Machine Learning:

A new toolbox for Theoretical Physics

Juan Rojo

VU Amsterdam & Theory group, Nikhef

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Reinforcement Learning

Reinforcement Learning

So far we have considered **two main paradigms** in Machine Learning problems

Supervised Learning: starting from a training dataset with **labelled examples,** $\{x_i, y_i\}_{i=1,N}$, produce a **model f(x)** that predicts and generalises the info in the training sample.
The labels y_i can be continuous (underlying law is function) or discrete (classification)

Unsupervised Learning: starting from a training dataset with **unlabelled examples,** $\{x_i\}_{i=1,N}$, produce a **model** that takes a sample as input and as output produces the solution of a practical problem, such as **clustering**, **dimensional reduction**, or **outlier detection**

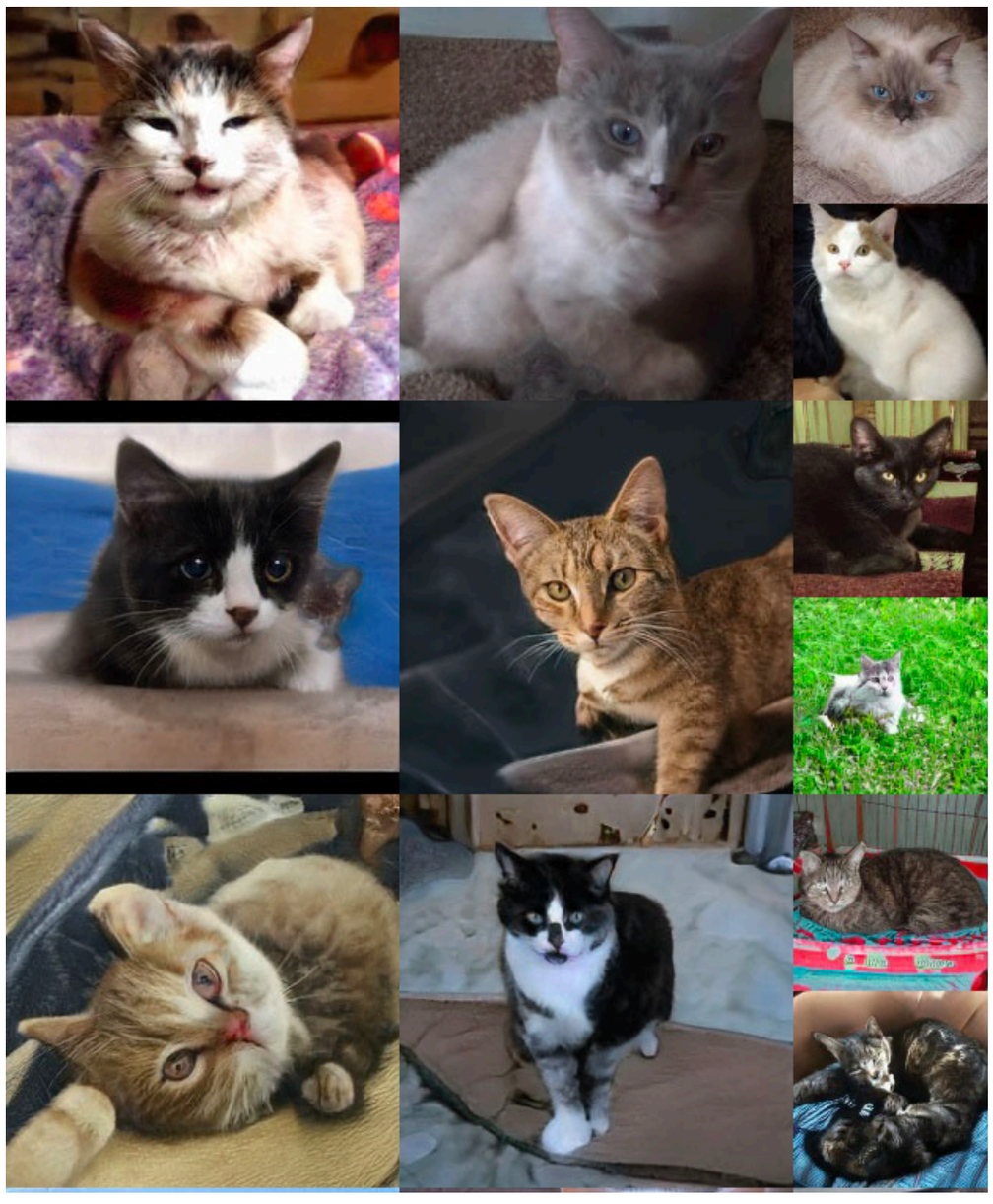
now we want to discuss a **third ML paradigm**

Reinforcement Learning: given a complex task in a complex environment (dynamic, non deterministic, only partly accessible) train an **agent** that carry out **autonomous action** in this environment and complete the requested task

Convolutional Neural Networks

Convolutional Neural Networks

Like physical systems, many datasets and supervised learning tasks also possess additional **symmetries and structure** what can (and should) be exploited



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eg we want to train a classifier to identify pictures of cats. What **high-level features** must one learn first?

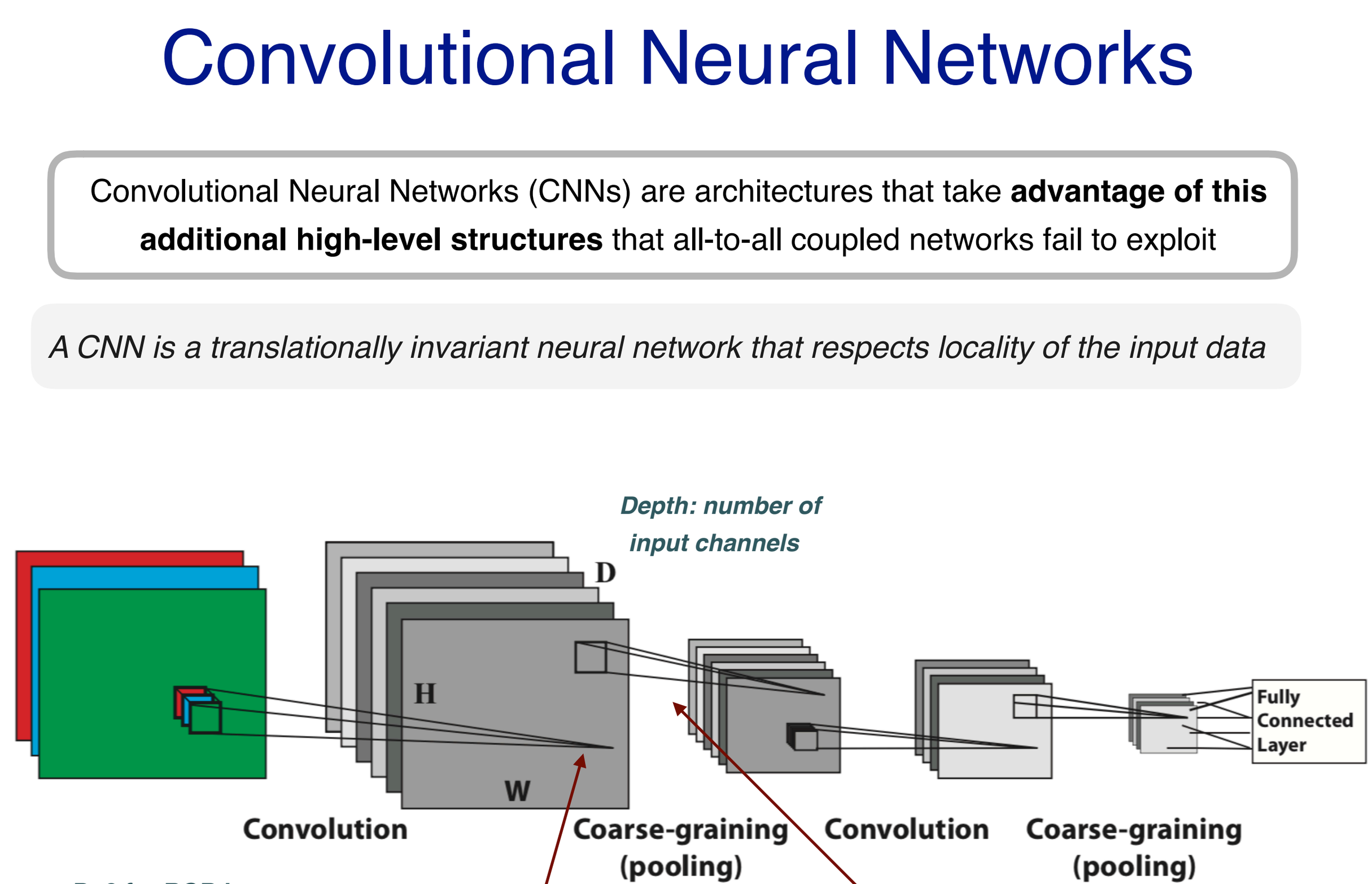
- *The features that define ``cat" are local in the picture: whiskers, tail, paws …: **locality***
- *Cats can be anywhere in the image: **translational invariance***
- *Relative position of features must be respected (eg whiskers and tail shoaled appear in opposite sides of ``cat"): **rotational invariance***

Our classifier should exhibit all these high-level features

Convolutional Neural Networks

Convolutional Neural Networks (CNNs) are architectures that take **advantage of this additional high-level structures** that all-to-all coupled networks fail to exploit

A CNN is a translationally invariant neural network that respects locality of the input data



Machine Learning and Quantum Computation