Cognition:

One need to have Attention, and memory.

Perception action reward cycle

Intelligence

Where does the knowledge come from in humans?

Genetic code

Interaction with the environment

The repository of knowledge in society.

Brain-Body and physical Constraints

Brain is an internal representation system

Function of the brain is to predict for the future.

Brain is a real time system that does the prediction.

Back of the brain is associated with the sensory processing.

Front of the brain is associated with the motor hierarchy.

1/3 of the cortex is dedicated to the vision.

Foveal Vision

Saccades (6 saccades per second)

Vision systems orient through saccades

Ventral Pathway

Dorsal Pathway

Interaction is the consequence of object

Content Addressable Memories - CAM

Phone book is an example of content addressable memory

Hebbian Learning

A picture containing knife, table

Description automatically generated

Kernel CAM - very similar to SVM

Computer vision and machine learning formulate perception as pattern recognition using statistical learning!

Brain can store anything, but it is more important what to store, thus its not the algorithm that decides but the system should do.

What is a learning machine?

Mapper -> cost -> Learning Algorithm

Cost function

Space-Time dependencies

1. Feature with respect to space
2. Features with respect to time

These both needs to be dealt differently.

Static Topology - Convolution Nets

Markov Random fields (latest feature extraction techniques)

Memory in Stochastic Processes.

Stochastic Processes is the random variable at a specific point in time.

Probability of an event at time n, then we need to find all the probabilities from the time 0 to n-1.

Markov Chain helps in the calculation.

Recurrent systems become very efficient because it does not store all the input but only the one that is important to do the required task

LSTM is one of the good systems to extract the information in time.

The way brain works and the way we do in technologies is very different and we should always keep this in time.

Slide number 17/25

Lagrange function

Necessary and sufficient conditions

Optimal Solutions

Optimal inverse temperature (beta)

Bozman machine -

**Variational problems for composite systems**

Type 1: Find optimal p belongs to P(x)

**15th July 2020**

**Making diagnosis or prognosis on the mean might not be sensible to apply on an individual patient.**

Machine learning gives the treatment of a successful young male to a very old female. Which might not be acceptable.

If all the DNA in all the cells are same, then where does the variability come from.

“Noise may creep in”

Lets x can be observed but not y.

Observed random variables and non-observable random variables

A plate.

Value of variables at higher level is independent variable values that are below in the hierarchical.

**17:20**

One book from the professor Pierre Baldi

Self-supervised learning

Compressing a data is in some way understanding the data.

What is finite field in mathematics.

What is convex and why it is important?

Saddle points

How to use NN when the input is of variable size.

Neutrino are the particle that can travel through the earth

SMILES language for chemical bond notation and representation.

SMIRKS

16.07.2020

Structured data provides the context

A tree is partial in order, not full ordered because it cannot be written in a sequence. A sequence is fully order.

Positional trees: Node position is important

State transition function

Close to a sequence is a binary tree.

Generative models are referred as probabilistic tree.

Generative process for a tree.

Vector on multinomial, vectors sum to one: Drichlet

Embedding?

More layers in deep NN is analogous to level of the graph.

Spatial domain and spectral domain

Spatial domain and frequency domain

Neighborhood Normalization in Graph

Erica Salvato 12:10 PM

So far you've basically focused on training procedures.

However, I think that, from a control perspective, once an agent has been trained, it should be useful to understand its ability to reproduce the same training performance. Therefore, I think that in this case it is necessary to perform a test.

In this situation, how do you usually deal with the stochasticity of learned policy?

If we consider stochasticity, we can only assess the average behaviour of a policy and its standard deviation, which would make a real implementation difficult.

During the test, is it correct, in your opinion, to consider epsilon-greedy policy without exploration (epsilon=0), or, in the case of Gaussian policy, to consider its average as the suggested action for the policy?

Igor Babuschkin 12:52 PM

Great question! There is no general answer for how to best evaluate the learned policy. You are right that the stochastic policy used during training will often have a worse performance, so it makes sense to modify the policy. In the case of Q-Learning the idea is to use the greedy policy at test time. For policy gradient algorithms we can reduce stochasticity by reducing the temperature of the softmax, or by using the mean in the Gaussian case).

Often that policy will have higher scores which justifies using it. There can be environments where using a deterministic policy is sub-optimal though, so it can’t be a general answer.

More work needs to be done on properly splitting the RL training into train and test regimes in my opinion.

Ghulam Mudassir 12:11 PM

If we have many states (like in 1000’s or millions ) so which algorithm is recomended Q-learning or DQN ?

Igor Babuschkin 12:55 PM

Q-Learning is just a part of the whole algorithm because it leaves out how to parameterize the Q function. DQN is a “full” system in the sense that it takes the idea of Q-Learning and adds the missing parts, like the network architecture. DQN should perform much better than simpler approaches (e.g. Q-Learning + linear regression) if you have many states, since the neural network can create useful representations that help make the policy make better decisions.

Fatemeh Nazary 12:18 PM

Hello, thanks for the very interesting lecture. My area of research is withing multimedia conversational systems. Do you think RL and Deep RL technique can be used to build conversational systems? In what way they can be beneifciall? can RL be used for building multi-modal interactive systems?

Igor Babuschkin 12:59 PM

In principle I think it’s possible, but we would need a reward function and sufficient data (interactions).

The multimedia aspect could be handled through carefully designing a good network architecture, but this can be super difficult depending on the types of media you are dealing with. Text is easier than videos for example.

RL could in principle allow the model to become “better” than a dataset of human interactions (where the meaning of “better” depends on what you want to do).

A big issue with using RL is data collection, because current RL algorithms are still very data hungry. So naive data collection from interacting with humans might be too expensive. Some clever ideas might be needed here.

15:00

Bayesian Hierarchical Models

Single-cell ‘omics

Omics comes from Greek meaning the complete complement.

Mixture model

17:20

Most of the knowledge in statistical form

Q-learning

Reinforcement Learning

Partially Observable Tasks

Benchmark tests

Genotype and phenotype

30,000 genes in a human

­­­We do not have simulators for patients to test the treatment on

Medical researchers have collected 500 patient data in Norway, from musculoskeletal disorder (MSD) questionnaires with more than 100 variables. Medical experts are not confident why a treatment plan worked. Thus, we do not have any labels.   
Also, to test a prescribed treatment plan we need to wait for couple of months when a patient got better. However, it may so happen that patient’s lifestyle changed meanwhile which lead to their betterment, instead of the treatment prescribed.  
Kindly share your views on how to approach such a problem, from real world, to assist physiotherapists to do treatment planning in the process of decision making.

17.07

10:00

Monte carlo tree search

Horn Clause

Taking the negation of the premis

Establishing isomorphic between logic and math

p-norm

Gødel T-norm

A picture containing knife

Description automatically generated

Here x is internal representation of an animal.

X could be an image, value, name, etc.

A screenshot of a cell phone

Description automatically generated