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CHAPTER 1

INTRODUCTION TO SEMINAR TOPIC

Introduction to Seminar:

Artificial Intelligence is a concept that has been discovered and tweaked since around the 1940s. Under AI we have Machine Learning where we work with statistics and algorithms. Finally, we have Deep Learning under ML where we deal with deep concepts like image and speech recognition.
Branches of Automation

Introduction to RL and DRL:

Reinforcement Learning is a subfield of machine learning that teaches an agent how to choose an action from its action space, within a particular environment, in order to maximize rewards
over time.
When Deep Learning is integrated with RL it is known as Deep Reinforcement Learning. It is seen in many real-world applications around us like games, recommendation engines for famous e-commerce websites, video-streaming platforms, etc.
This seminar will mostly cover the application of DRL which is used in recommendation systems. Recommendation systems are something that we all come across daily from recommendations on Google maps to OTT services like Netflix, Amazon. Increasing watch time for video streaming platforms or increasing sales for e-commerce websites can be done by self-supervised recommendation systems. Multiple factors like the interactions between users and items are taken into consideration. Recommendation systems can be enhanced by RL by concentrating on the interaction between the agent i.e. the user and the environment i.e. the website. Resulting in maximizing the cumulative reward for the agent based on the interaction.
This seminar focuses on how reinforcement learning and deep reinforcement learning work and their use in 2 states of art recommendations frameworks namely Self-Supervised Q-learning (SQN) and Self-Supervised Actor-Critic (SAC).
Objectives of this seminar include gaining a good understanding of MDP and applying this knowledge to understand the 2 recommendations frameworks mentioned above.

CHAPTER 3

Reinforcement Learning & Deep Reinforcement Learning

Reinforcement Learning is a Machine Learning method that deals with how software agents should take actions in an environment.

Reinforcement Learning is a part of the deep learning method, This helps to maximize some portion of the cumulative reward. This neural network learning method helps to learn how to attain a complex objective or maximize a specific dimension over many steps.

Markov decision processes

In MDP, there is an agent that interacts with the environment that it is placed in. The agent gets a representation of the current state of the environment sequentially over time. Based on the state, the agent chooses a particular action which leads to a change in the environmental state, and the agent is rewarded as a cause of the action that it took.

There are 5 major components involved in an MaDP:
Agent
Environment
State Space (S)
Action Space (A)
Reward Space (R)

The process of transitioning from one state to another happens sequentially over and over again. Throughout this process, it is the agent's goal to maximize not just the immediate reward, but the cumulative rewards it receives over time

At each time step t, the agent receives a representation of the environment's current state $S_t \in S$. Based on this state, the agent selects an action $A_t \in A$. This gives a state-action pair for time t as (S_t, A_t).

Time is incremented to the next time step t+1, and the environment is transitioned to a new state $S_{t+1} \in S$. At this time, the agent receives a numerical reward $R_{t+1} \in R$ for the state-action pair (S_t, A_t).
The following diagram (fig 1) illustrates the above-mentioned algorithm.

Markov decision processes

Expected Return

The goal of the agent is to maximize the total rewards which can be represented as the sum of future rewards till the last time step T. This is called the expected return denoted by G. G is given by

G = Rt+1 + aRt+1 + a2 Rt+1 + ...
G = k = 0∞akRt+k+1

Where Rt is the return at time t and a is a number ranging from 0 to 1.

Policies and Value Functions

A policy is a function that maps a given state to probabilities of selecting each possible action from that state. It is denoted by π. If an agent follows policy π
at time t, then π(a|s) is the probability that At= a if St, = s. An optimal policy is a policy that gives the highest expected reward among all the policies.

Value functions give a measure of how good a particular action is. This is achieved by using an action-value function which is denoted by qπ. The value of action A in state S under policy π is the expected return from starting from state S at time t, taking action A, and following policy π thereafter is given by

qπ(S, A) = Eπ[k = 0∞akRt+k+1 | St, = S, At= A]

An optimal state value function is denoted by q* and is defined as

q* = max qπ(S, A)

q*must always satisfy an equation called as Bellman Optimality Equation which is given as

q*(S, A) = E[Rt+1 + a*max q*(S', A')]

S' and A' denote the next state and action respectively. This equation ensures that the agent is following an optimal policy and the next state S' will be the state from which best possible action A' can be taken at time t + 1.

Working of Reinforcement Learning:
Consider the scenario of teaching new tricks to a dog.
As a dog doesn't understand English or any other human language, we can't tell him directly what to do. Instead, we follow a different strategy.

We emulate a situation, and the dog tries to respond in many different ways. If the dog's response is the desired way, we will give him food.

Now whenever the dog is exposed to the same situation, the dog executes a similar action with even more enthusiasm in expectation of getting more reward(food).

That's like learning that a dog gets "what to do" from positive experiences.

At the same time, the dog also learns what not to do when faced with negative experiences.

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