Norsk Regnesentral (NR)
Norwegian Computing Center

Petter Abrahamsen

Joining Forces 2018

www.nr.no


NUSSE:
- 512 9-digit numbers
- 200 additions/second

Our latest servers:

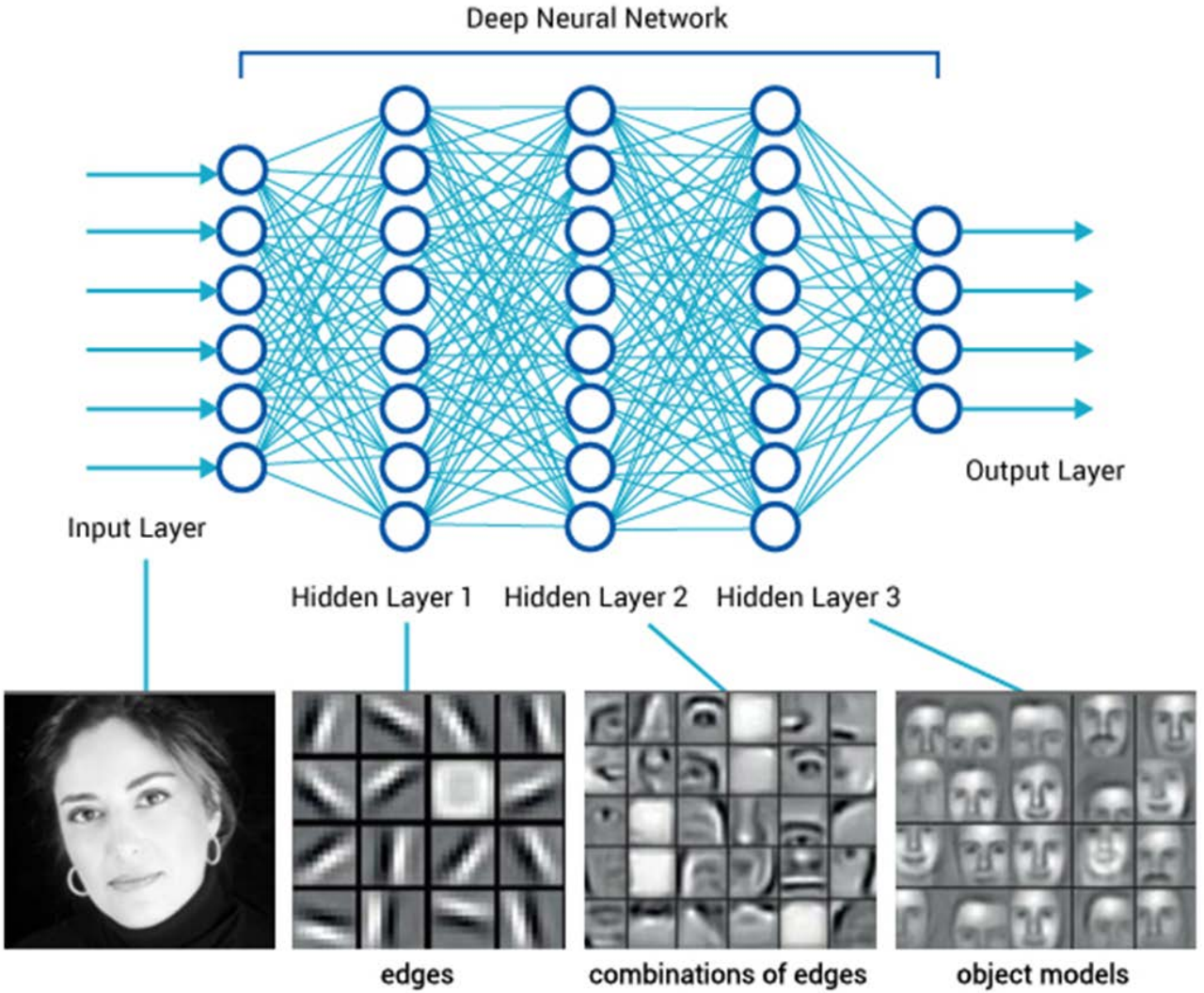
- Four Titan X GPUs
- 14 336 cores
- Any gamers dream fulfilled..

Our latest servers:

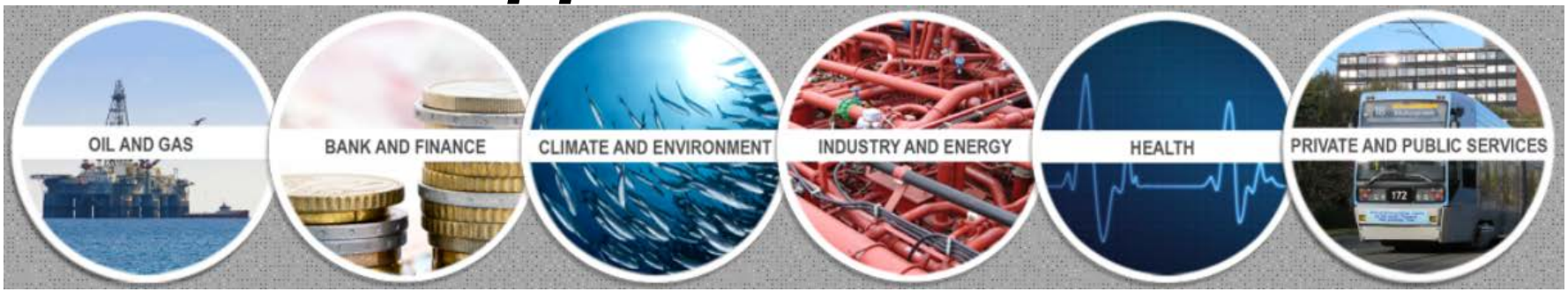
- Four Titan X GPUs
- 14 336 cores
- Perfect for making money…

Photo by Chesnot/Getty Images

We use the GPUs for Deep Learning



NR is an *applied* research institute

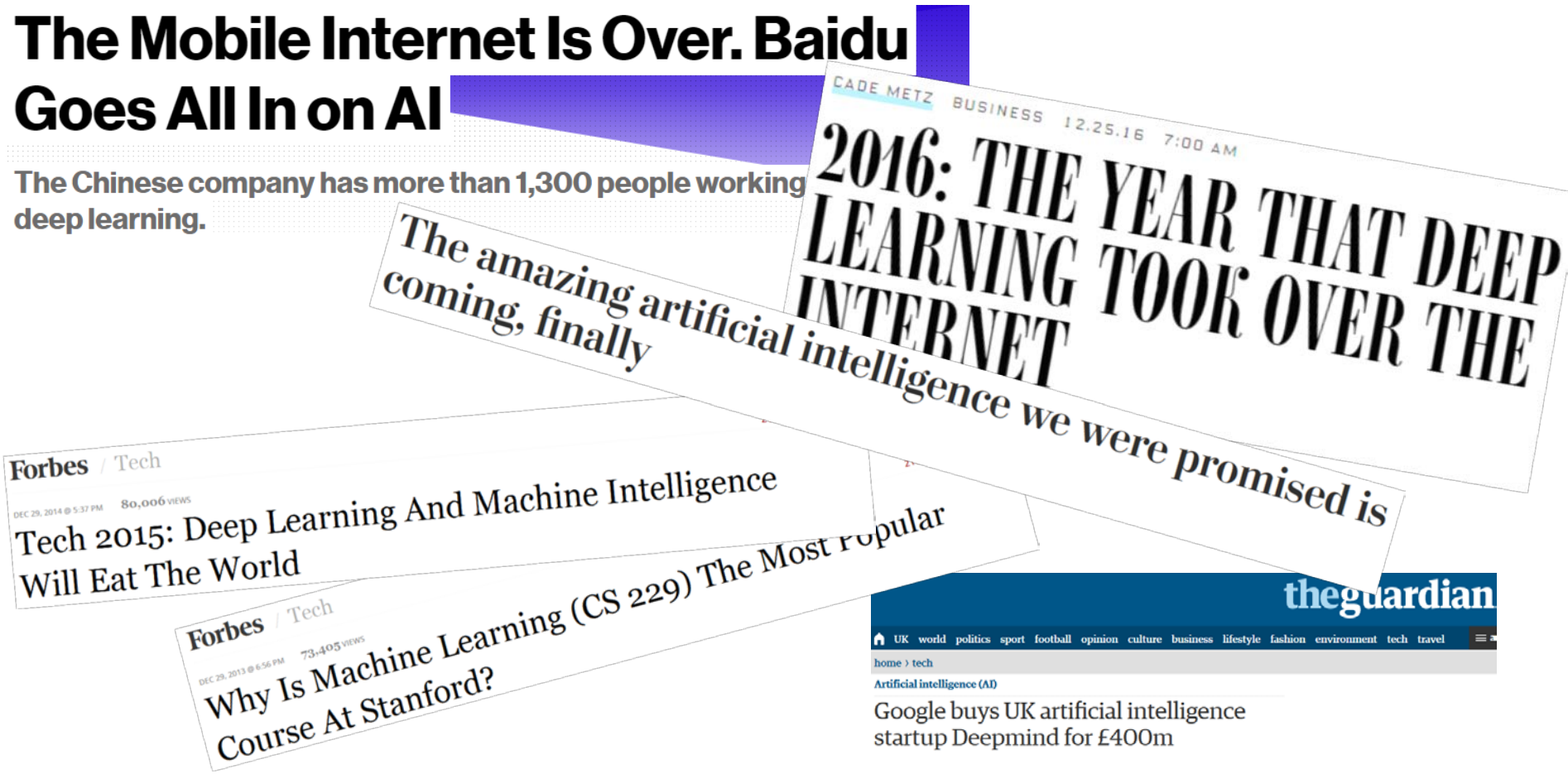


- Established by the government in 1952 to run NUSSE
- **Private** non-profit foundation since 1985
- Financed by:
  - Domestic private companies
  - Public sector
  - Norwegian Research Council and EU grants
  - International companies
- Revenue 100 mill. NOK

NR has three main activities

- Statistical and mathematical analysis and modeling
- Remote sensing, image analysis and pattern recognition
- Information and communication technology (ICT)

Deep learning – a revolution in computer vision

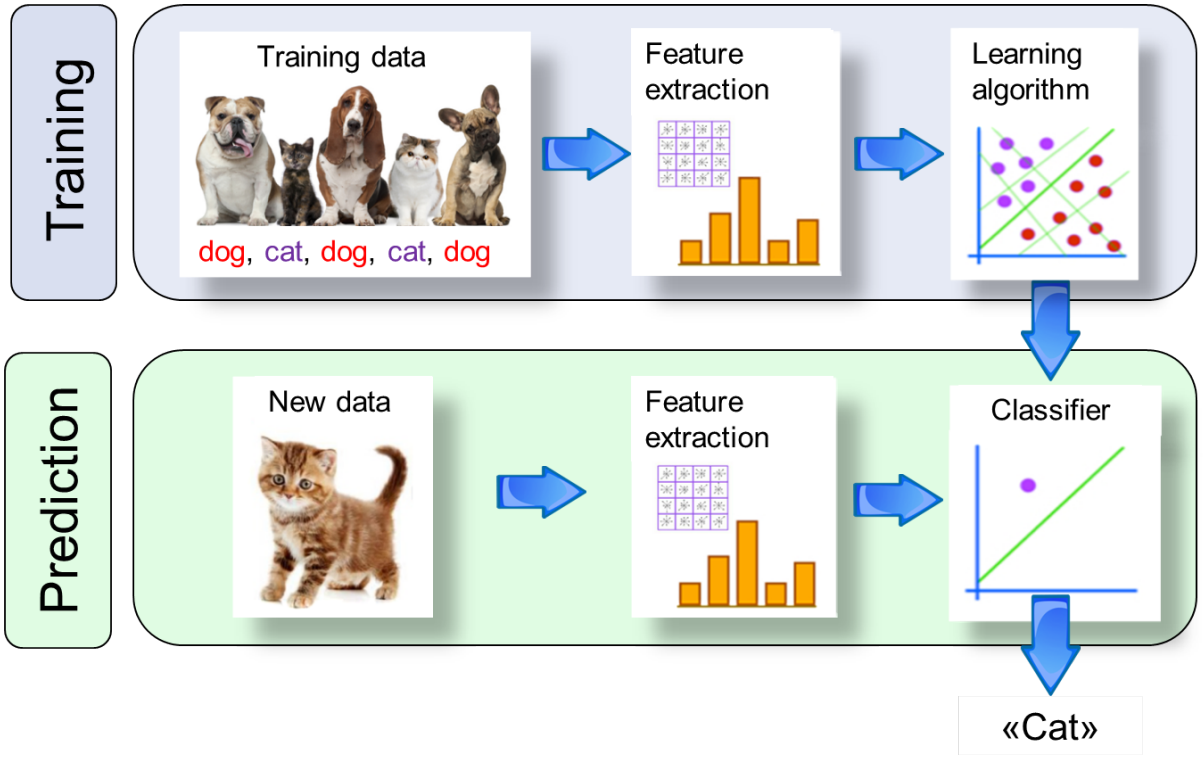


NR Microsoft Azure Google facebook amazon web services Baidu 百度 IBM

Machine learning

Machine Learning is based around the idea that we should really just be able to give **machines access to data and let them learn** for themselves

The “classical” machine learning process



Why the Machine Learning revolution now?

More data

More (cheap) computational power

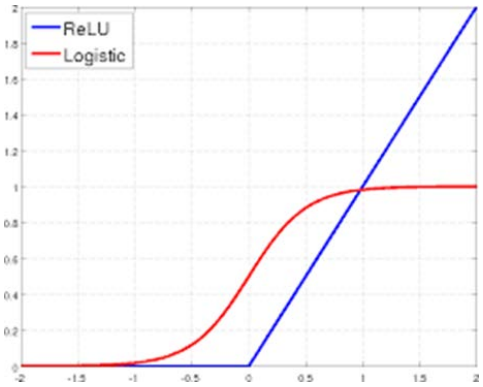
Three persistent Canadians

Hinton

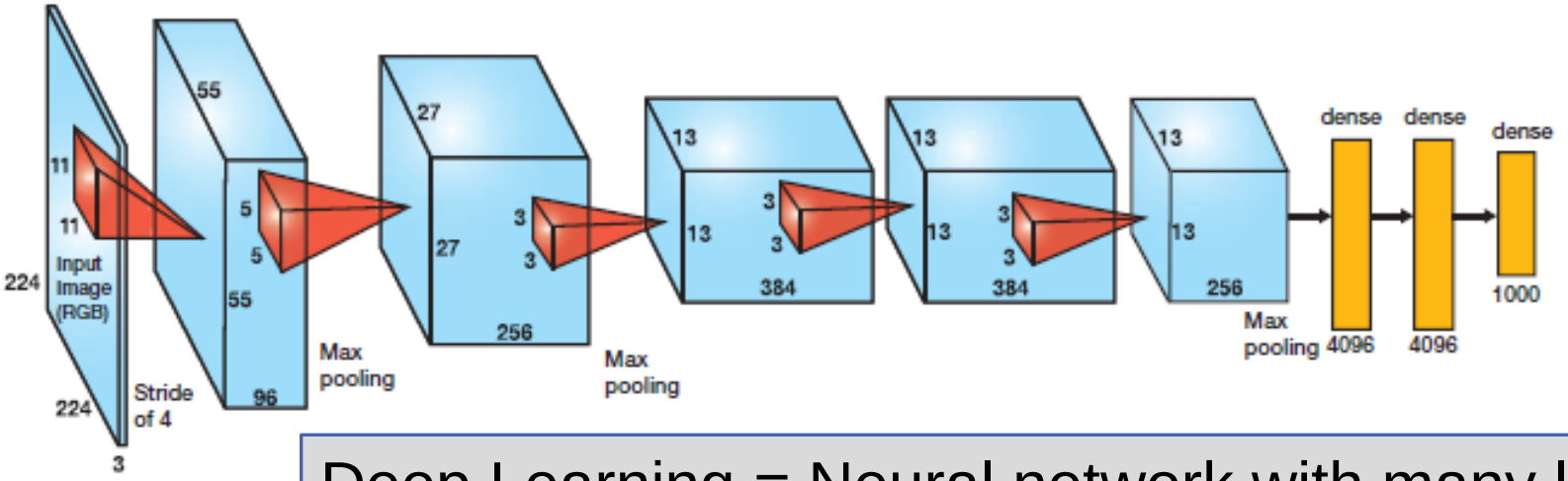
LeCun

Bengio

Some new tricks



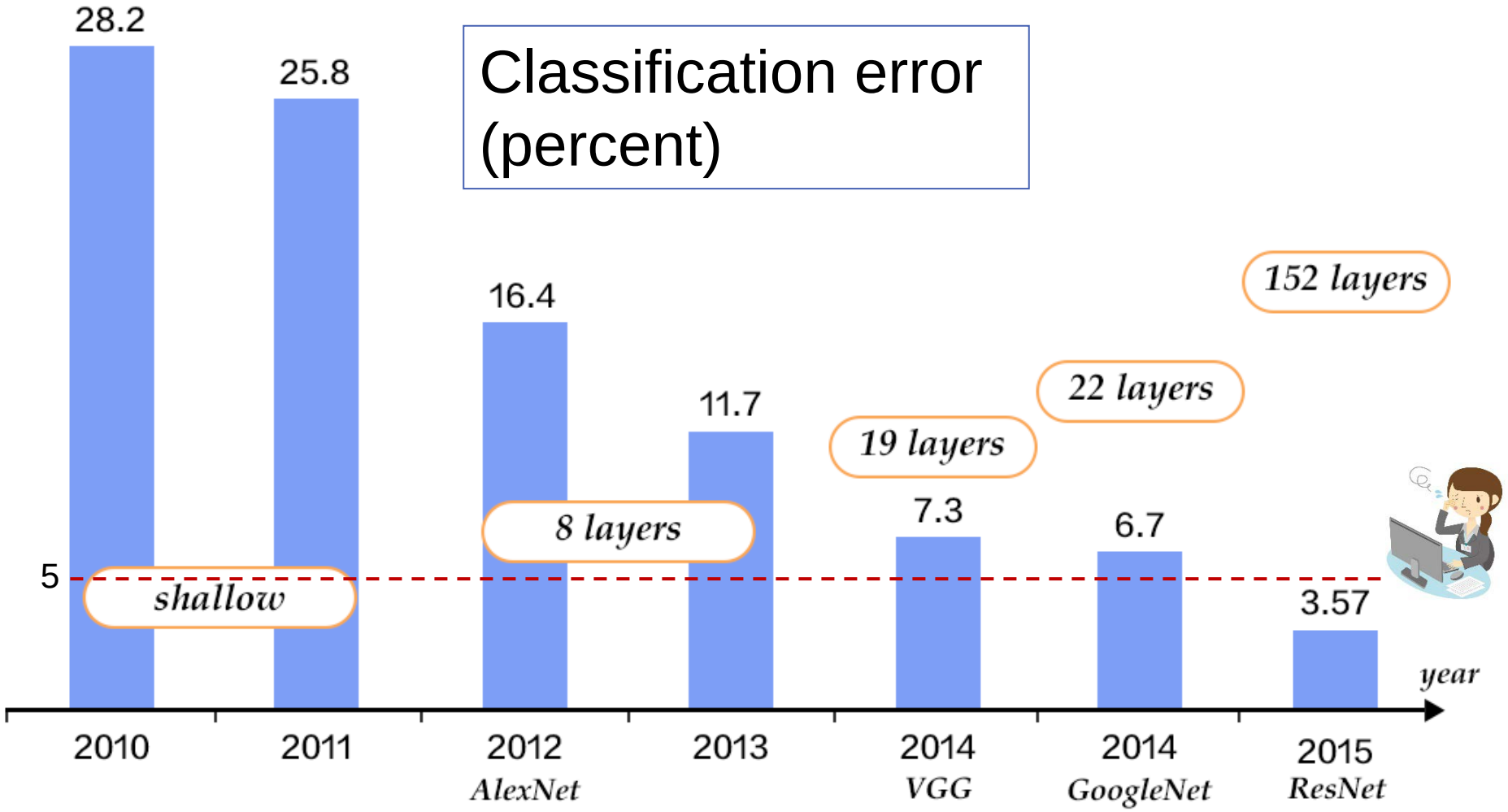
ImageNet 2012 contest winner
(Krizhevsky et al.)



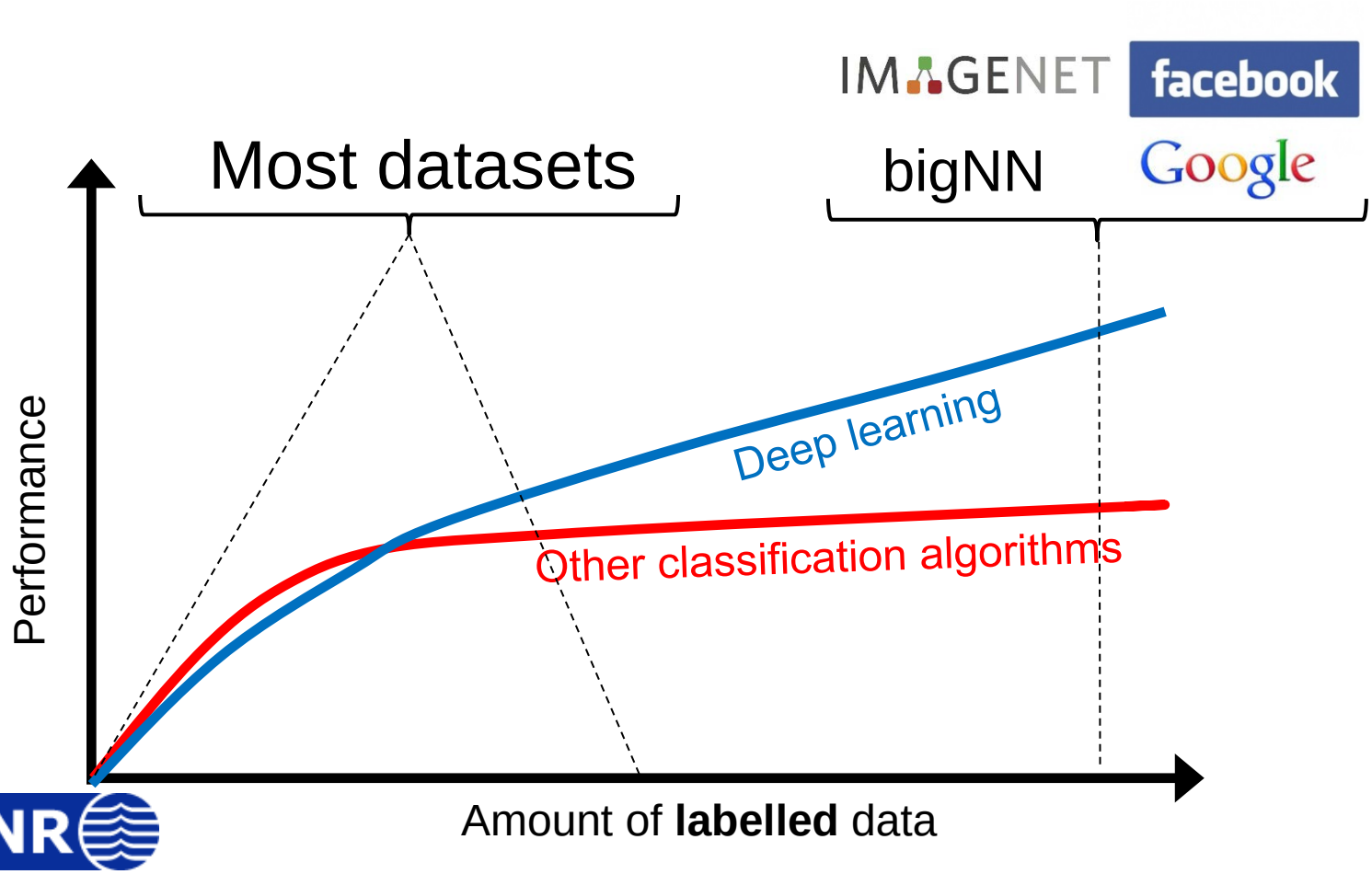
Deep Learning = Neural network with many layers

- Large convolutional neural network
  - 8-layers
  - 60 million parameters
  - Trained with back-propagation on GPU, using all known tricks
- **Error rate: 16 %**
- **Previous state-of-the-art: 26 % error**
- **A REVOLUTION in computer science**

ImageNet Large Scale Visual Recognition Challenge (ILSVRC)

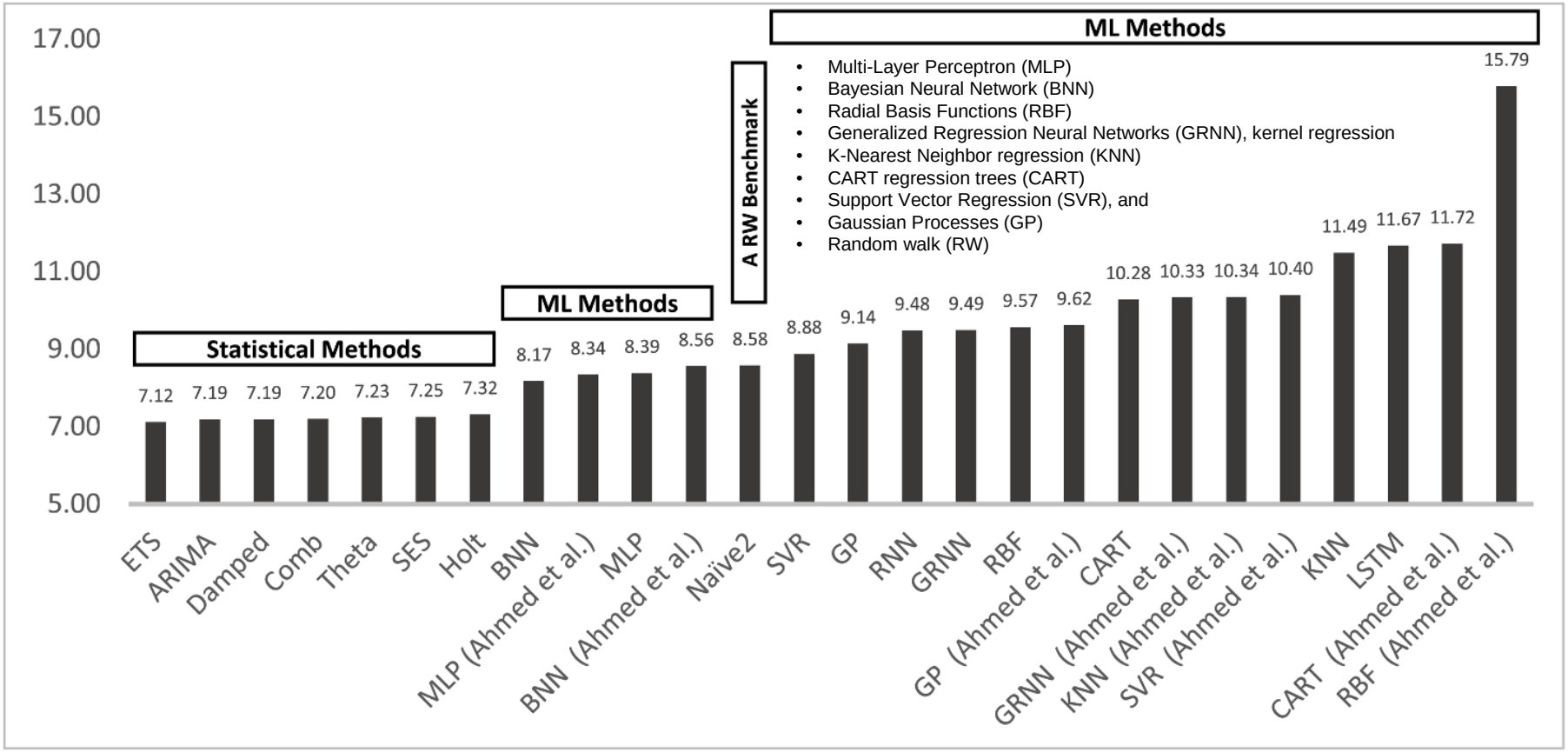


Machine learning performance



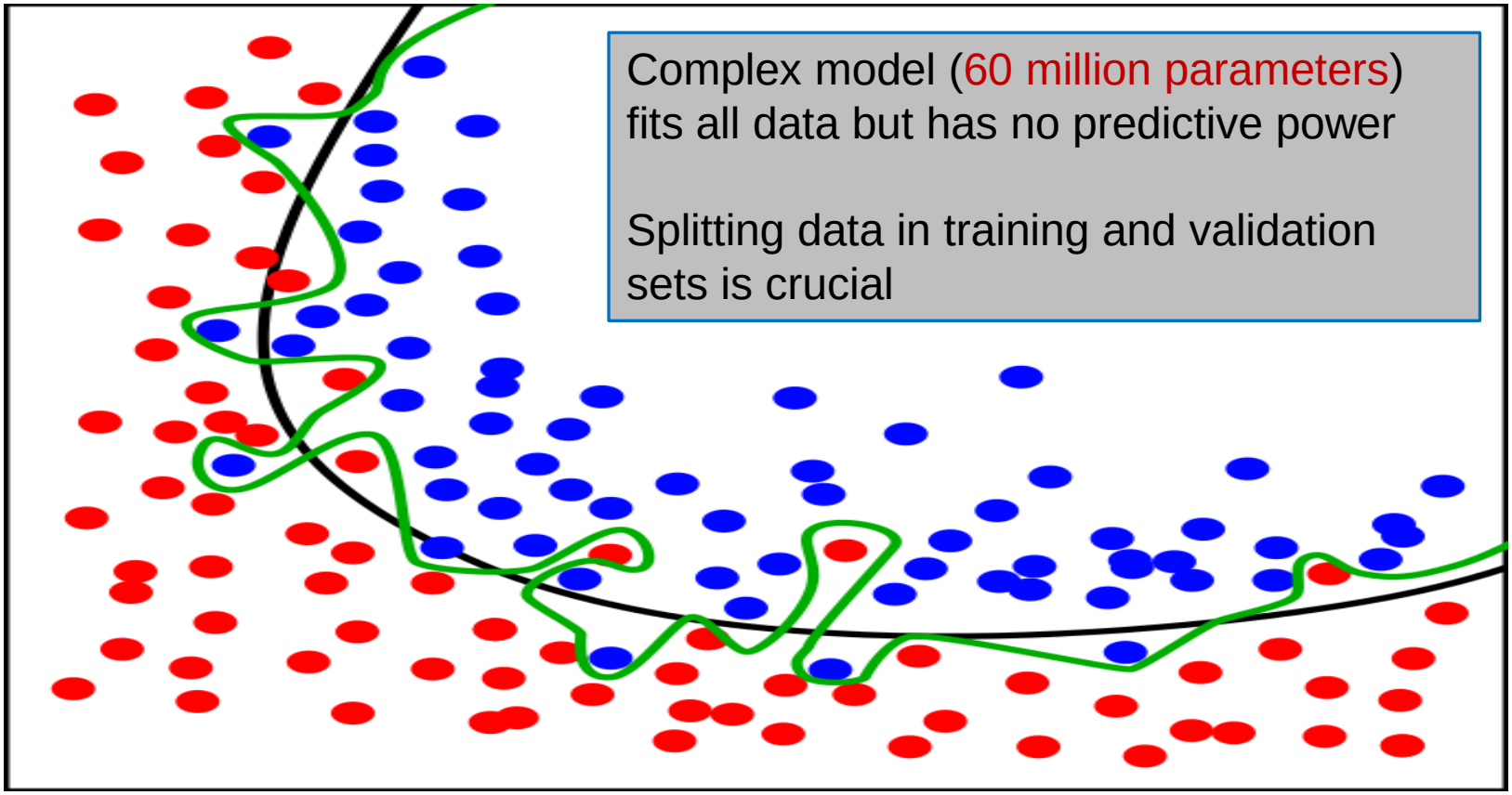
Machine learning (ML) performance

Time series one-step-ahead prediction



Makridakis S, Spiliotis E, Assimakopoulos V (2018) Statistical and Machine Learning forecasting methods: Concerns and ways forward. PLoS ONE 13(3): e0194889. https://doi.org/10.1371/journal.pone.0194889

Overfitting is very common in Machine Learning algorithms



Forskningsrådet

sfi

BigInsight

BIG INSIGHT – Statistics for the knowledge economy

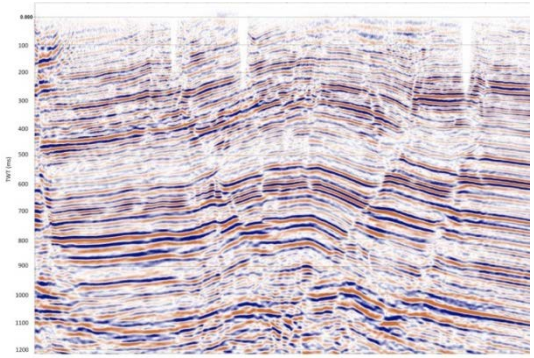
- **Norsk Regnesentral**
- University of Oslo
- Oslo University Hospital
- University of Bergen
- ABB
- DNB
- DNV-GL
- Gjensidige
- Hydro Energi
- NAV
- Skatteetaten
- Folkehelsa
- Cancer Registery of Norway
- Telenor

NR

BIG INSIGHT shall focus on two central innovation themes; deeply novel **personalised solutions** and sharper predictions of **transient behaviours:**

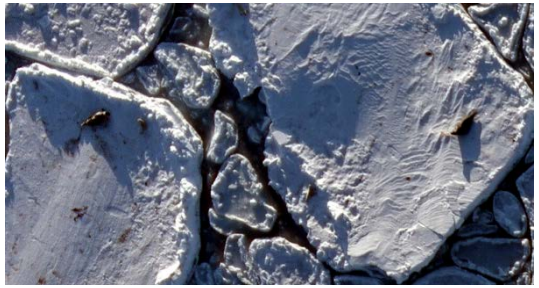
- discover radically new ways to target, towards individual needs and conditions, products, services, prices, therapies, technologies, thus providing improved quality, precisions and efficacy.
- develop new approaches to predict critical quantities which are unstable and in transition, as customer behaviour, patient health, electricity prices, machinery condition, etc.

Machine learning projects at NR

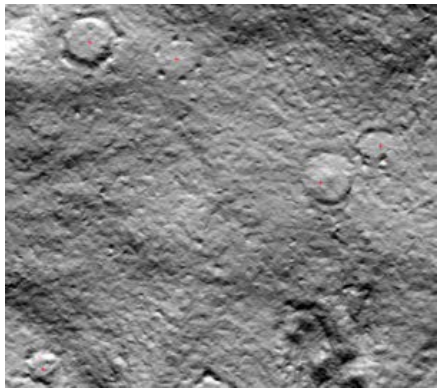


Interpretation of seismic

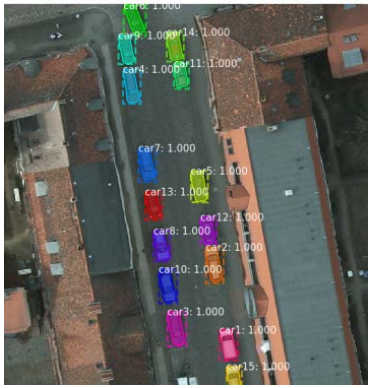
Interpretation of ultrasound



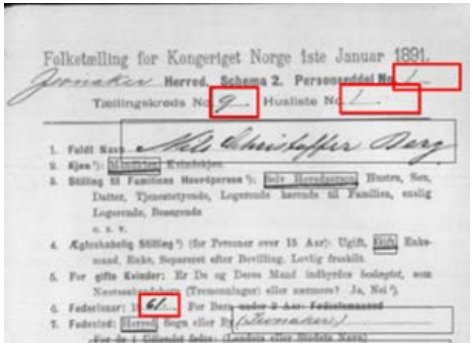
Count seal pups



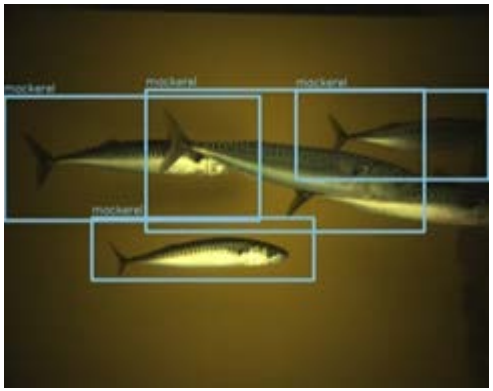
Find cultural heritage



Counting vehicles



Recognizing names in old census



Classifying fish

Choose method that suits the problem

Deep learning

Network analysis

Text Mining

Classification trees

Clustering

Gradient Boosting

Statistical models

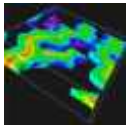
Monte Carlo Simulation

Regression

The SAND (Statistical Analysis of Natural Resources) group

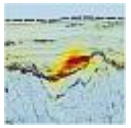
- One of 3 research groups at NR
- Currently 16 persons
  - 9 PhD's
  - 1 PhD students
  - Background from math, statistics, physics, computational chemistry, computer science
- 350+ conference contributions and journal articles
- Main markets are
  - National oil companies
  - International oil companies
  - Roxar Software Solutions
  - National research institutes
  - Public science funding including EU

Main research areas

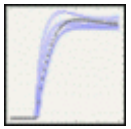


Petroleum reservoir models

Structural geology



Inversion of geophysical data



History matching and dynamic data

Decision support and data analysis

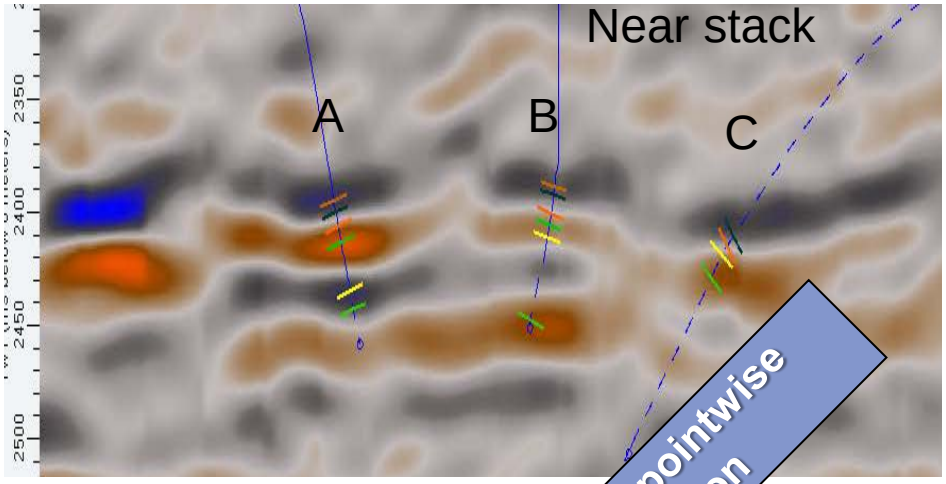
GIG consortium: (www.nr.no/GIG) Geophysical Inversion to Geology

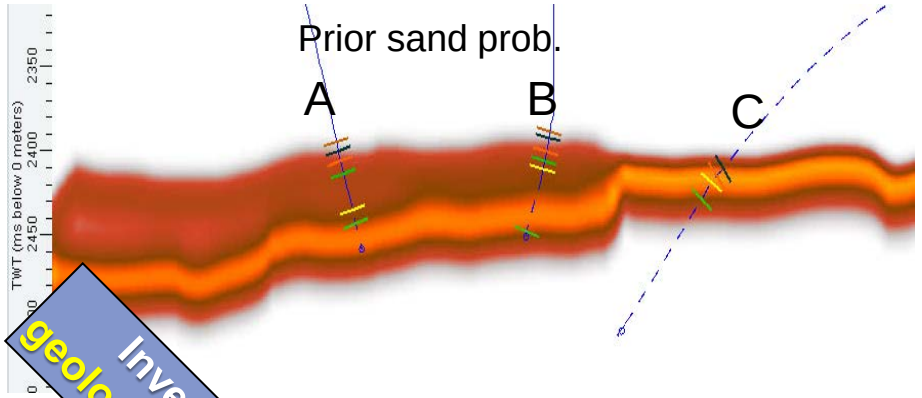
Geophysical inversion is hard:

- **Ambiguous**: Same response from different geology
- **Indirect measurement**
  - E.g. seismic velocities instead of porosity and permeability
- **Uncertainty**
  - Physics model inaccurate
  - Noise

Inversion requires “regularization”:
Restrict the space of possibilities

GIG: Basic idea is to regularize inversion by geological constraints

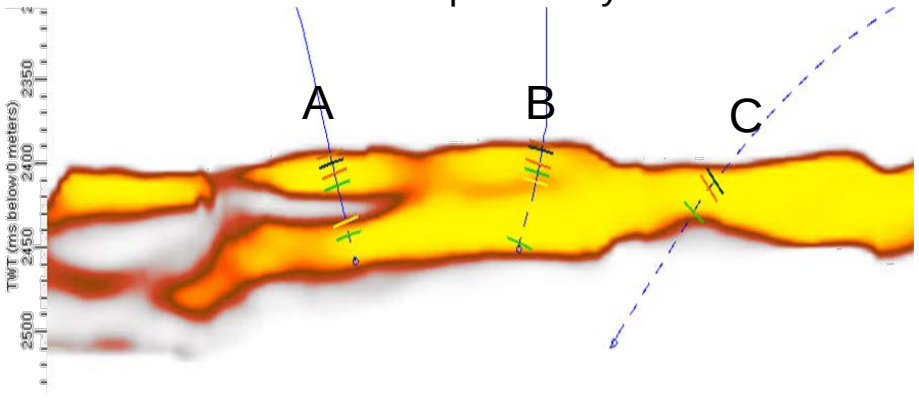




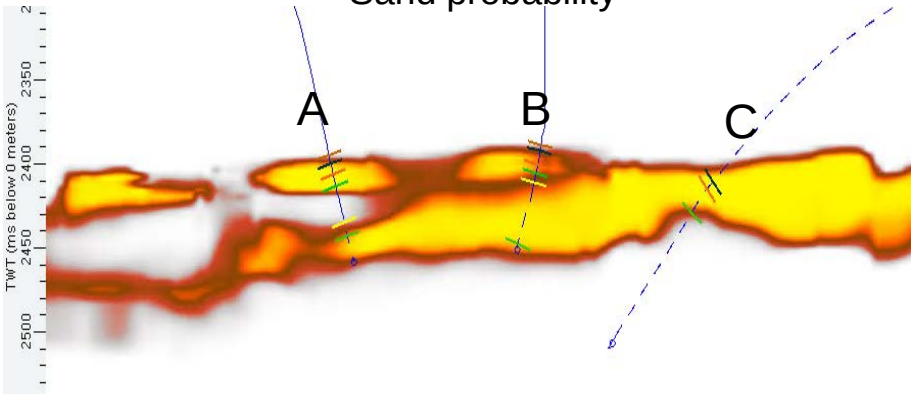
Standard pointwise inversion

Inversion with geological constraints

Sand probability

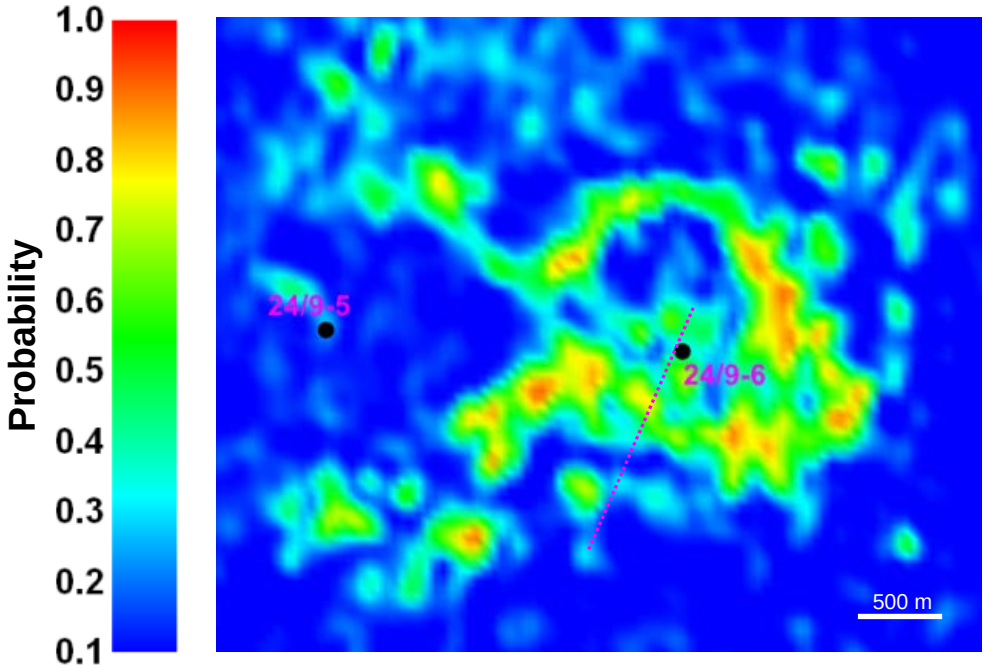


Sand probability

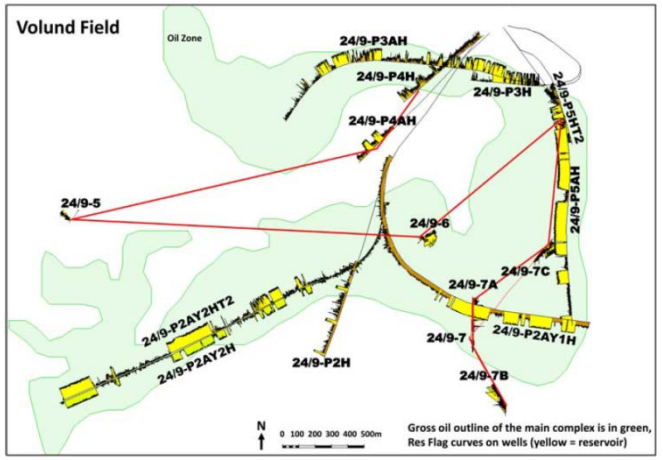


The maximum probability for hydrocarbons

Probability map from inversion

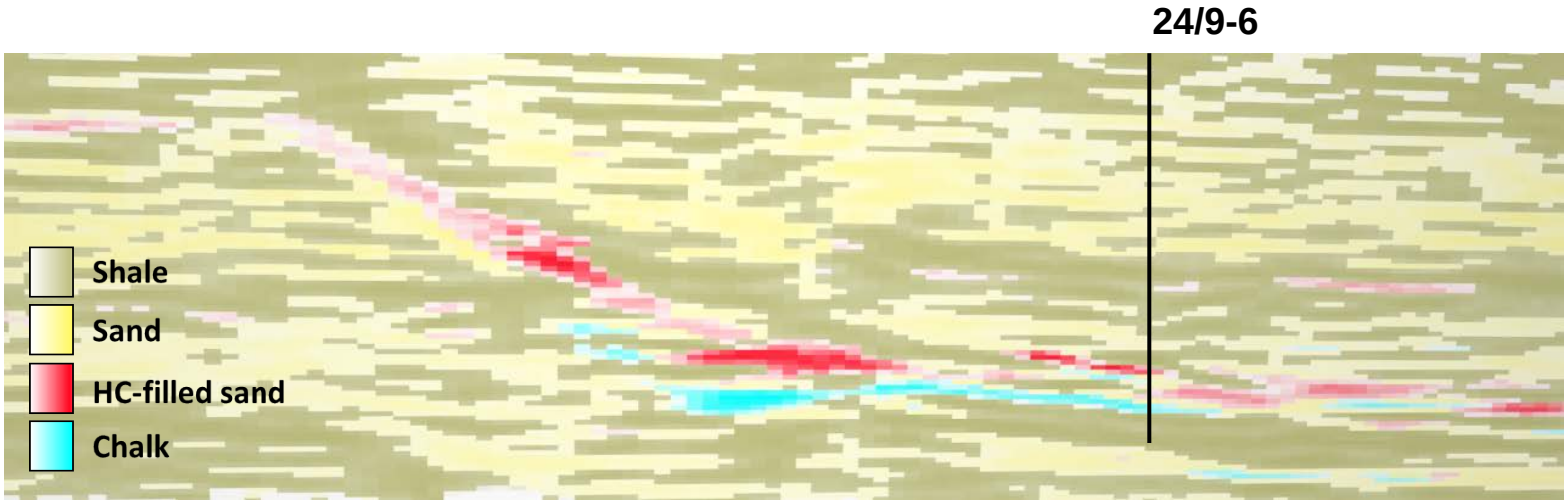


Gross oil outline at Volund (Schwab et al., 2015)



Aker, E., Røe, P., Kjøsnes, Ø., Hauge, R., Dahle, P., Ahmadi, G.R. and Sandstad, O.A., 2017, Probabilistic prediction of lithology-fluid-classes from seismic - A North Sea case study, Presentation at 4th International Workshop on Rock Physics, Trondheim, 01.06.2017

Longitudinal cross section of most probable Lithology-Fluid class



- The hydrocarbon filled sand injectite is evident
- Intense colours are more certain

We have

- Unique competence
  - math/statistics/machine learning/programming
  - long experience in petroleum applications
- Long history of successful projects
  - Research (publications, presentations, PhD's,…)
  - New methods
  - Case studies
  - Commercial software

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Thank you for your time