From traditional machine learning to deep learning

FORCE Hackathon and Advances of Machine Learning on Subsurface Data

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Norsk Regnesentral

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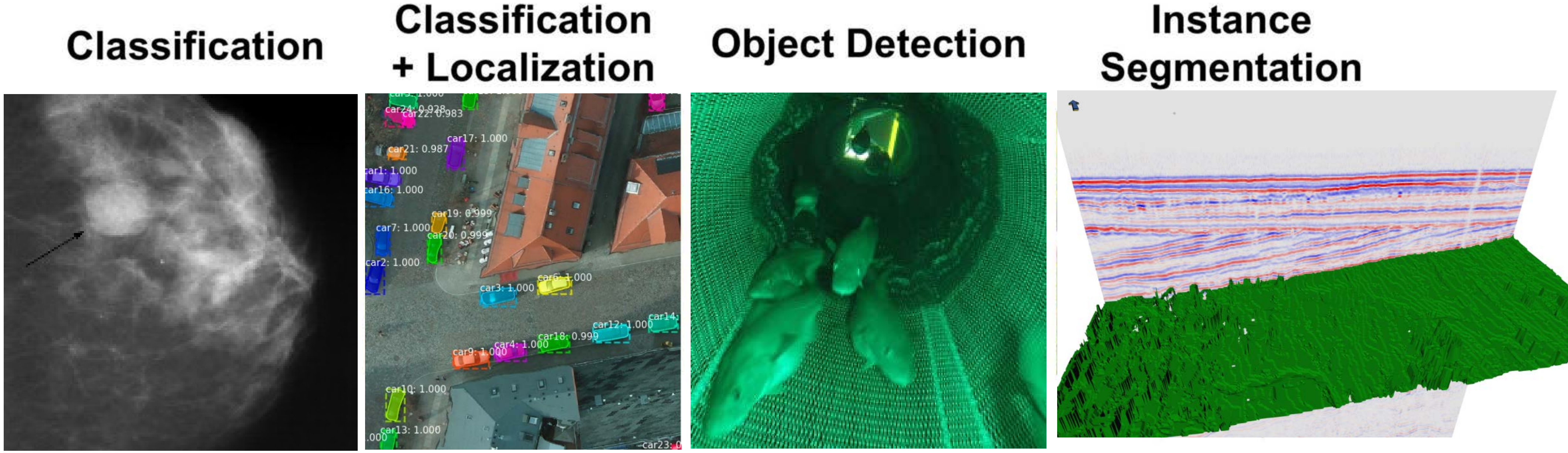
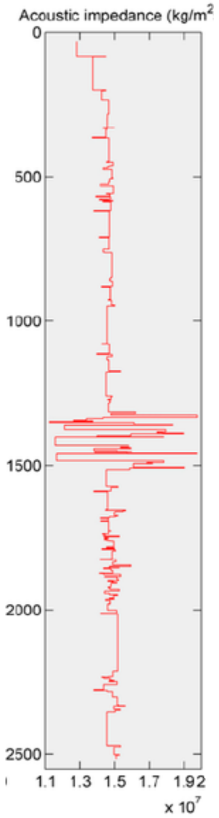
Norsk Regnesentral
NORWEGIAN COMPUTING CENTER

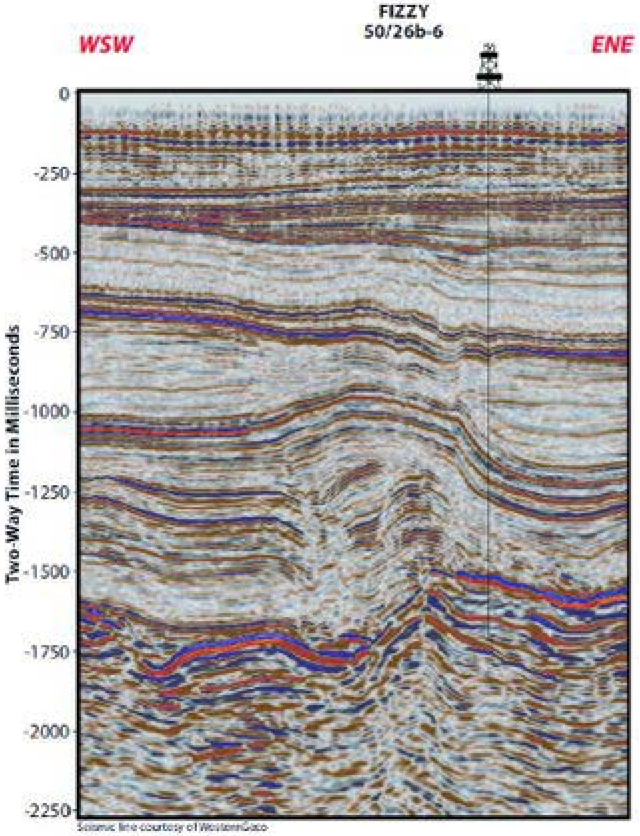
- Research institute with about 80 employees, located in Oslo
- Specialize in statistical analysis, machine learning, image analysis



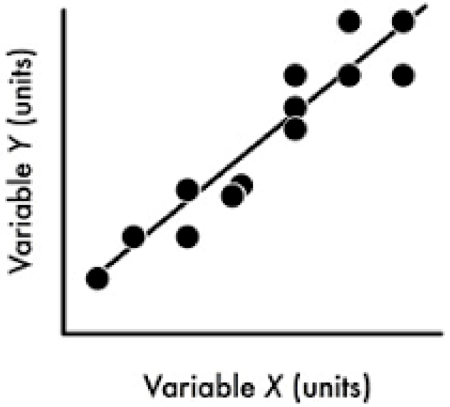
Input data



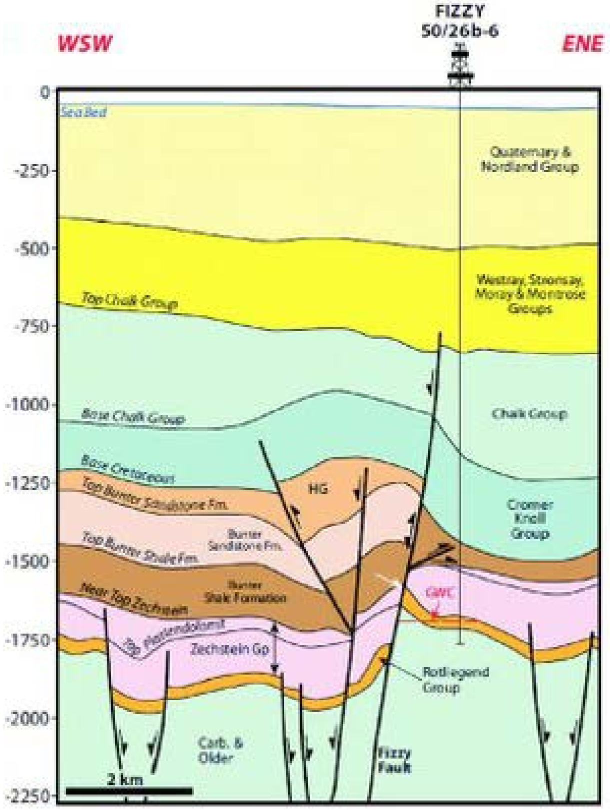


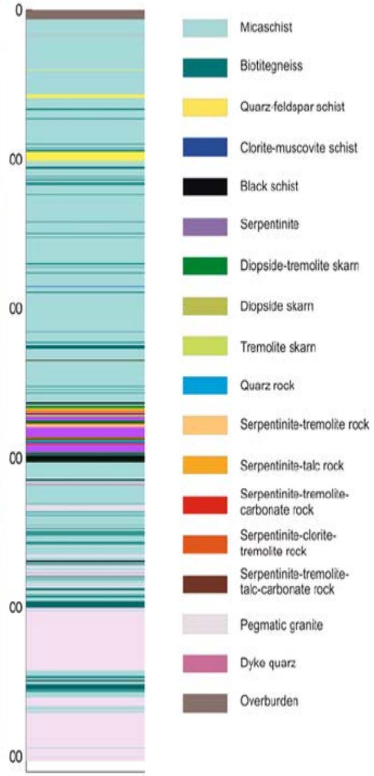


Relationship

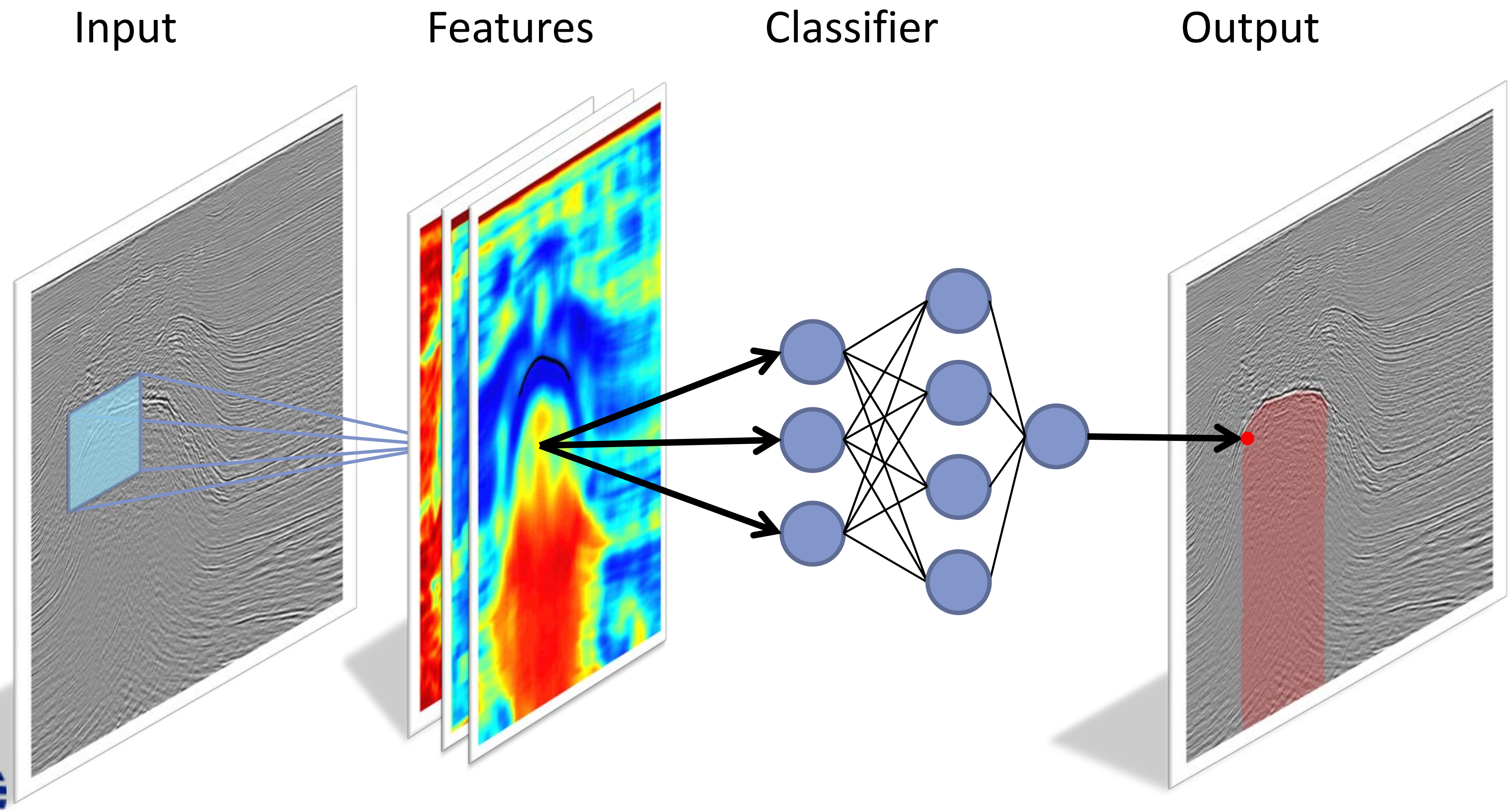


Output

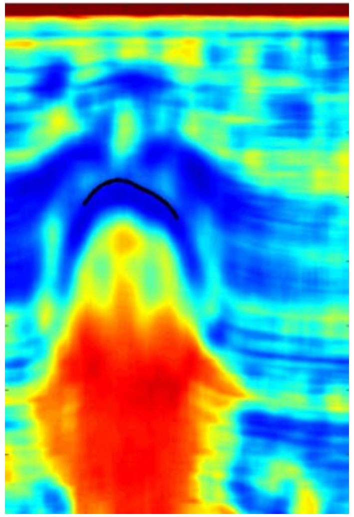




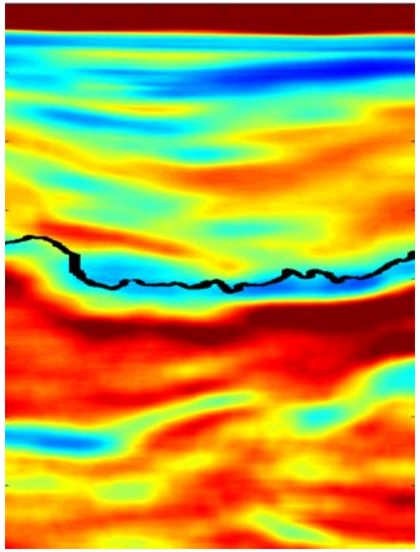
Traditional machine learning

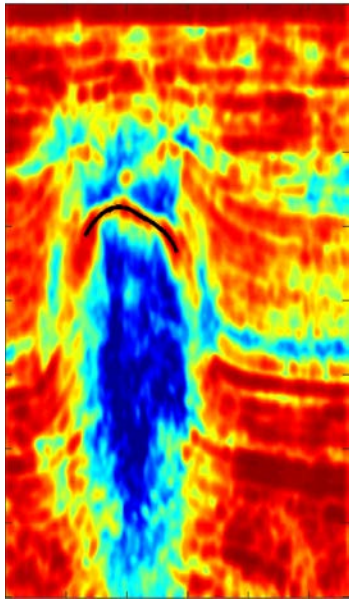


Training a classifier

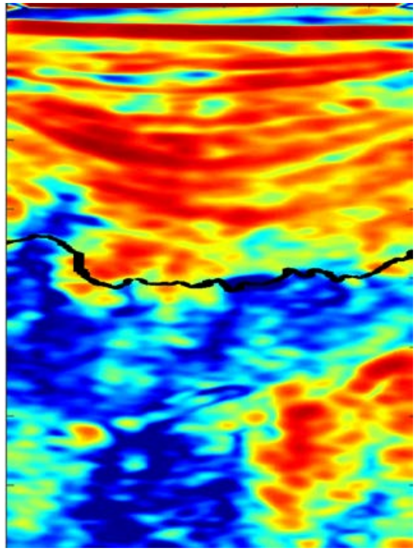


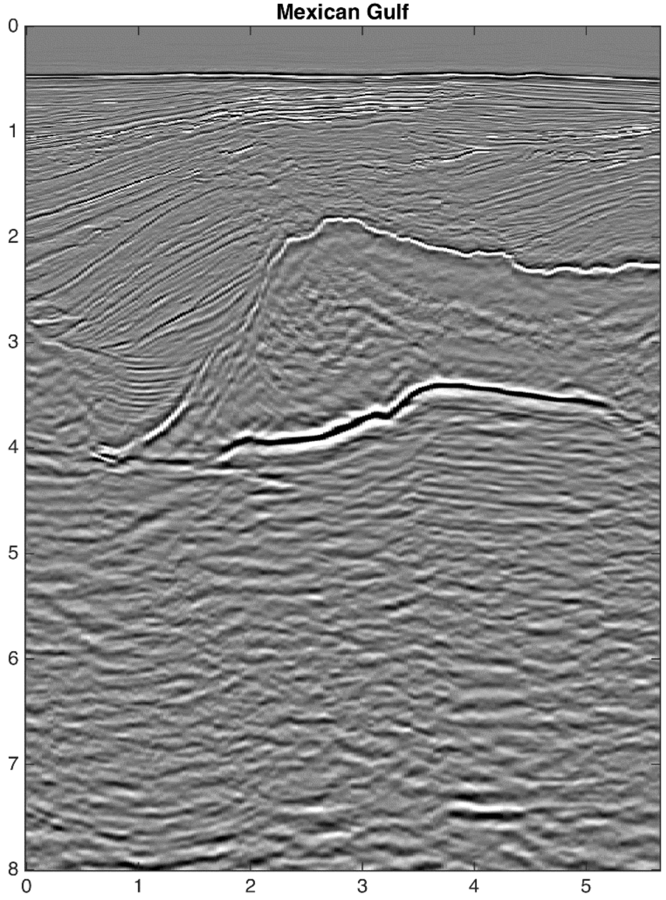
Feature 1



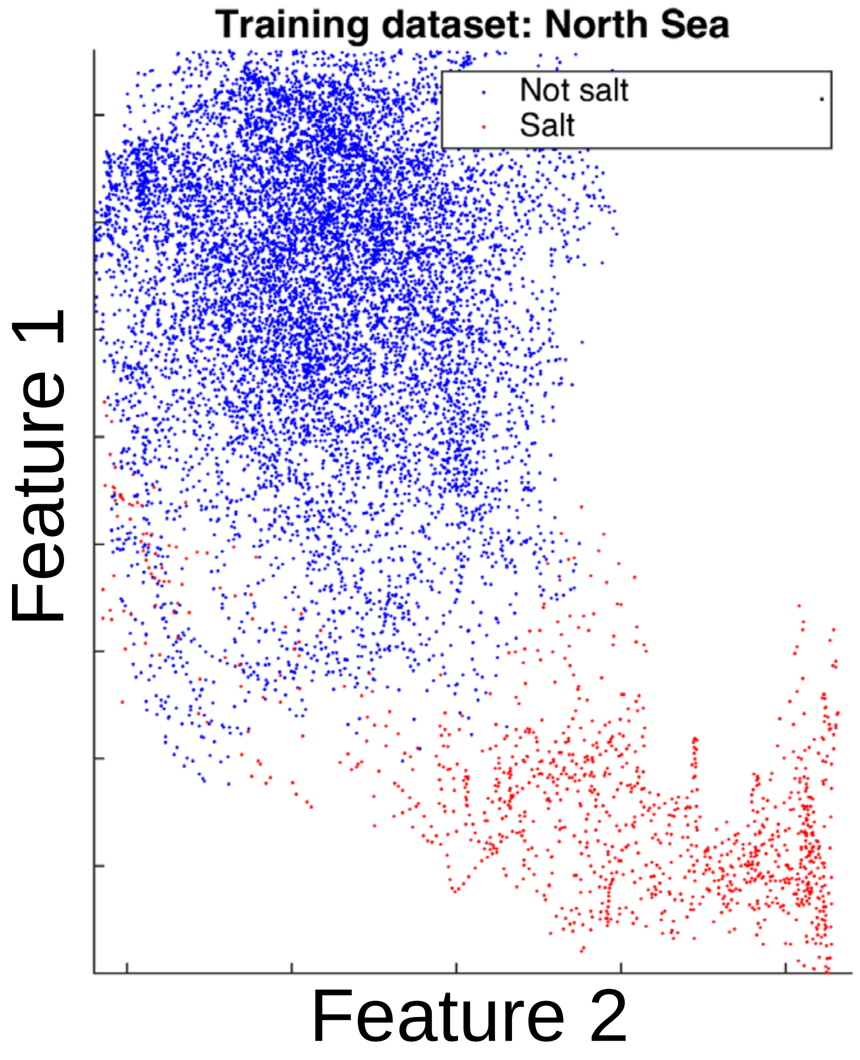


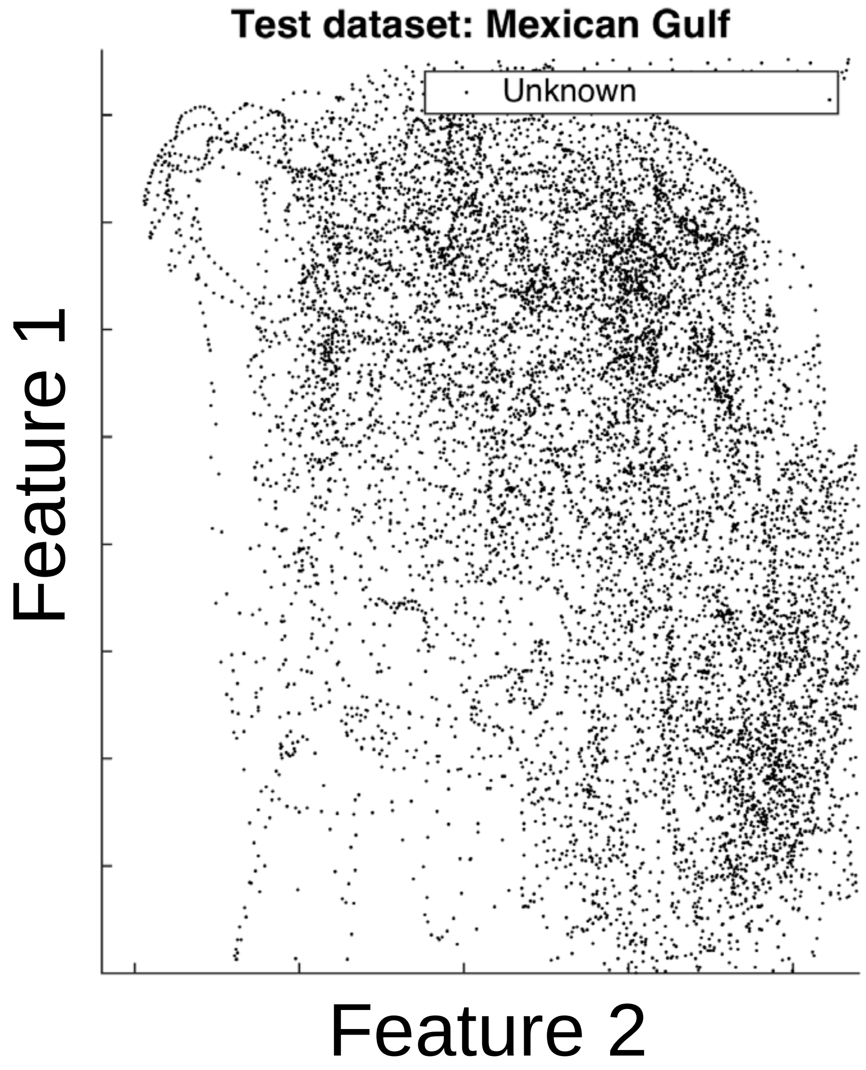
Feature 2



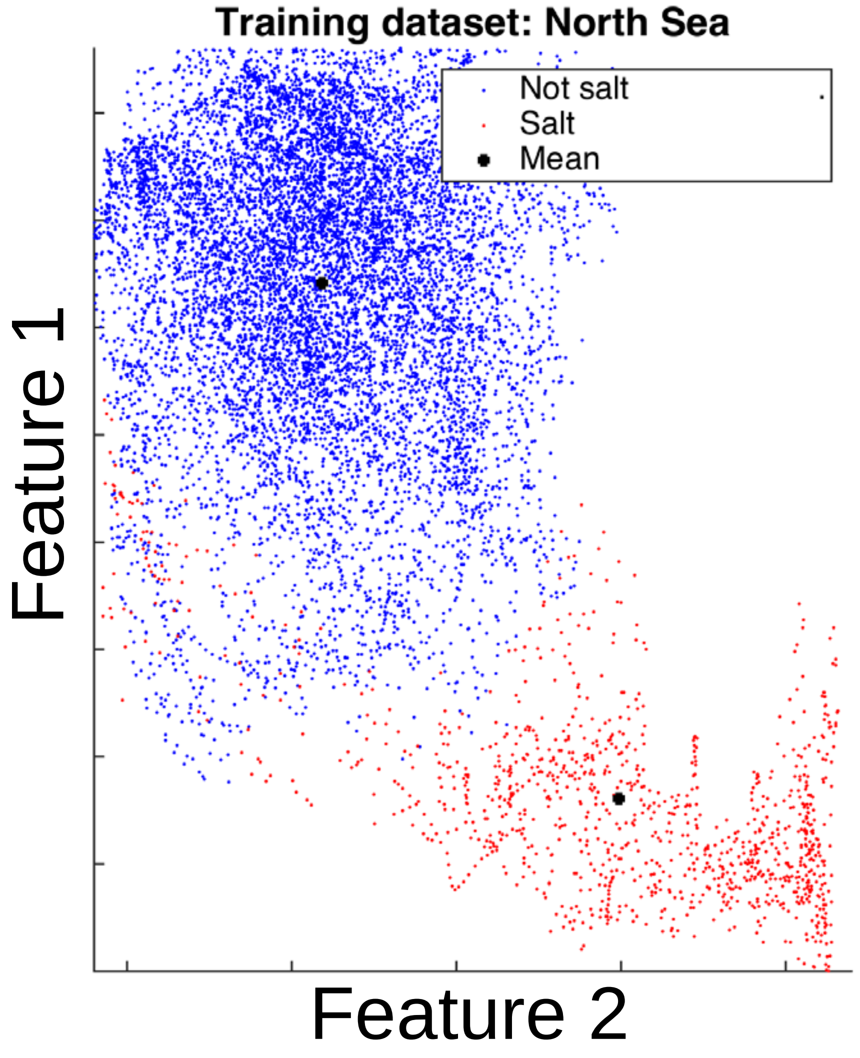


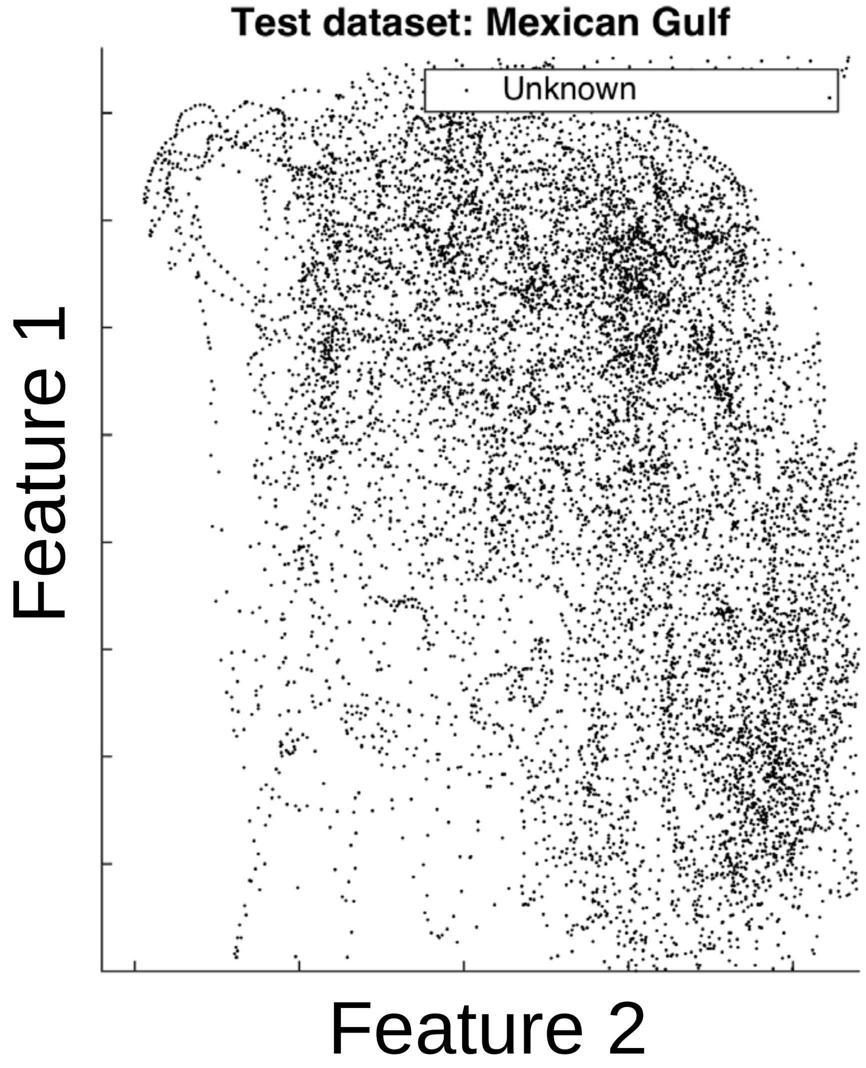
Training a classifier



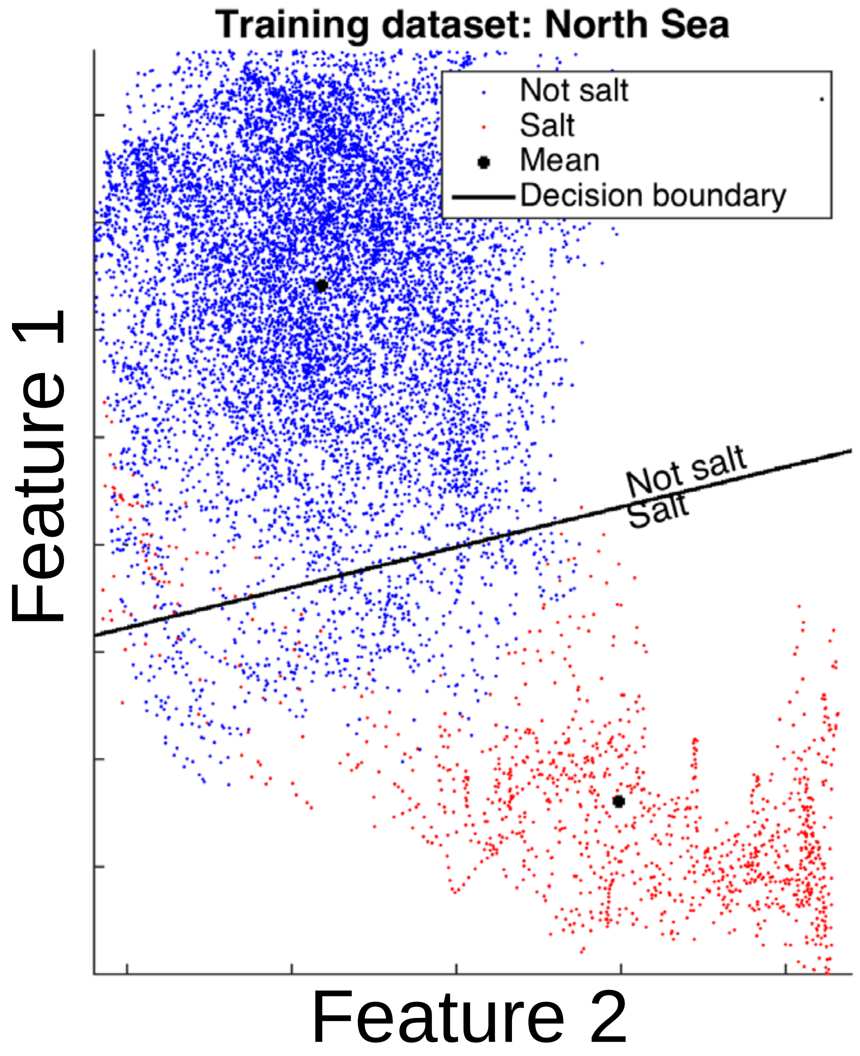


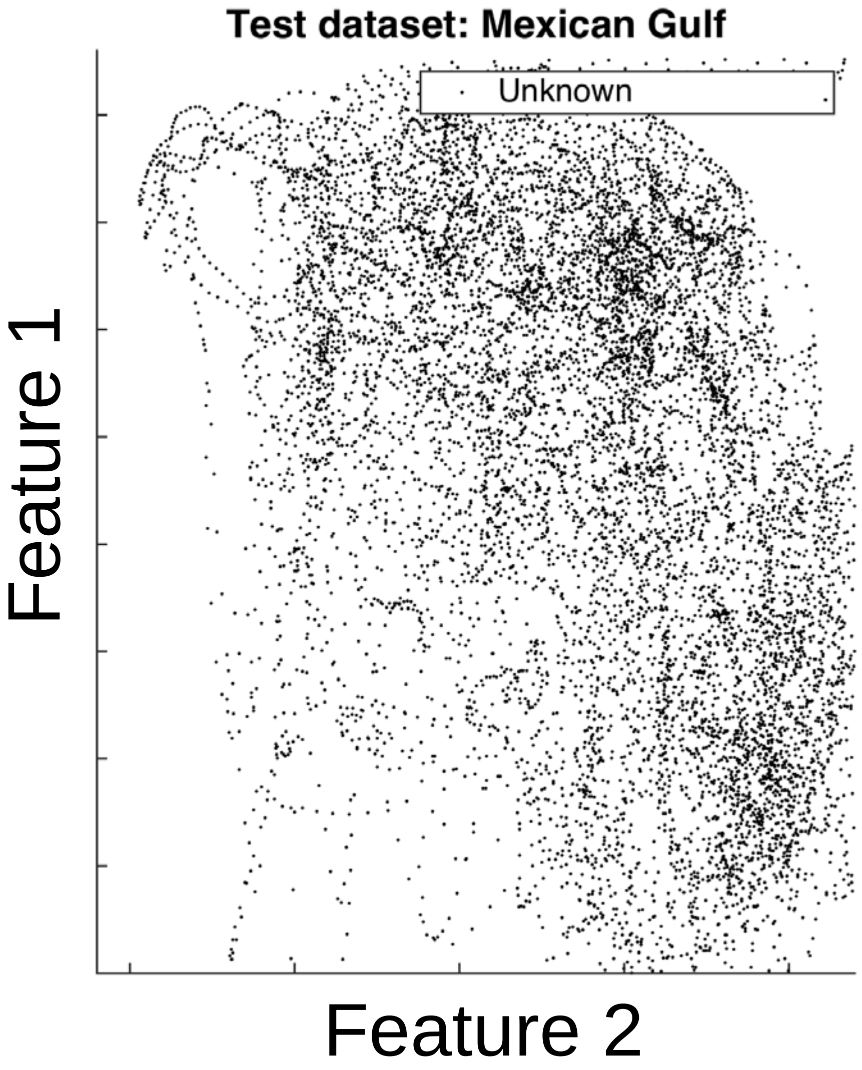
Training a classifier



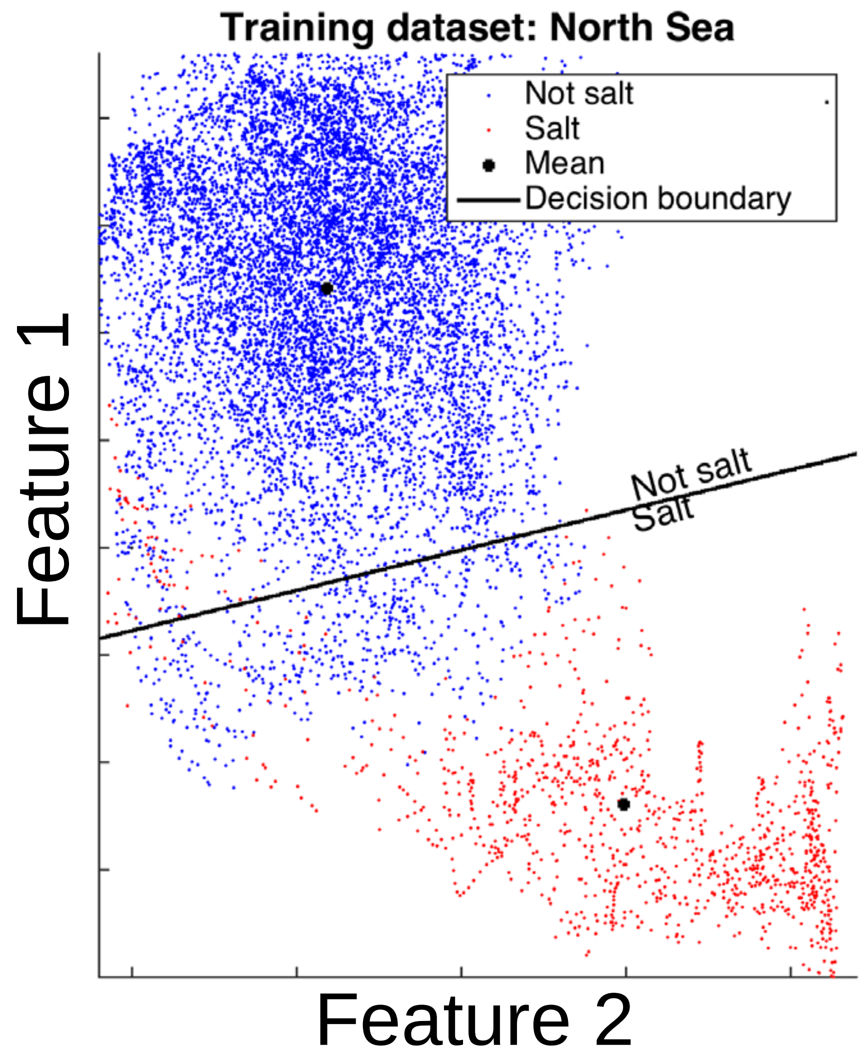


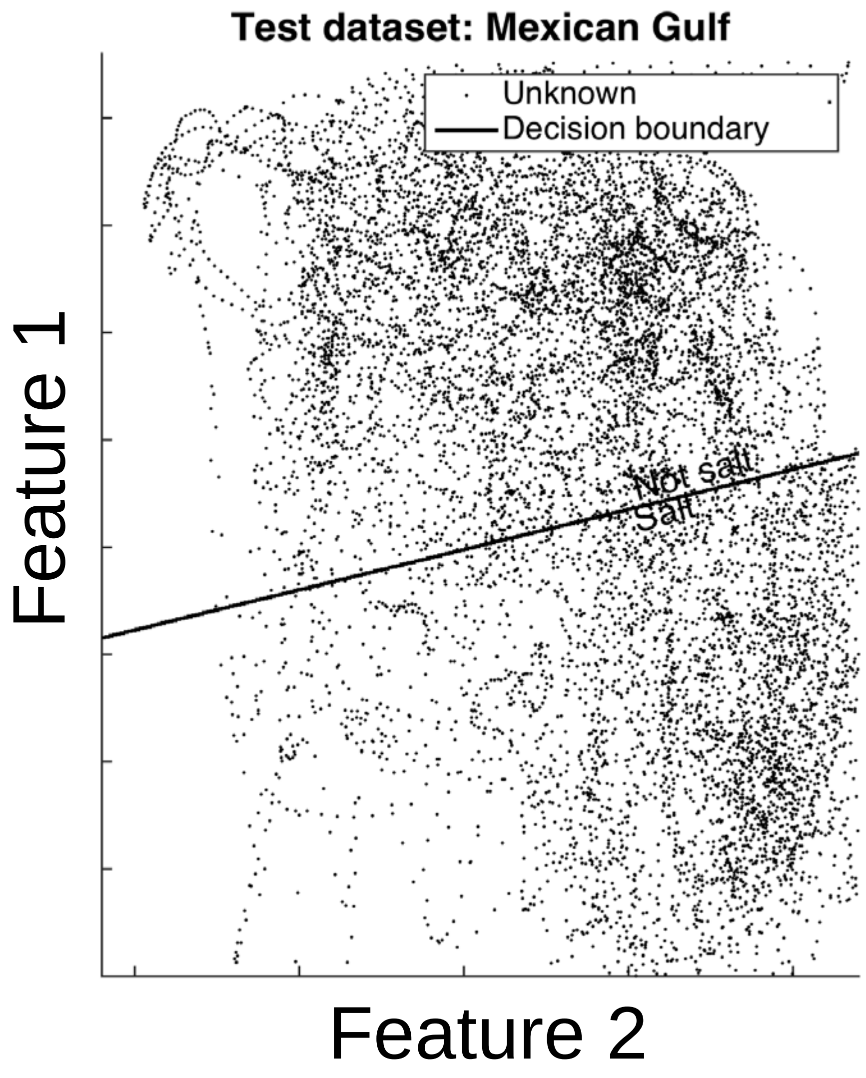
Training a classifier



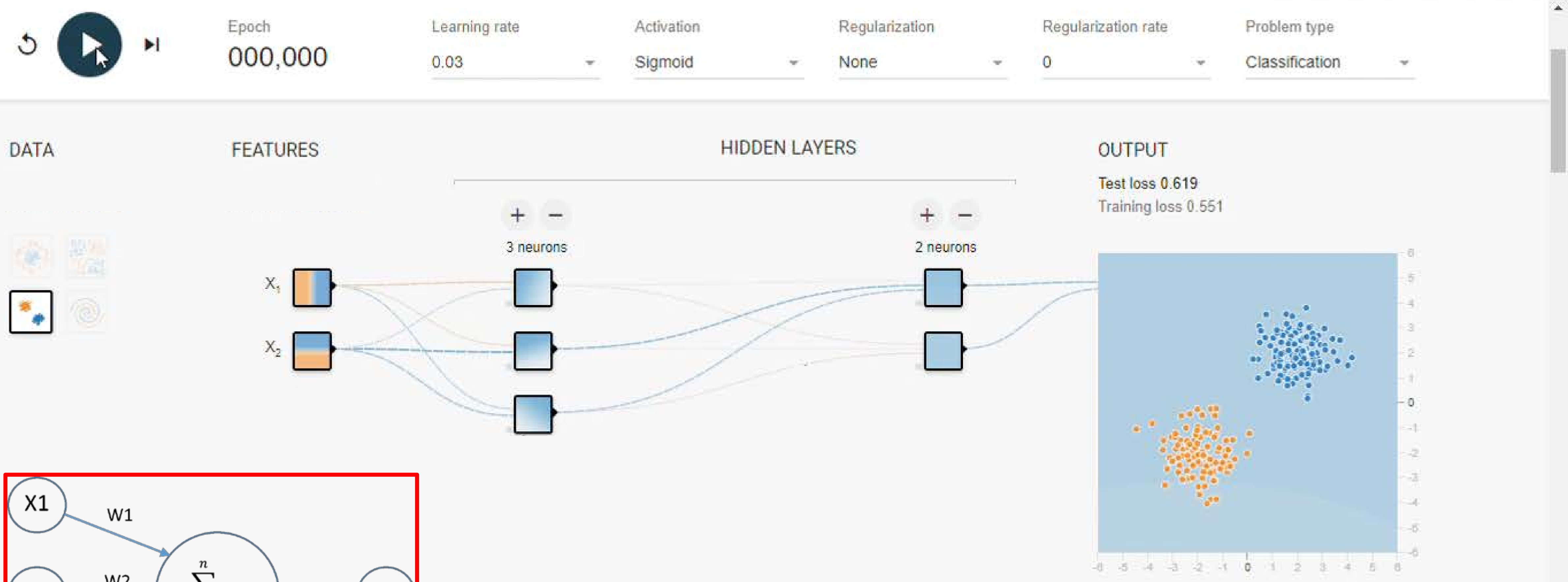


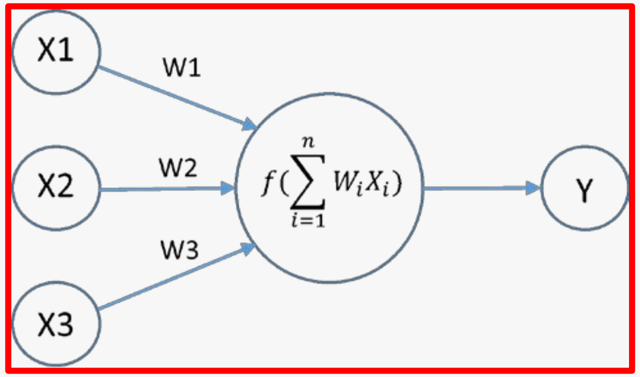
Training a classifier





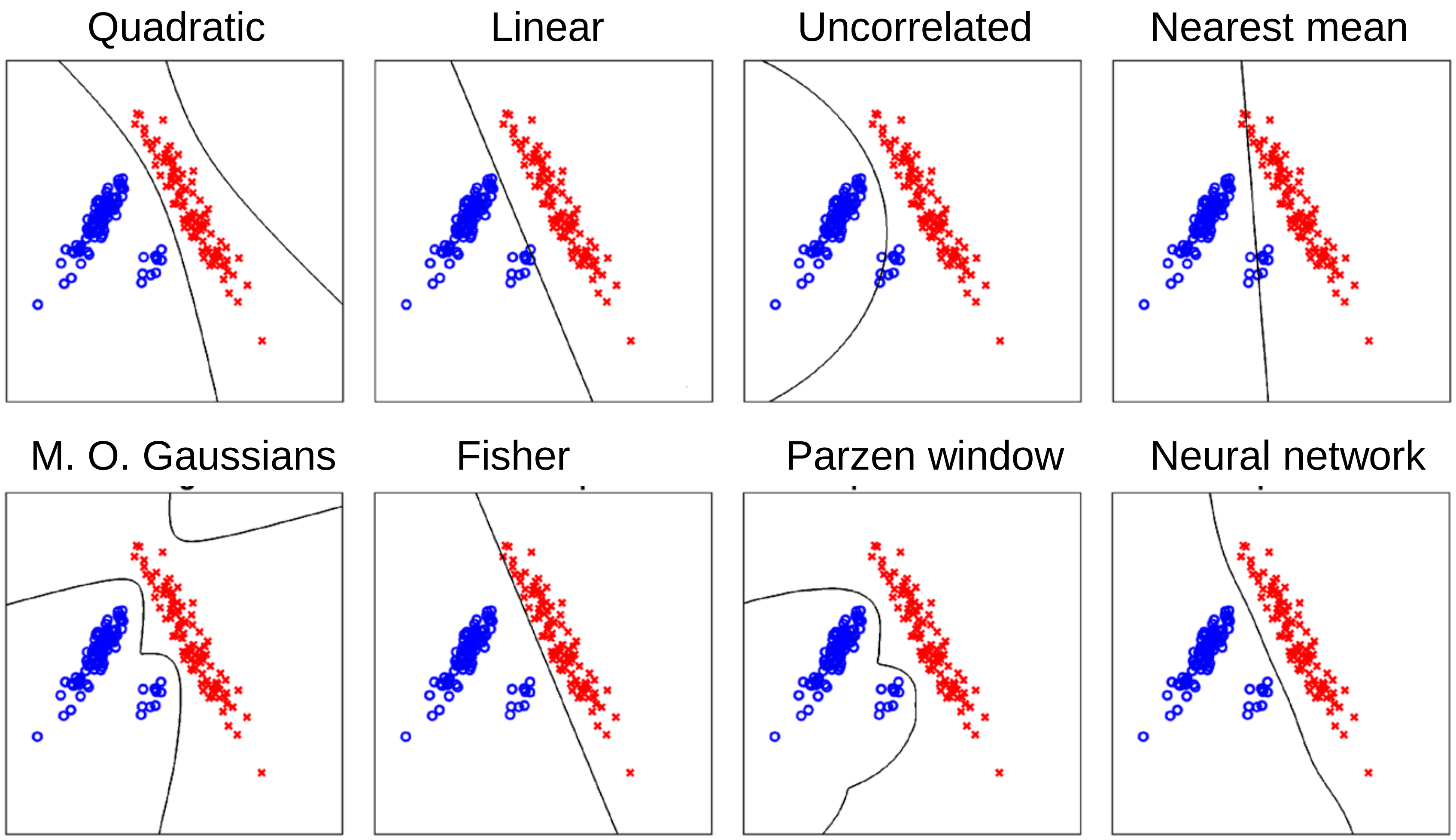
Neural network classifier



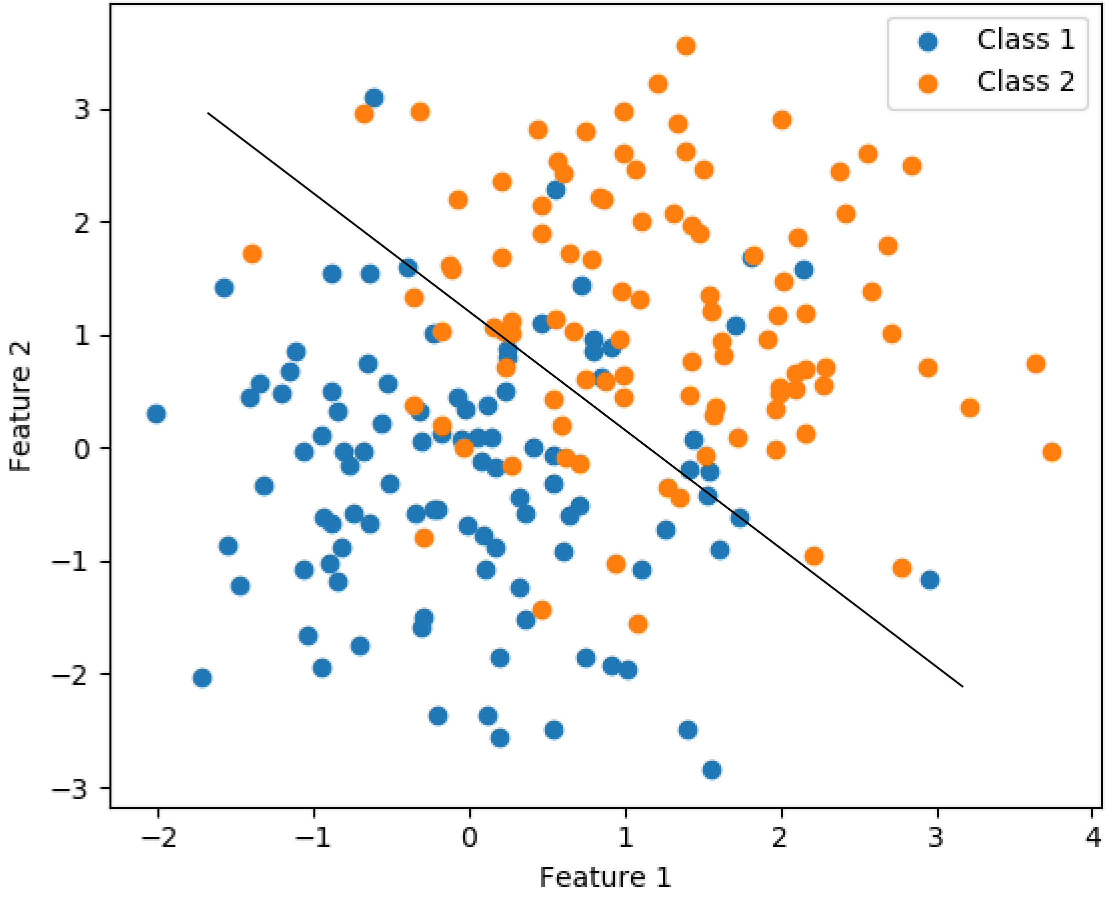


playground.tensorflow.org

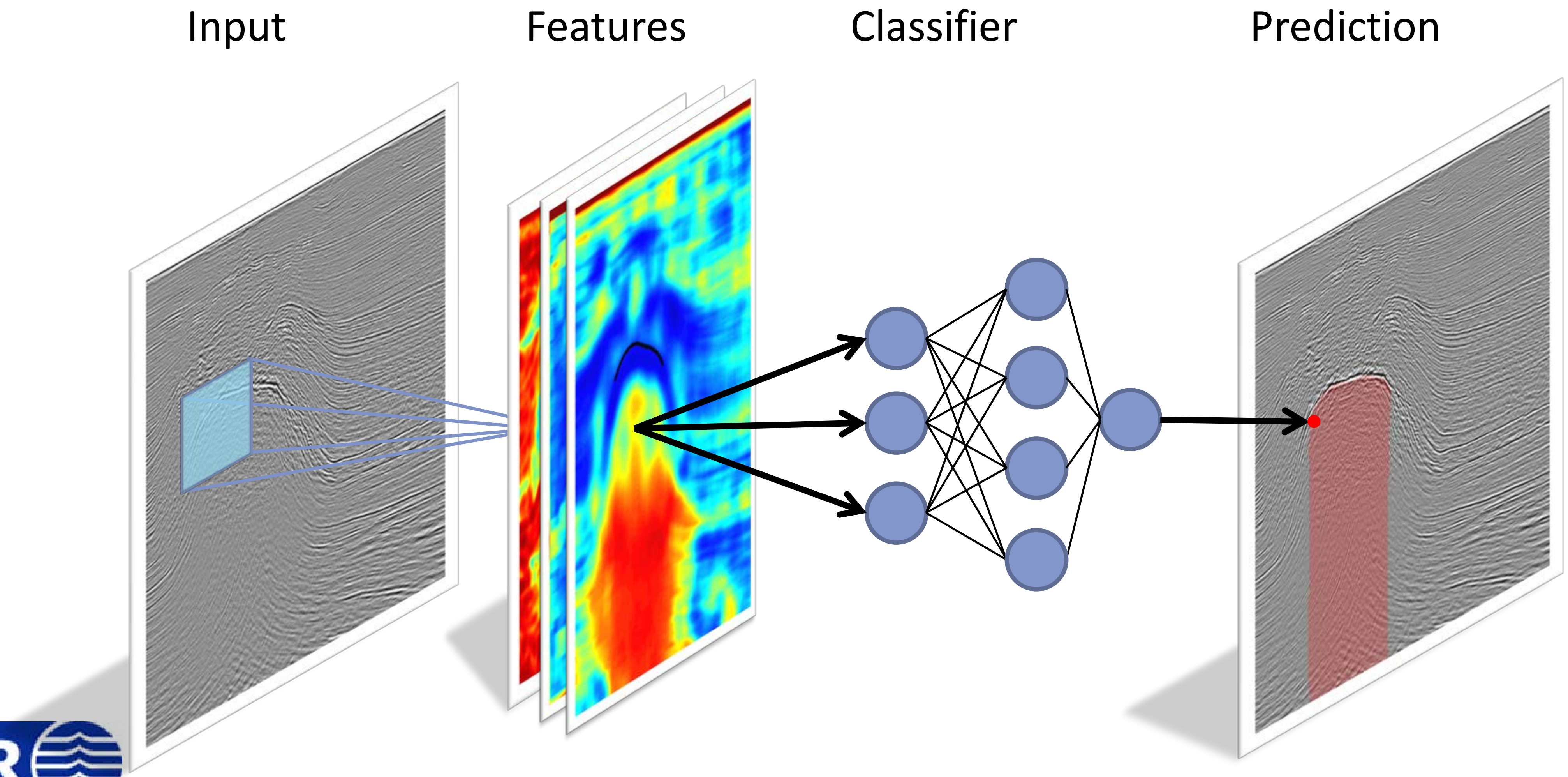
Different types of classifiers



What if the features are bad?



Traditional machine learning

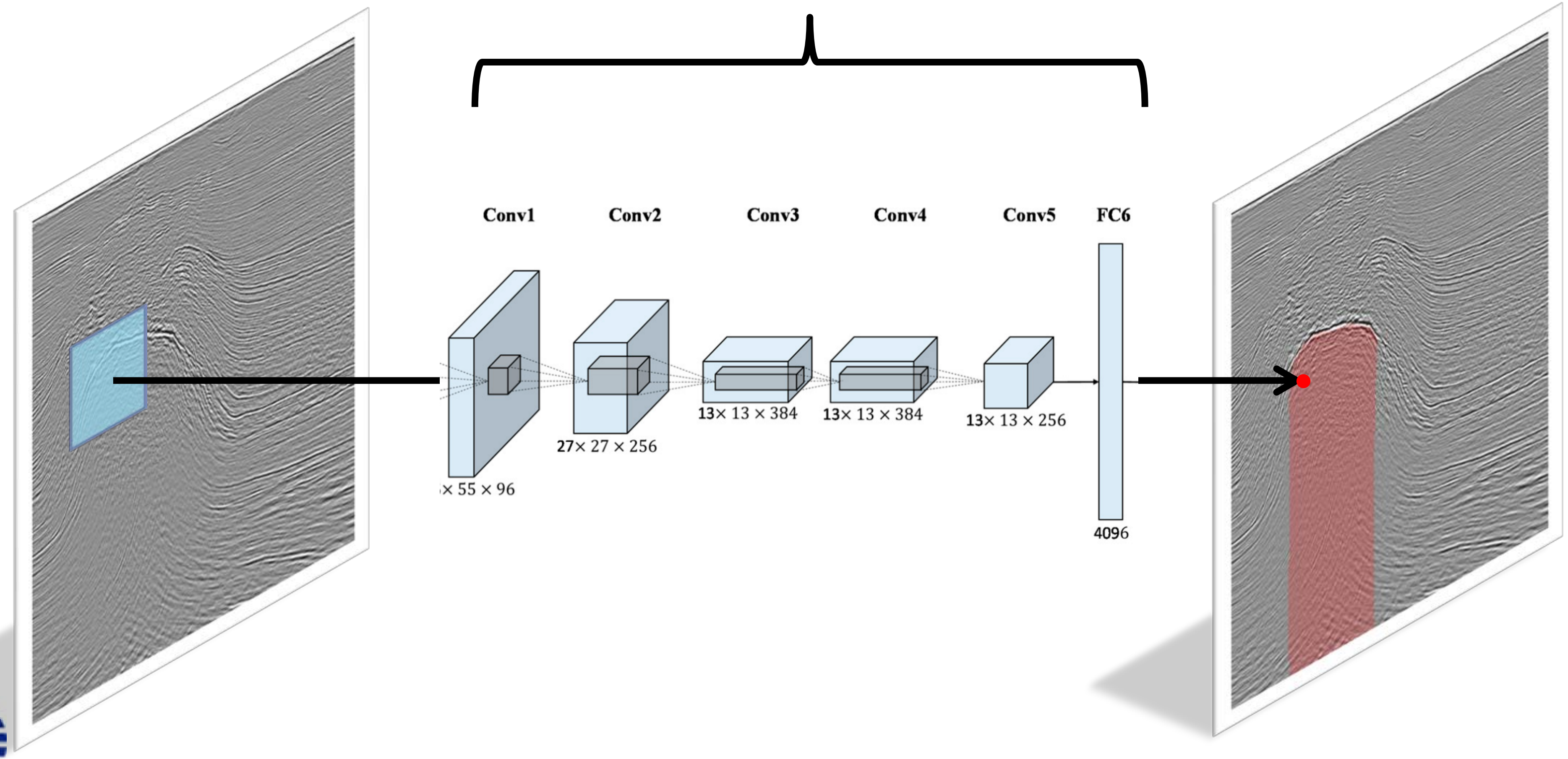


Deep Learning

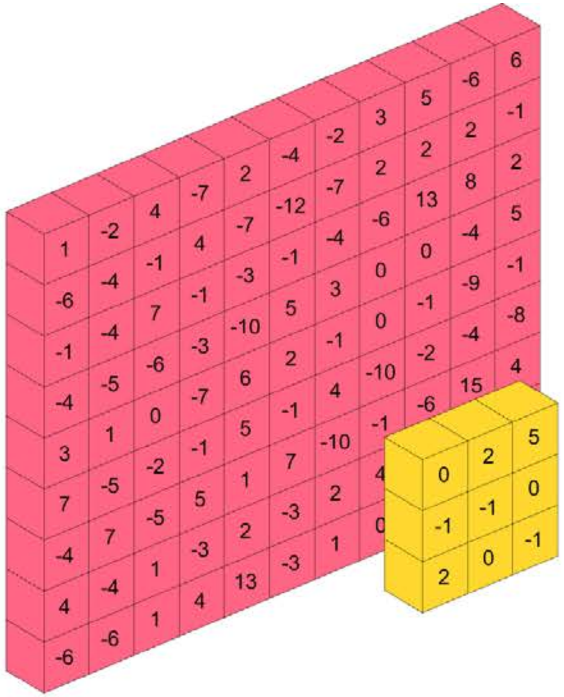
Input

Convolutional Neural Network (CNN)

Predicted salt



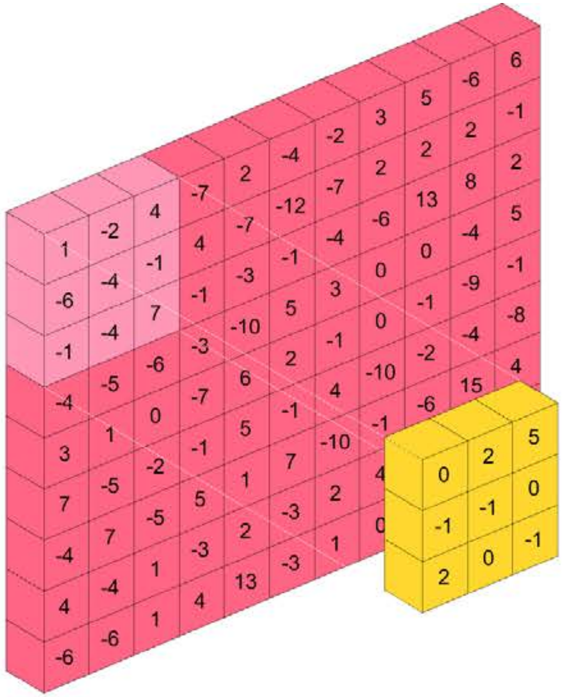
Convolution



Input

Filter

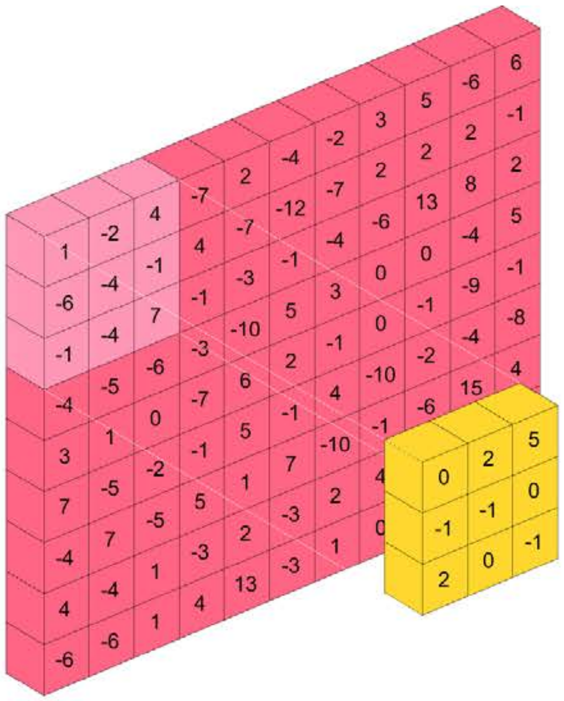
Convolution



Input

Filter

Convolution

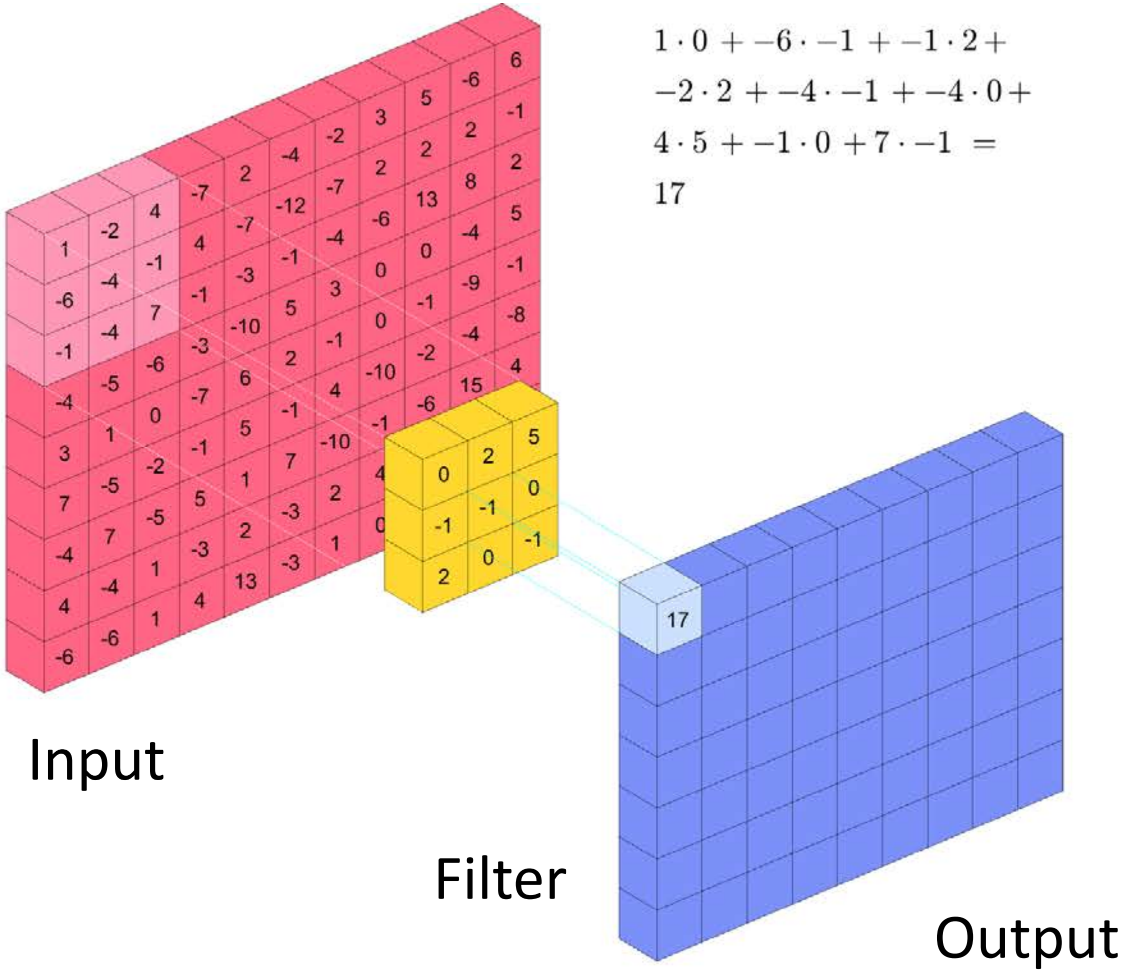


$$1 \cdot 0 + -6 \cdot -1 + -1 \cdot 2 +$$
$$-2 \cdot 2 + -4 \cdot -1 + -4 \cdot 0 +$$
$$4 \cdot 5 + -1 \cdot 0 + 7 \cdot -1 \ =$$
$$17$$

Input

Filter

Convolution



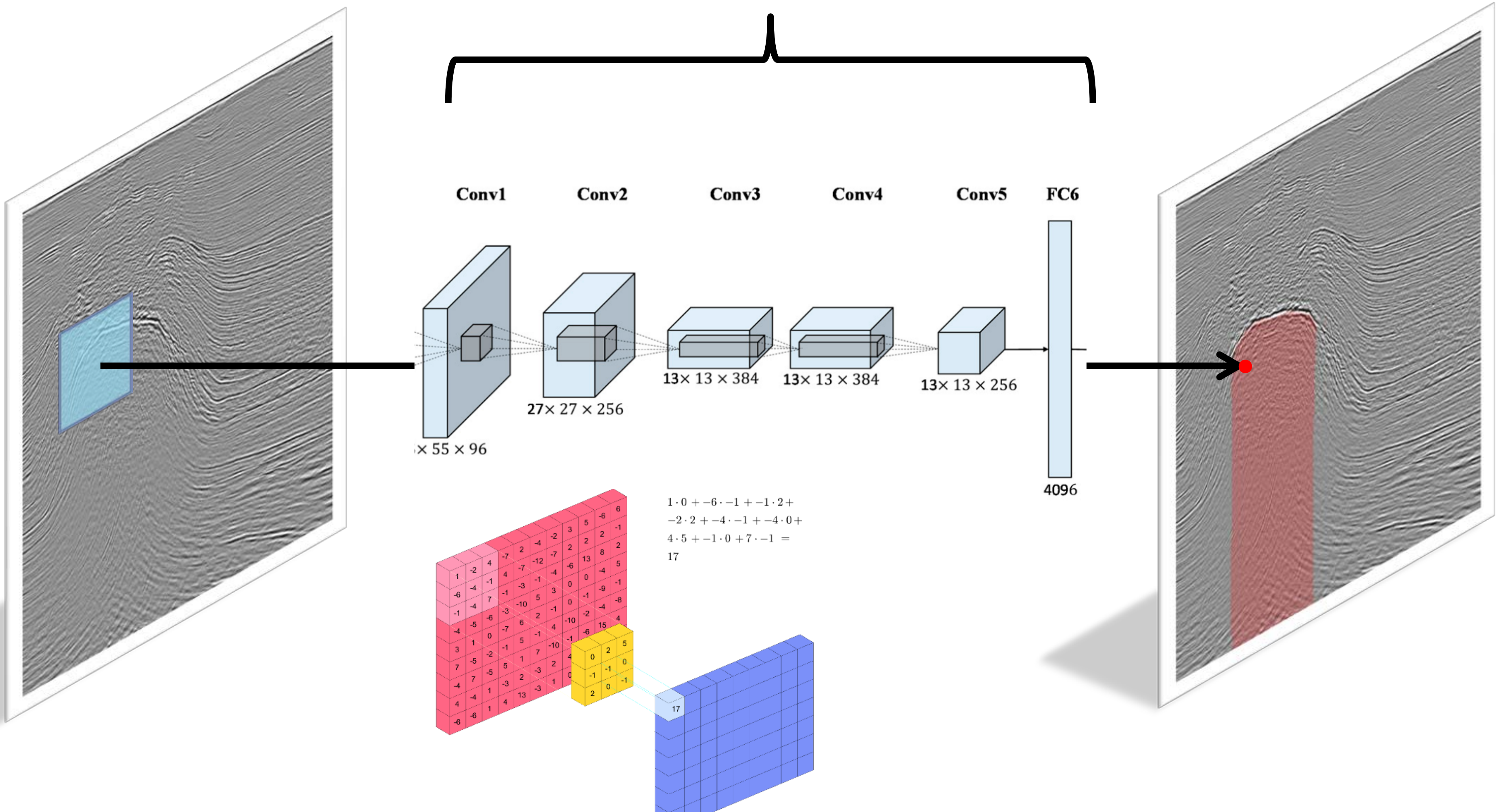
Convolution

Deep Learning

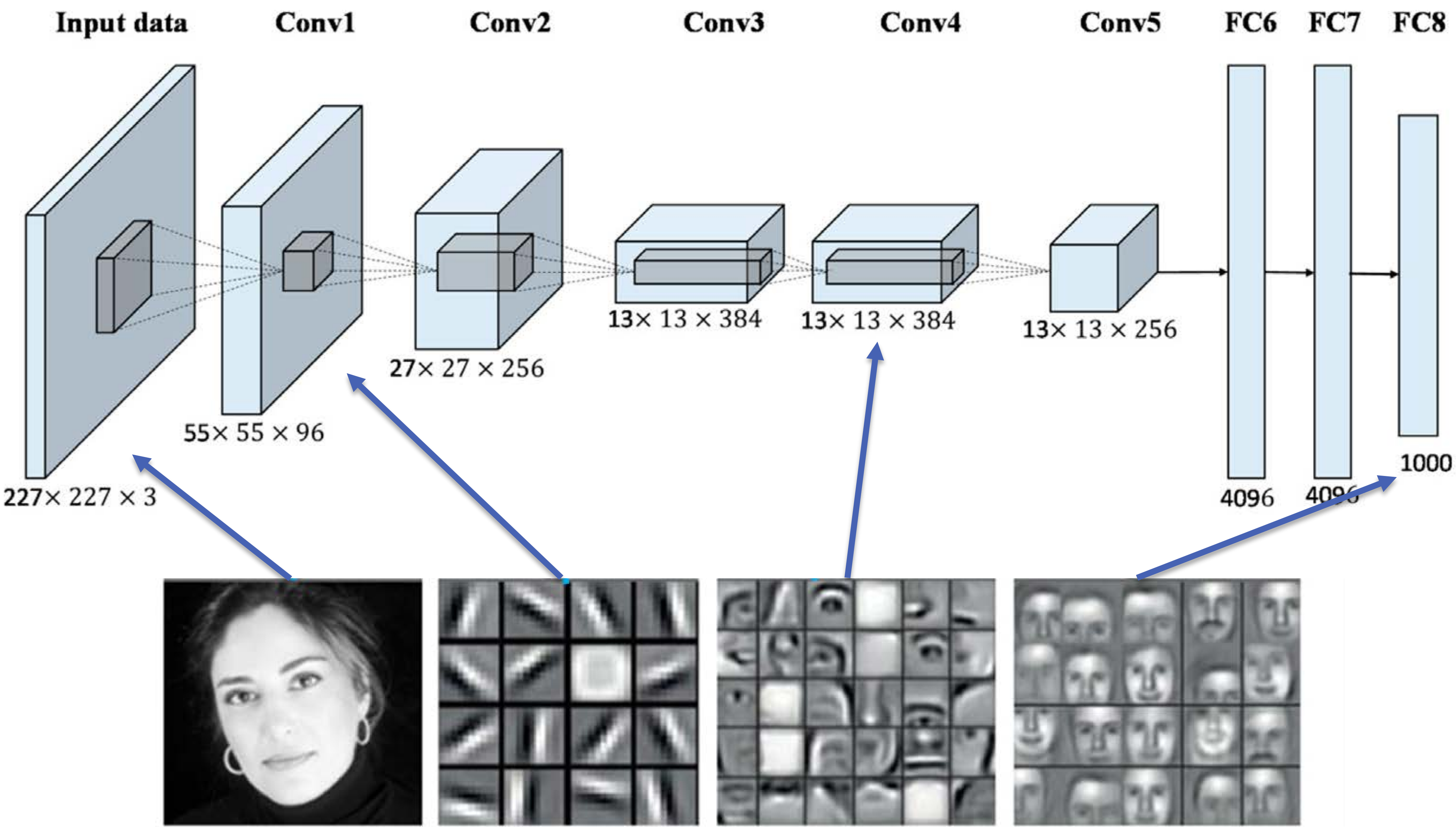
Input

Convolutional Neural Network (CNN)

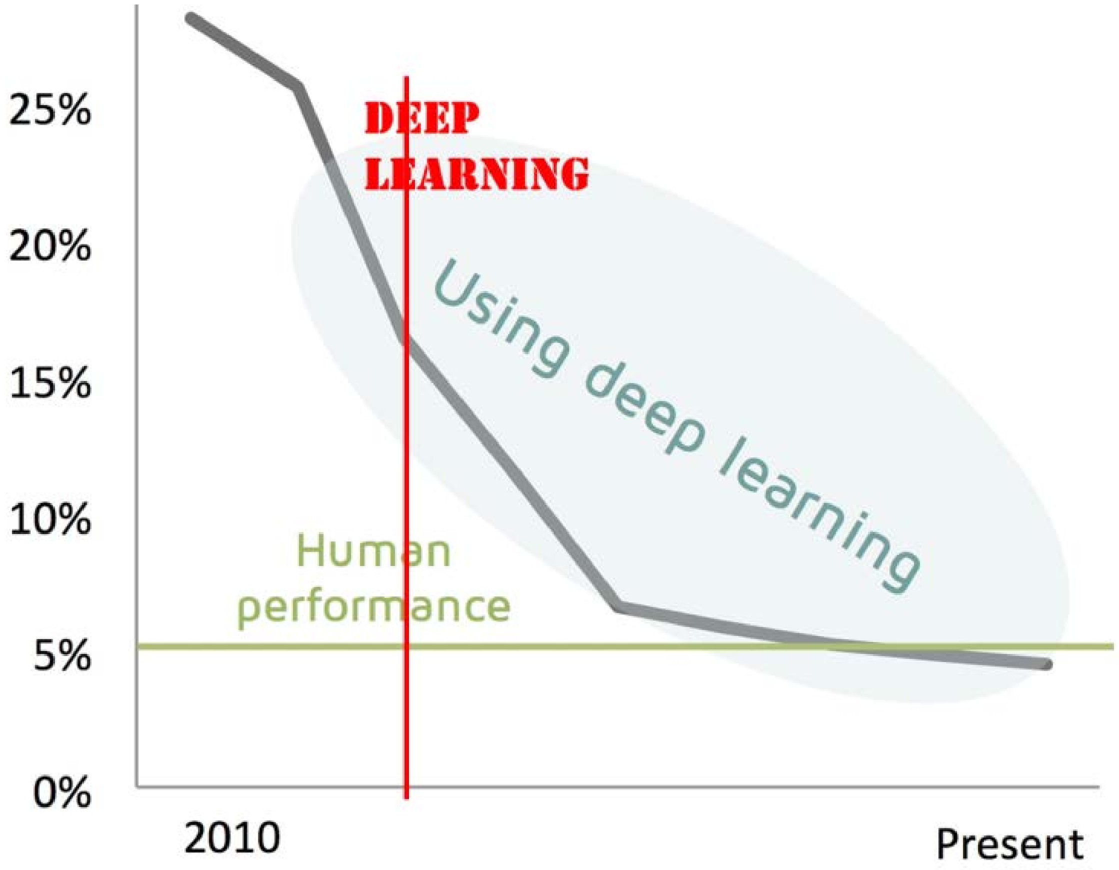
Predicted salt



CNNs learns high level features

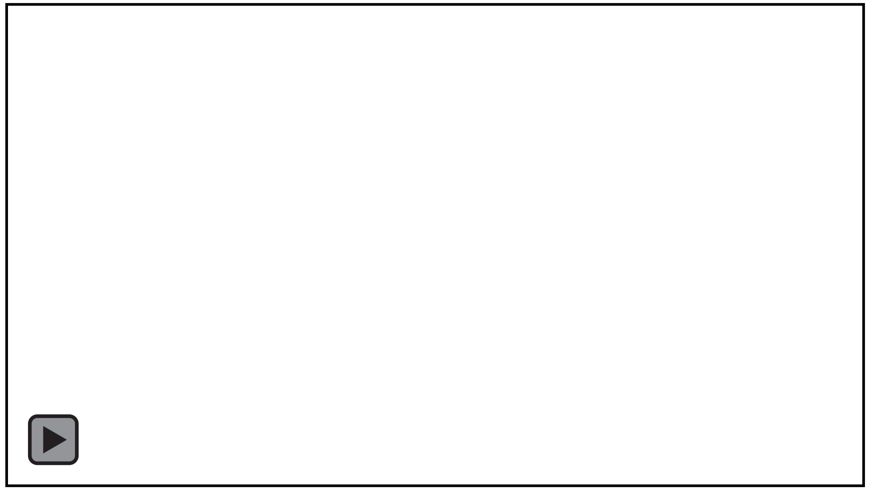


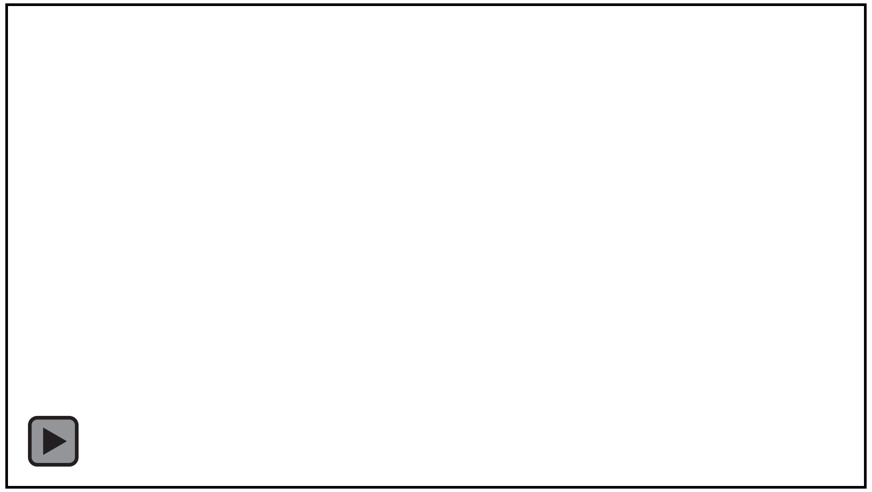
Deep learning
– a revolution in computer vision

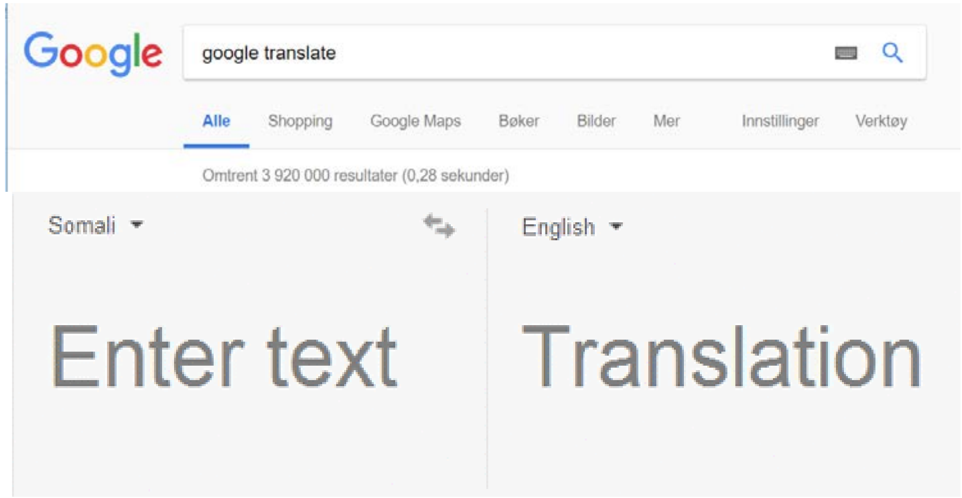


- Much higher accuracy
- Much more training data

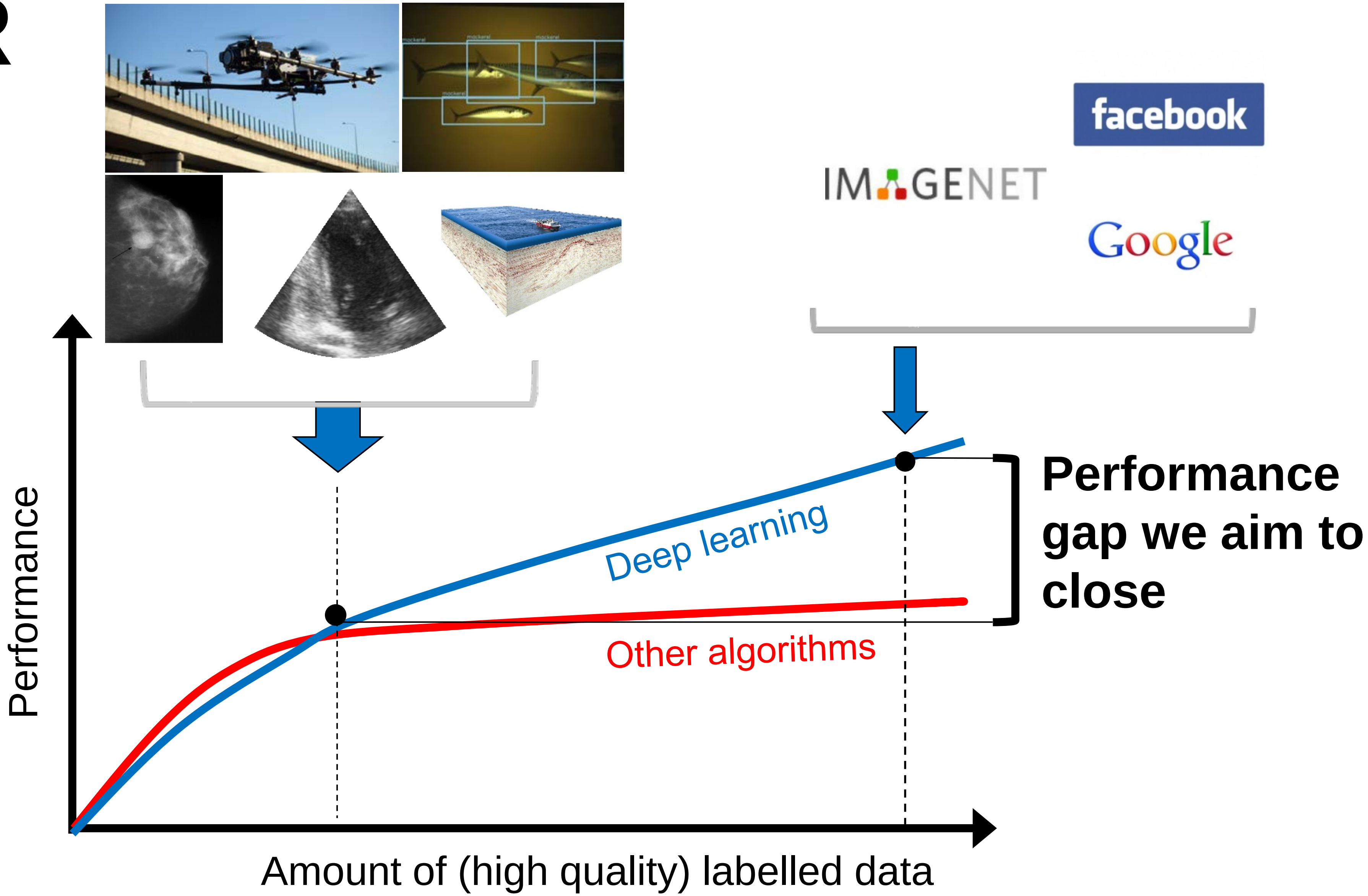
Deep learning is pushing AI







Research challenges we aim to solve at NR

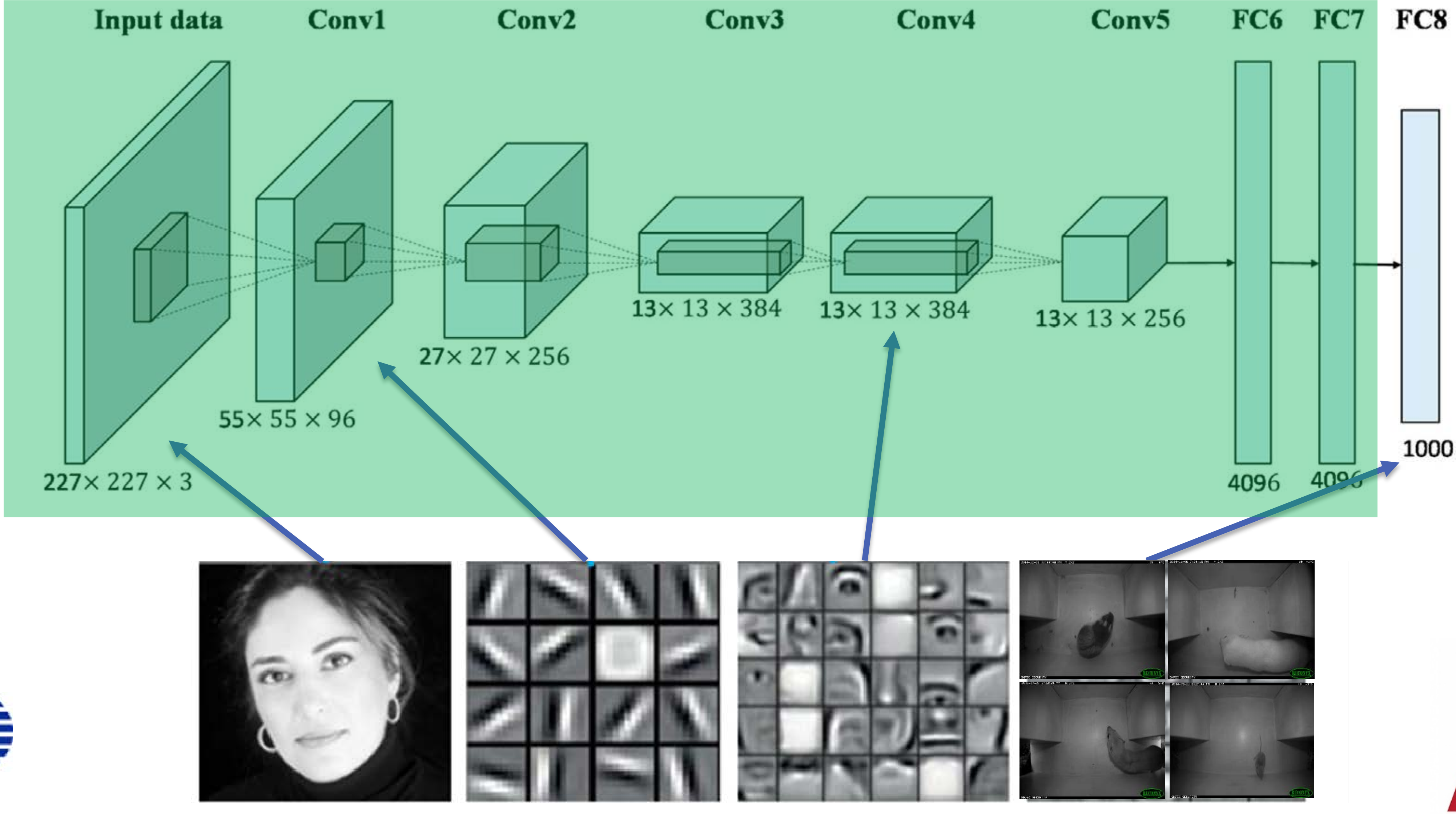


NR experiment: Recognition of animal species

Goal: Predict the species in the box

Challenge: around 1500 labelled images

NR experiment: Recognition of animal species



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NR experiment:
Recognition of animal species

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NR experiment: Recognition of animal species

1: Røyskatt (192)
2: Fugl (120)
3: Spissmus (191)
4: Snømus (60)
5: Snø (196)
6: Lemen (212)
7: Rusk (223)
8: Vole (254)
9: Vann (157)
10: Tomt (211)

Confusion table:

---------------------- Predicted ----------------------------------

True	1	2	3	4	5	6	7	8	9	10
1	188.	0.	2.	1.	0.	1.	0.	0.	0.	0.
2	0.	120.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	186.	0.	2.	0.	0.	0.	0.	3.
4	3.	0.	1.	56.	0.	0.	0.	0.	0.	0.
5	0.	0.	2.	0.	192.	0.	0.	0.	2.	0.
6	0.	0.	0.	0.	0.	211.	0.	1.	0.	0.
7	0.	0.	3.	0.	0.	0.	217.	1.	1.	1.
8	1.	0.	1.	0.	0.	0.	3.	249.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	157.	0.
10	0.	0.	0.	0.	0.	0.	1.	0.	0.	210.

Correct recognition rate = **98.3**%

NR experiment:
Recognition of animal species

NR

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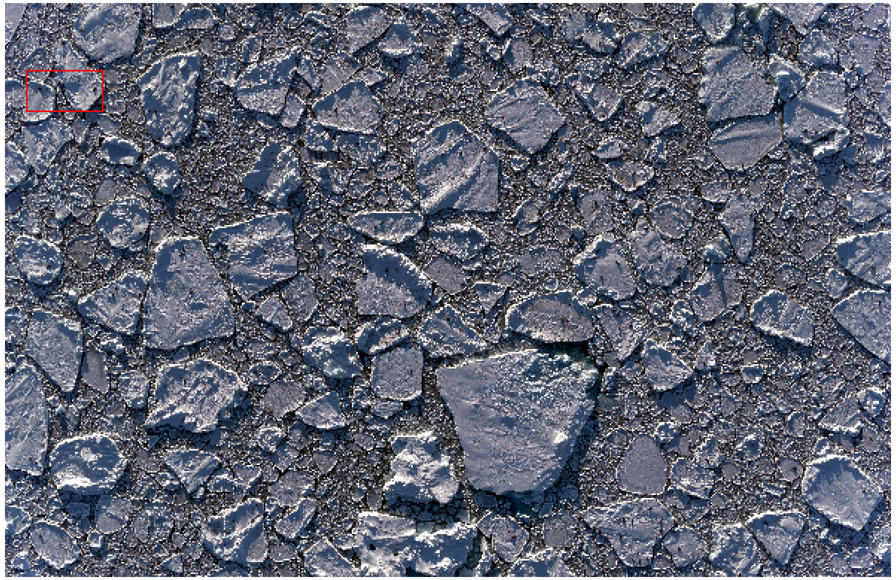
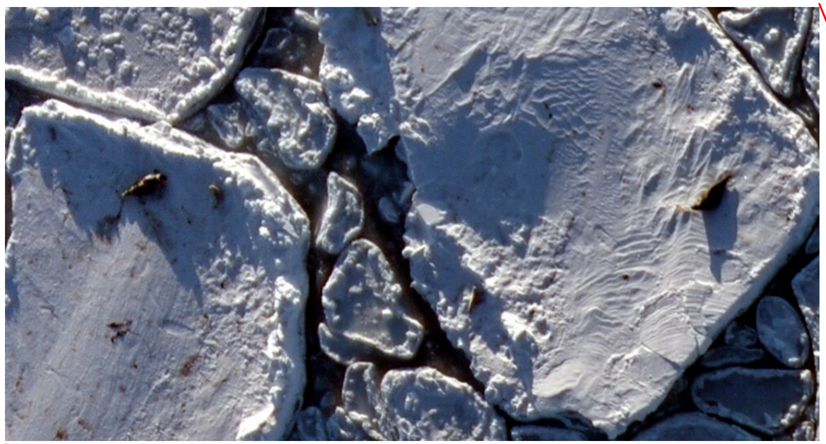
NR-project: Seal detection

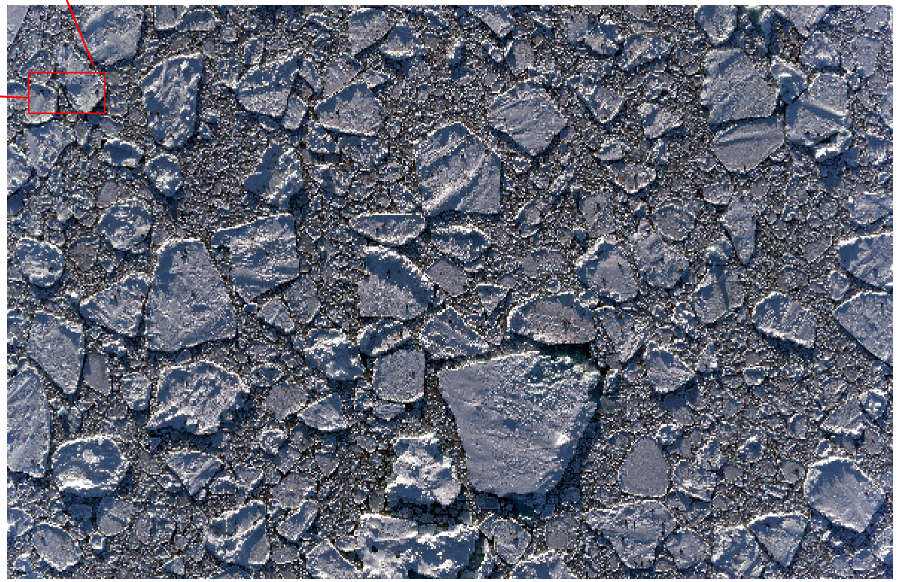
Havforsknings Instituttet – Marine Research Institute



https://www.verticalmag.com/news/into-the-ice-a-pilots-diary/

NR-project: Seal detection





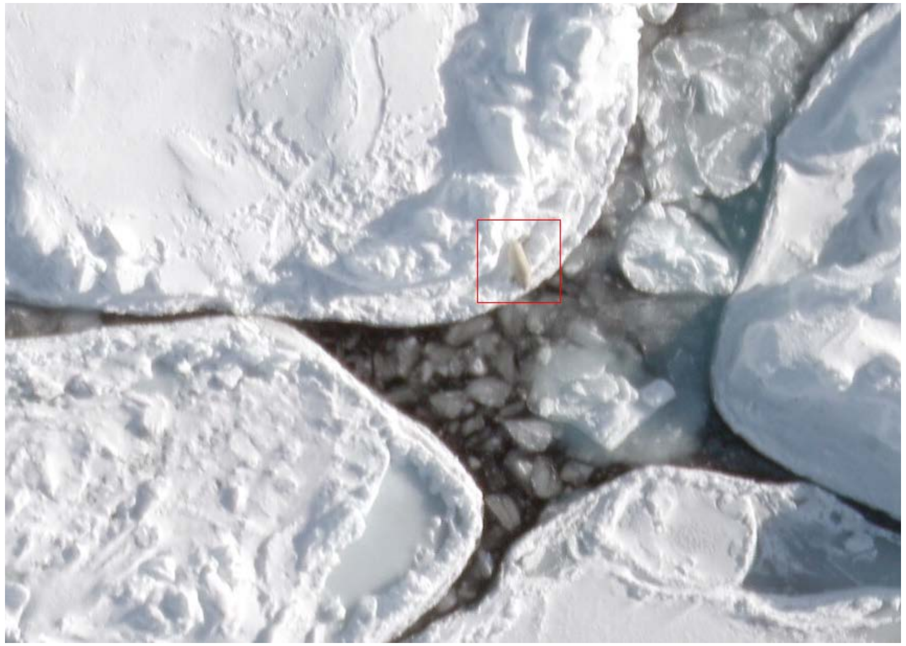
The challenge is that we have several thousands of large images covering sea ice.

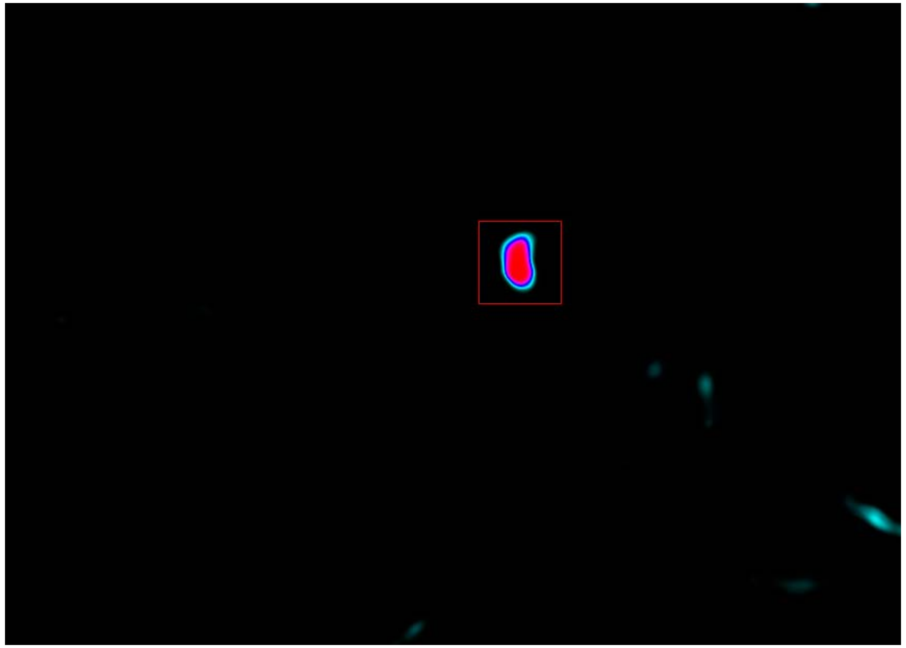
NR-project: Seal detection

- Dataset from the West Ice 2007 & 2012 and Canada 2012
- About 10000 seal pups (9000 harp seals and 1000 hooded seals) have been identified.
- About 90000 background images

Some results

Accuracy 3 classes (background, harp, hood): **99.7%**

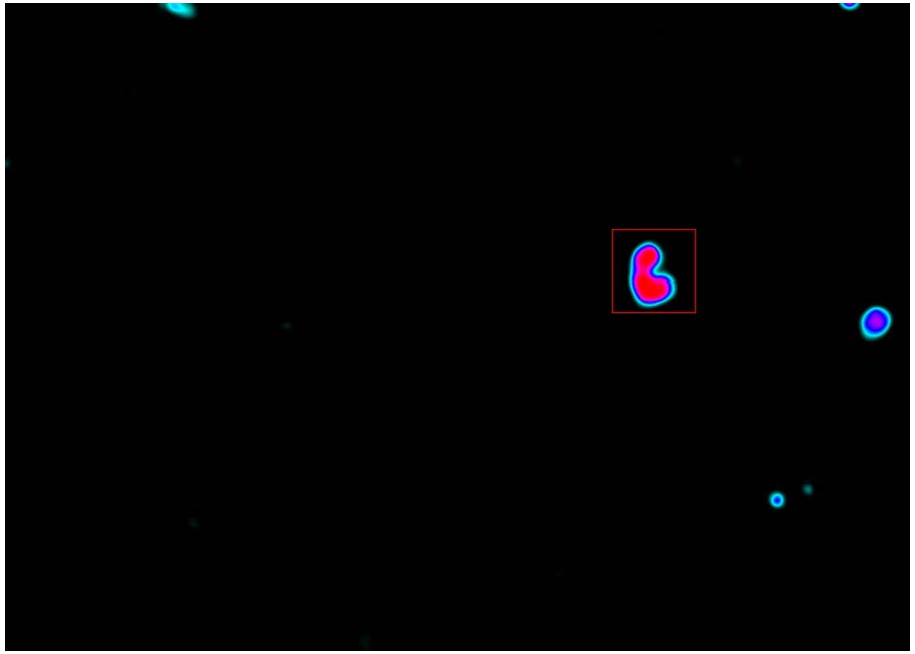




Heat map

Some results

Accuracy 3 classes (background, harp, hood): **99.7%**



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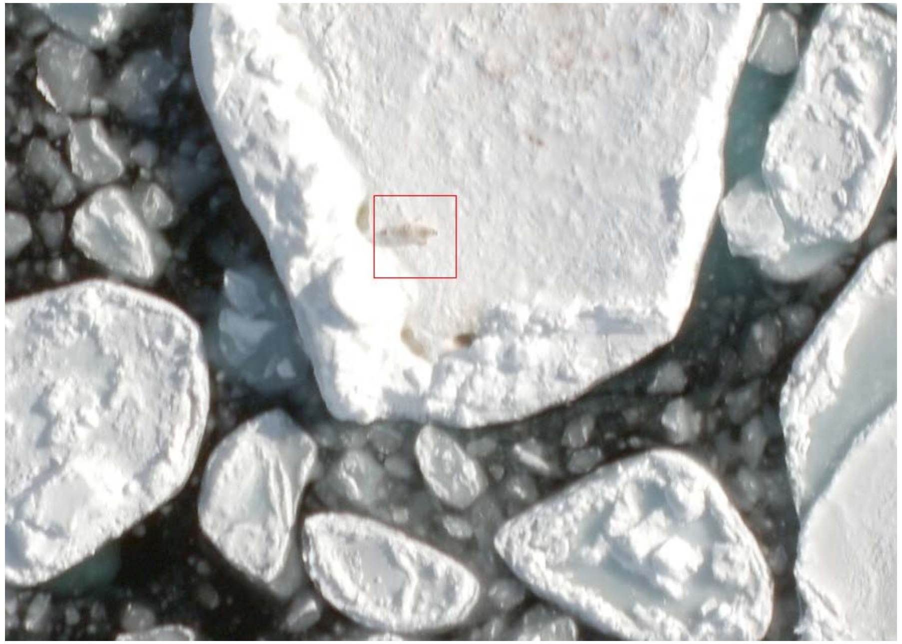

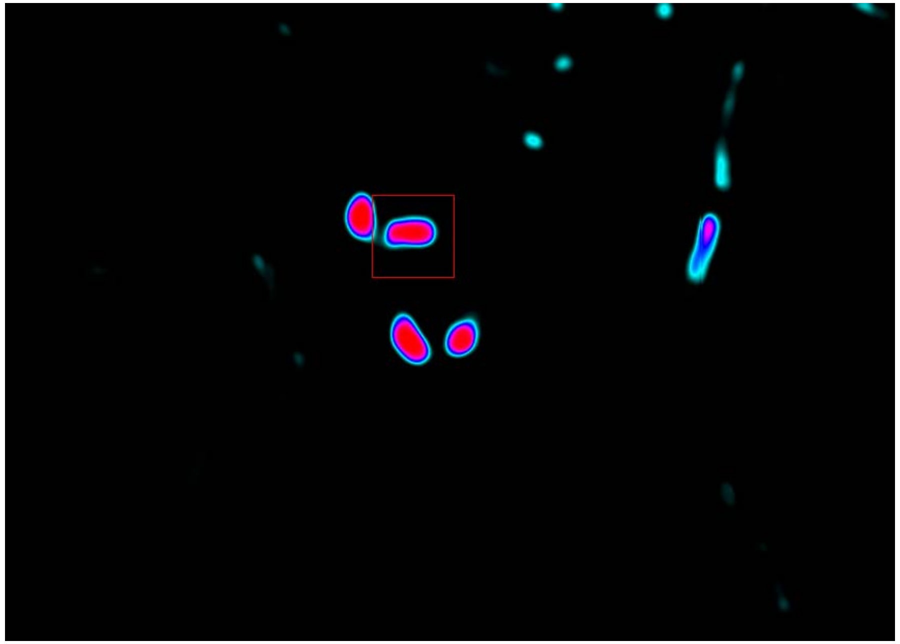

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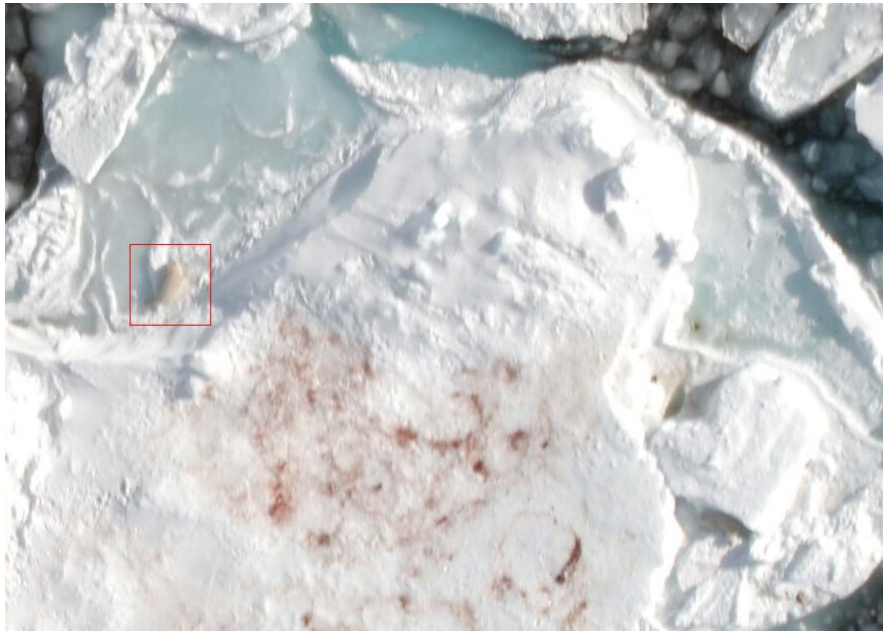
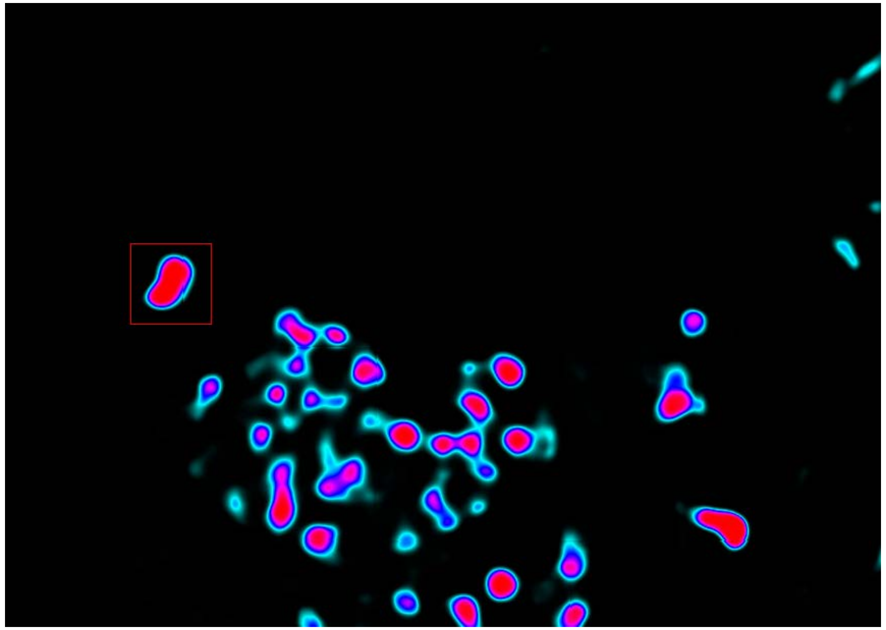
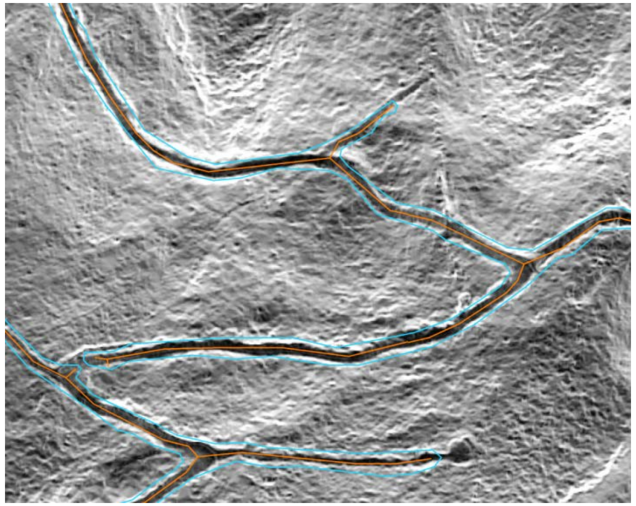
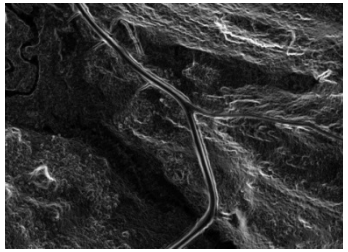
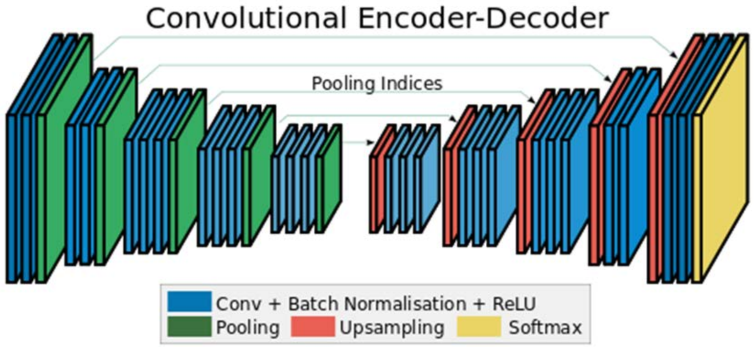


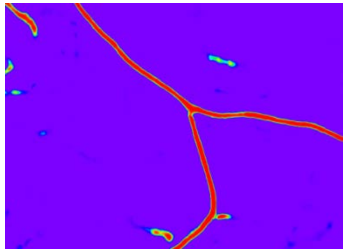


Mapping of roads from airborne laser scanning data



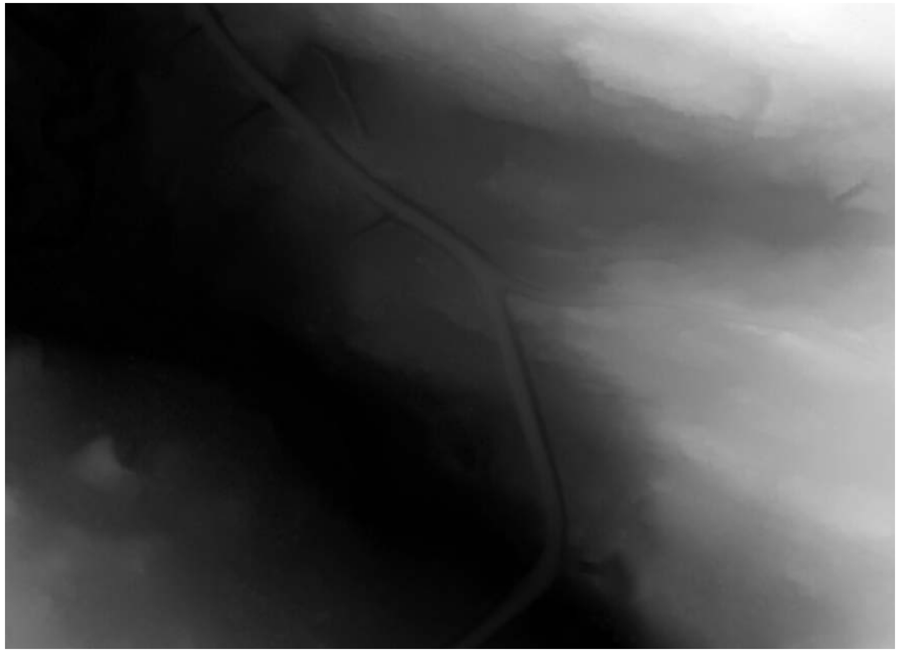




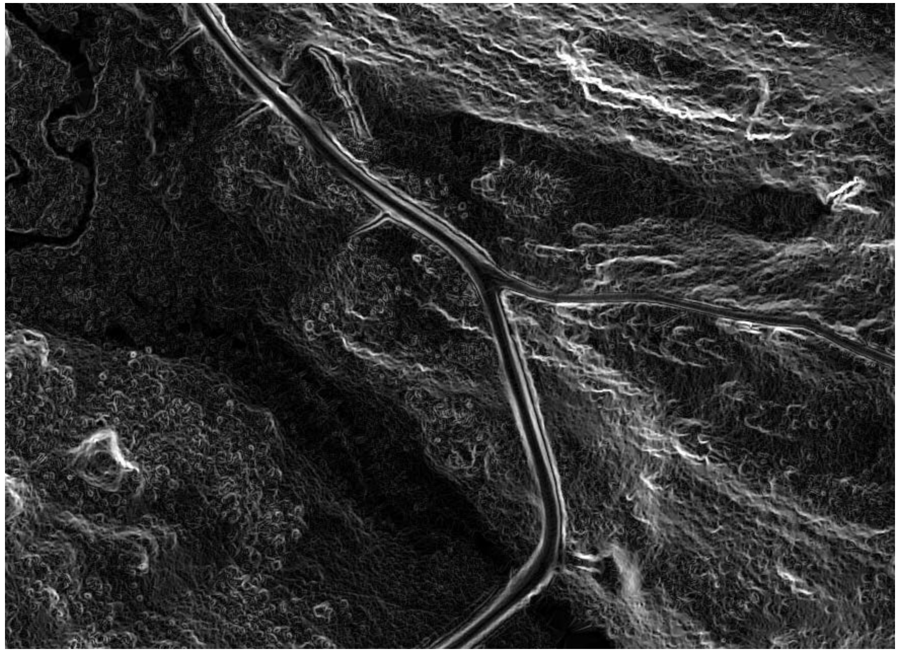


Kartverket

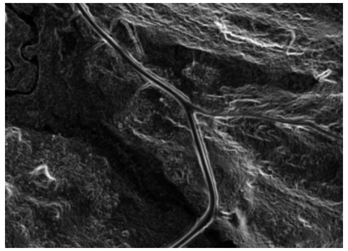
NR-project: Mapping of roads from airborne laser scanning data

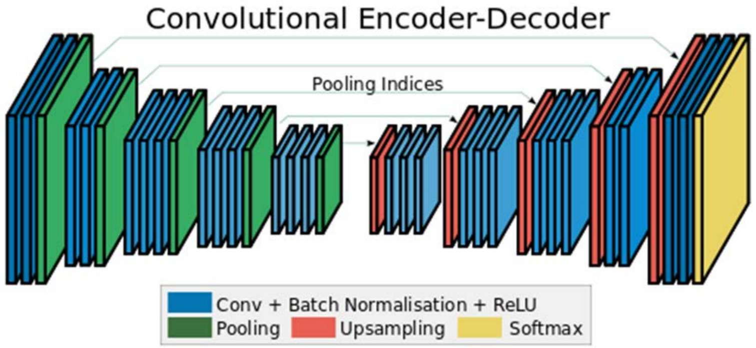


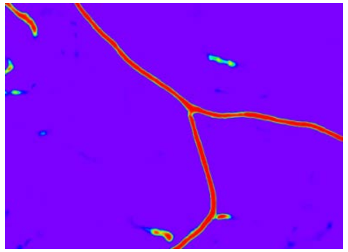
Digital elevation model (DEM)



Gradient (slope) of the DEM







NR

Kartverket

Results

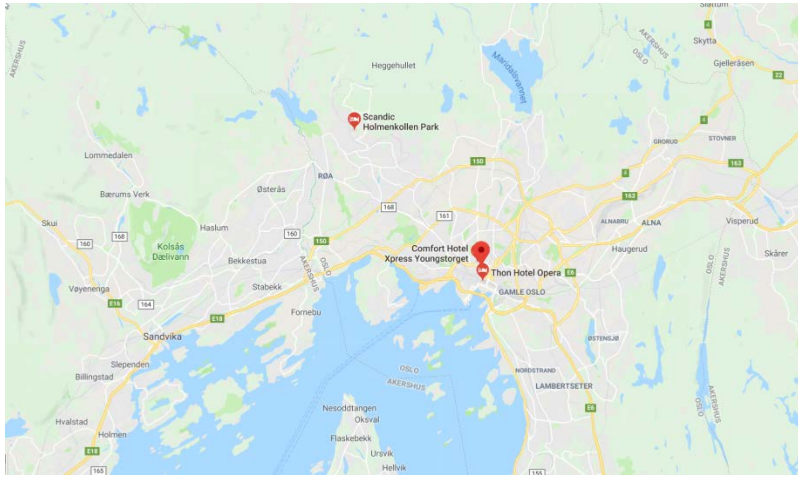
Results

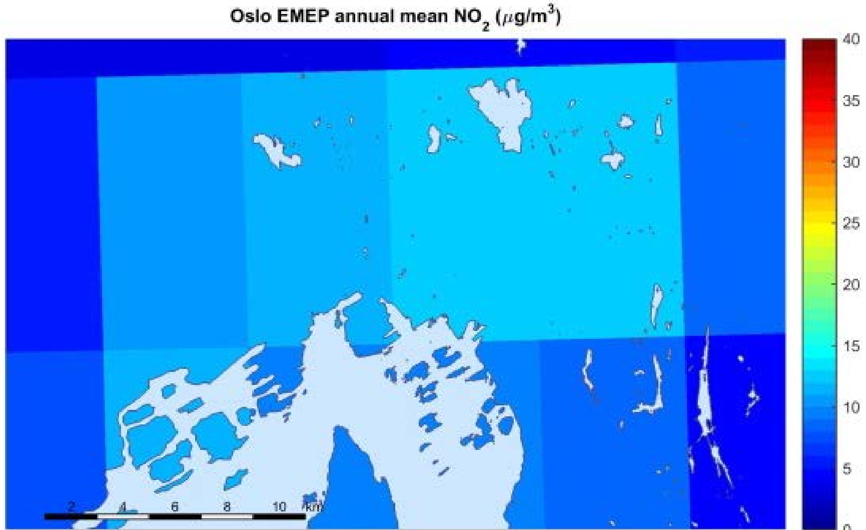
Kartverket

Results

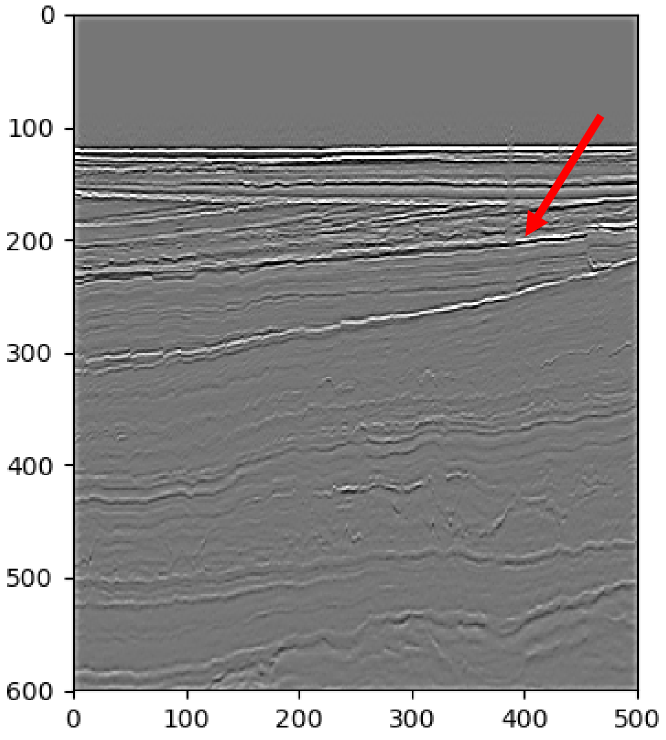
Airquip – Counting cars from satellites

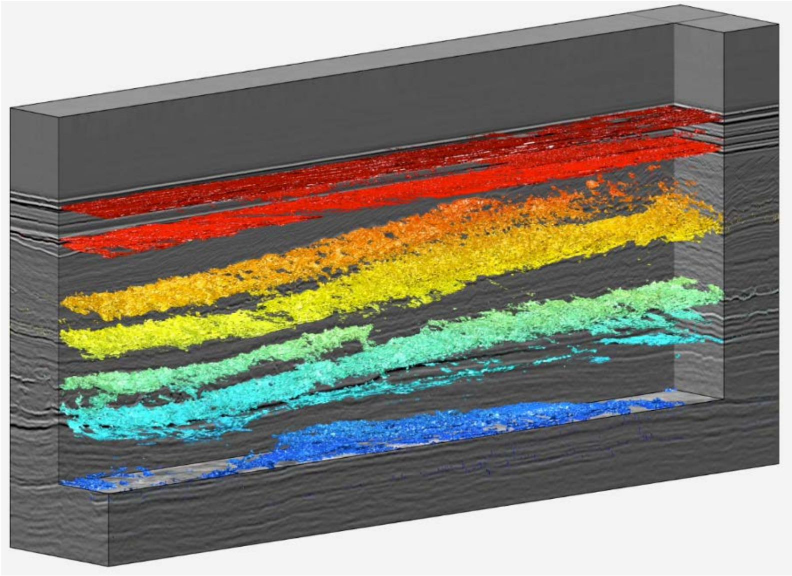
Metrologisk institutt

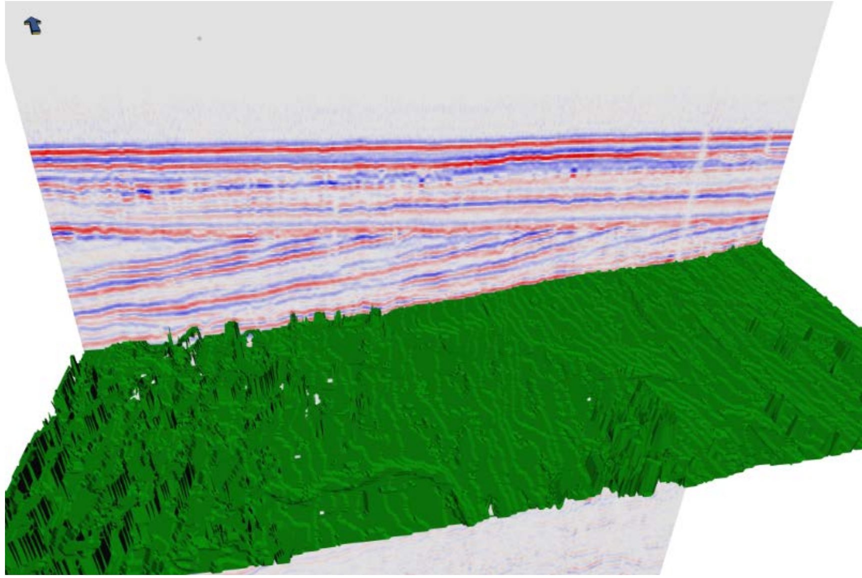




Extracting key horizons

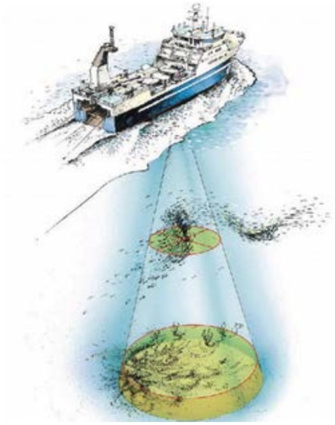


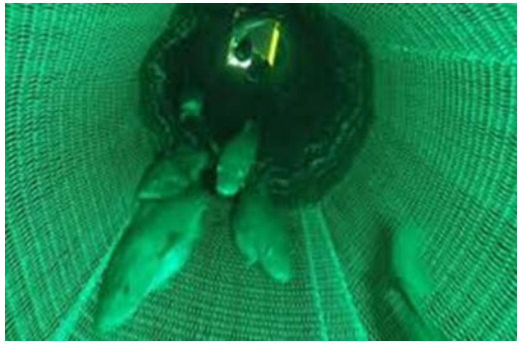


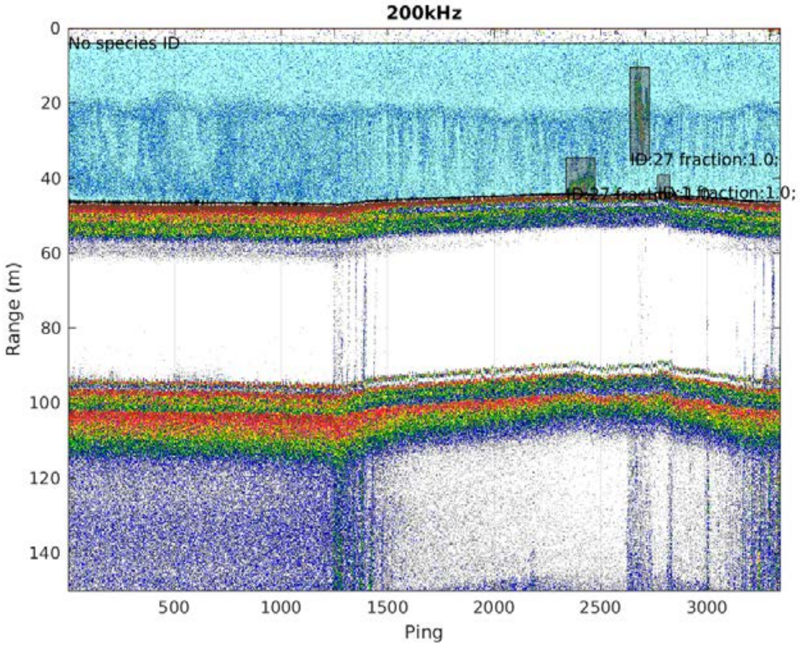


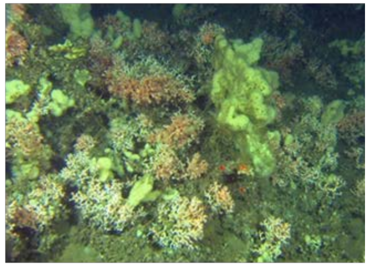
equinor

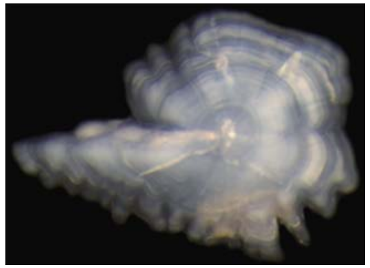
COGMAR:
Image analysis for marine data











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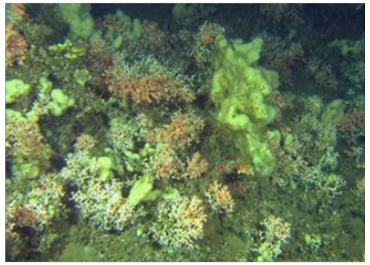
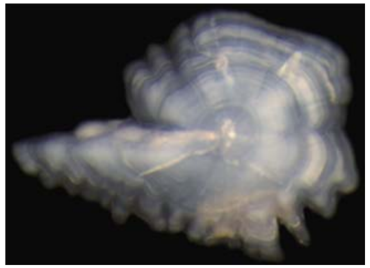
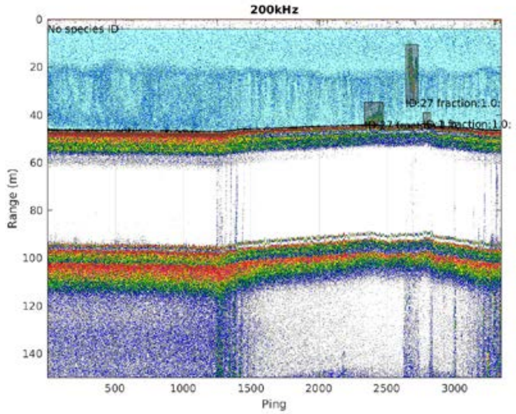
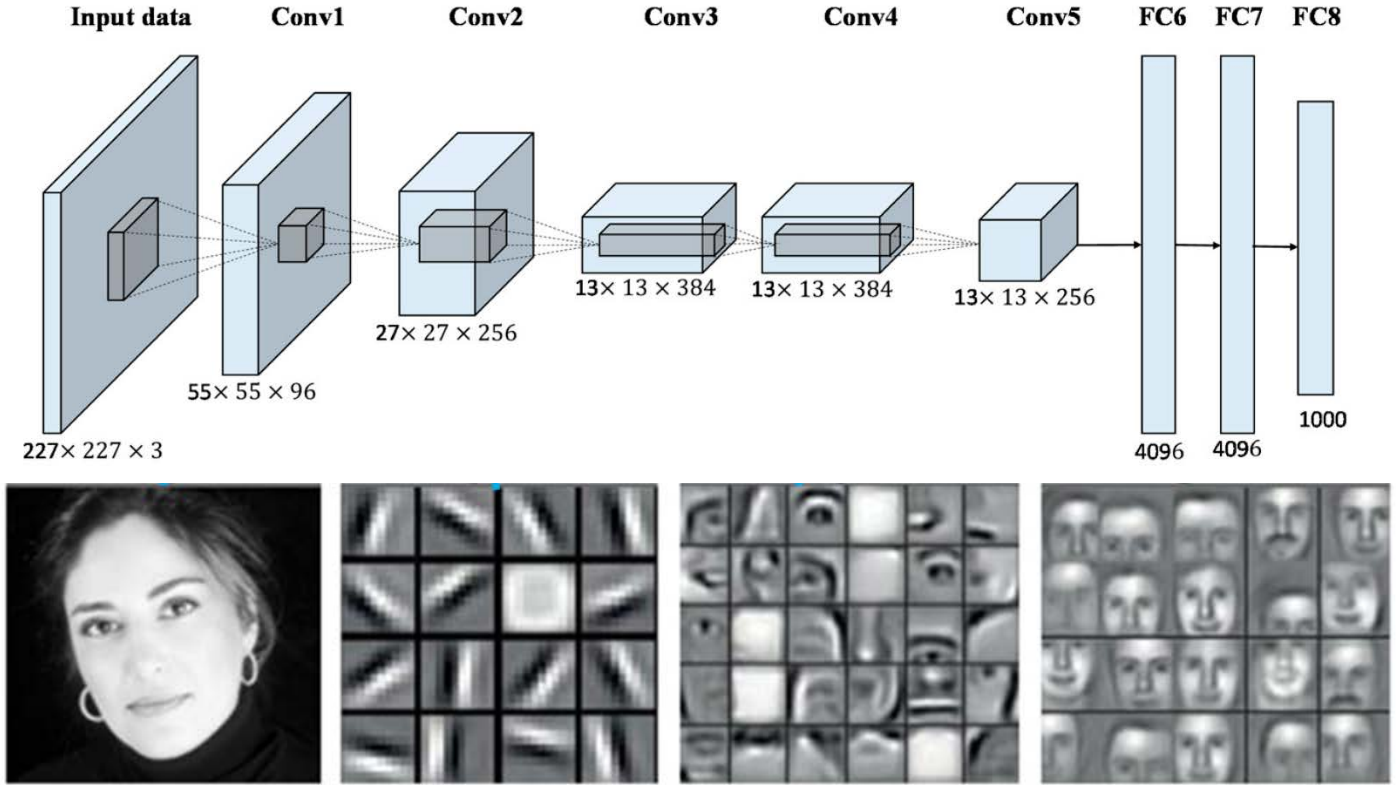
DEEP VISION

Problem: Transfer learning

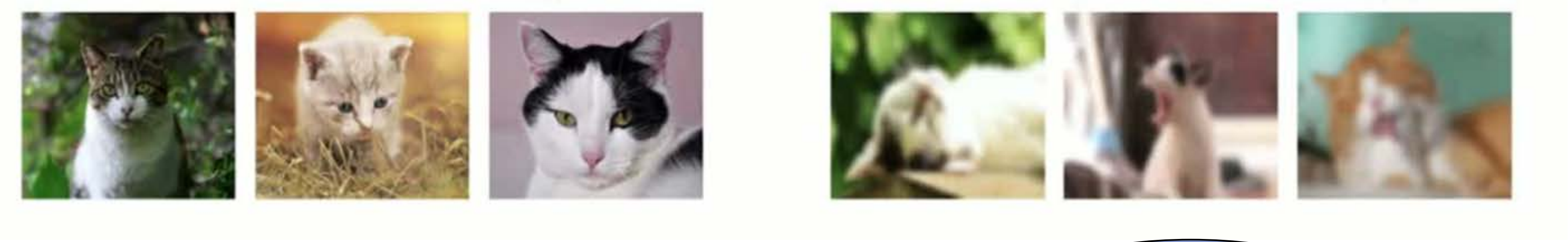


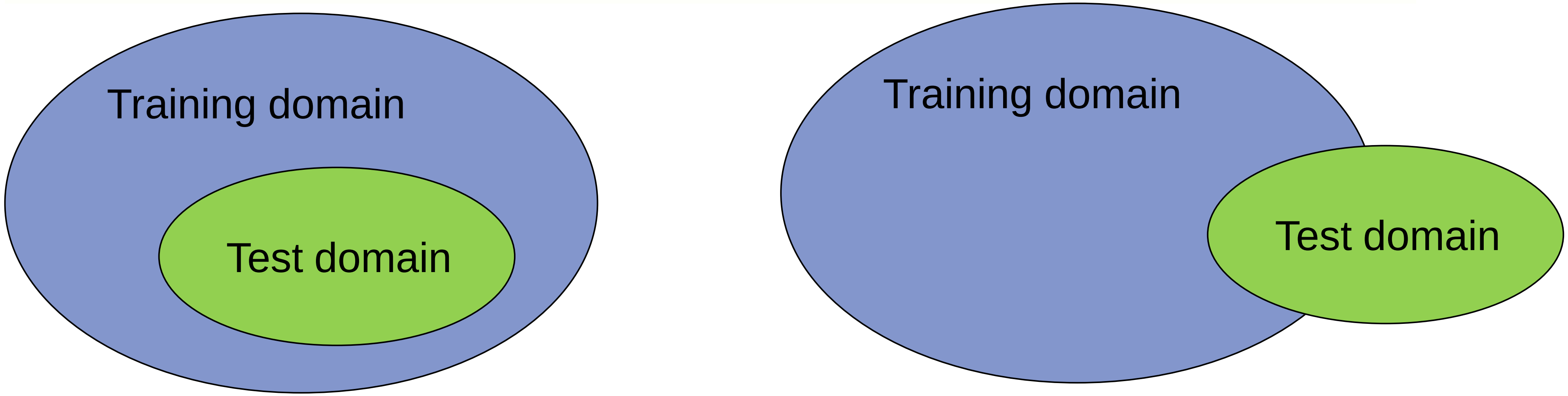




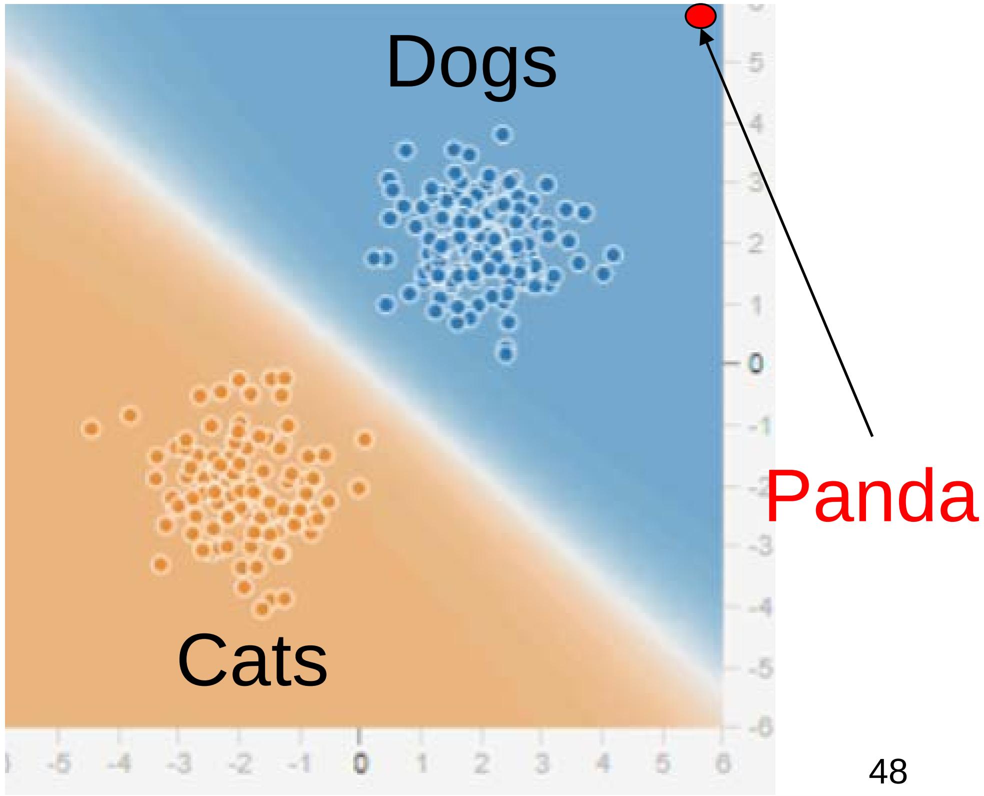


Problem: Domain shift





Problem:
No uncertainty estimates
No out-of-distribution detection



Problem: Confounding variables

Thank you for the attention.

Questions?

anders@nr.no