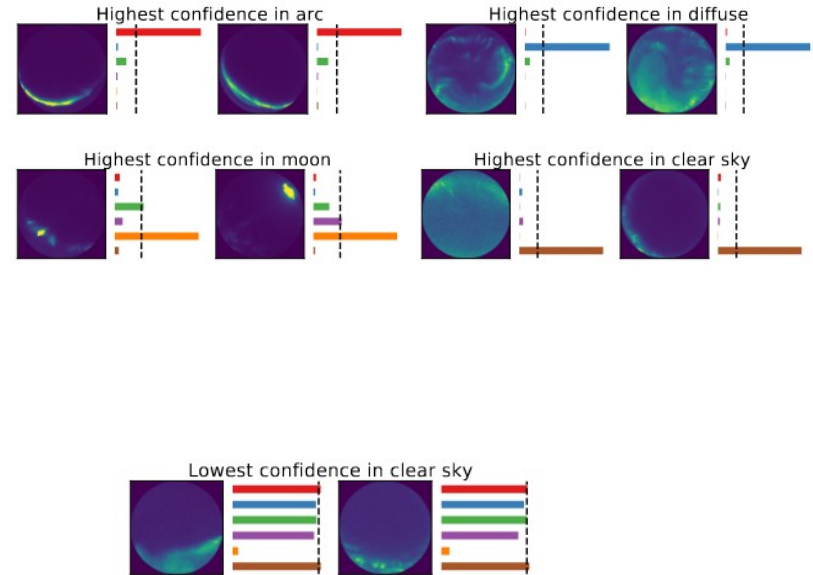
OATH 2052 (clear)   OATH 2053 (arc)

Performance on unseen Data

- ~550000 Unseen Images

- Classified by new Algorithm

  - Arcs: 43544

  - Diffuse: 81547

  - Discrete: 70334

  - Clouds: 316050

  - Moon: 46

  - Clear: 38765

Application: Prediction of magnetic field disturbance

- Removed images classified as non-aurora and by meteorological data (n~180000 left)

- Assign locally measured magnetic field

- Predict disturbance from mean magnetic field based on extracted features

- Poor per-image performance, but running average fits nicely

- Performing better than fitting the mean

UiO : Department of Physics
University of Oslo
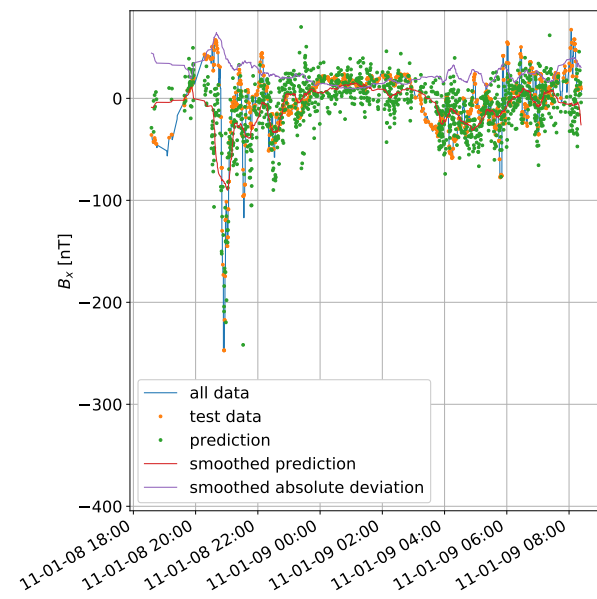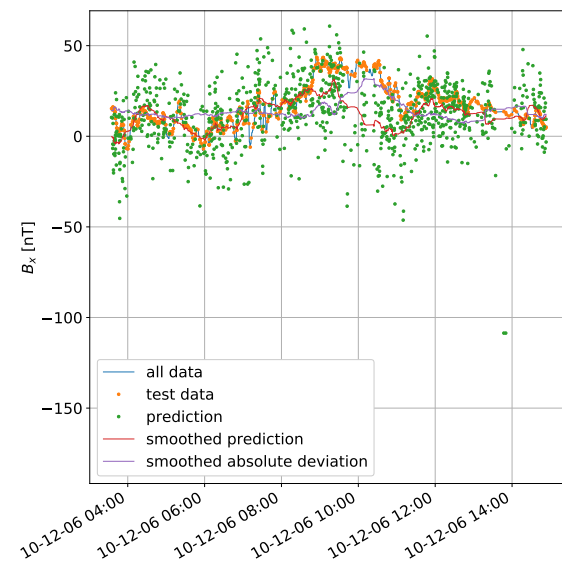
Conclusion

- Transfer Learning for Aurora Image Classification works

- 2 classes "aurora" ↔ "no aurora" with human like precision

- Classifier excels at Preprocessor for removing clouds / non-aurora

- Features are usefull for other processes like magnetic field disturbance prediction

Read our paper:

Transfer Learning Aurora Image Classification and Magnetic Disturbance Evaluation (TAME) – Pending Peer Review, PrePrint available here:

https://doi.org/10.1002/essoar.10507386.1

http://tid.uio.no/TAME/