# Lecture\_5a

Hello and welcome to the first lecture in this week. We are going to be discussing reinforcement learning. In this lecture video, we're going to look at: recap of machine learning, what is reinforcement learning, applications of reinforced learning, the environment as it relates to reinforcement learning. That is the real environment, simulated environment, the agent in reinforcement learning and the policy in reinforcement learning.

The three popular broad subfields or subsets of machine learning are: supervised learning, as covered before, unsupervised learning, as covered before and the reinforcement learning. All the subfields or subsets of machine learning premise on making machines, particularly computers, to learn by teaching them what comes naturally to humans or animals. Reinforcement learning problems merely involve learning want to do. That is how to map situations to actions to maximise the numerical reward signal. Essentially, reinforcement learning problems are closed-loop problems, mainly because the learning system's actions influence its later inputs. And this is the most popular definition for reinforcement learning postulated by Richard and Andrew in their textbook Reinforcement Learning: An Introduction. In contrast to supervised learning and unsupervised learning frameworks, which are implemented using static data (data datasets), reinforcement learning works with data from a dynamic environment that is an environment that is subject to changes. The goal of reinforcement learning is not to cluster data (as we've seen in unsupervised learning), nor labelled data (as we've seen in supervised learning). Rather, reinforcement learning focuses on finding the best sequence of actions that we generate the optimal outcome also called the reward. And to achieve this goal, reinforcement learning uses a piece of software called an agent

which explores, interact with and learns from the environment.

Broadly speaking, reinforcement learning can be grouped into two cases: model-free reinforcement learning and model-based reinforcement learning. In model-free reinforcement learning, the agent, that is the piece of software that explores, interact with and learns from the environment, doesn't need to know anything about the environment, but it can still learn how to interact with the environment. And this allows the agent to work in any environment and learn the optimal policy. This is based on the assumption that a policy has access to the observations, rewards, actions and enough internal states of the dynamic environment. In model-based reinforcement learning, the agent employs a model of the dynamic environment or part of the dynamic environment which allows it to explore parts of the environment without having to physically take that action. The models used in model-based reinforcement learning complement a learning process by making the agent to avoid areas of the dynamic environment that are known to be bad and focuses on exploring the rest. Applications of reinforcement learning.

Reinforcement learning can be used to address high-dimensional control problems mainly found in various industrial automation applications such as robotics. Reinforcement learning can also be used in conjunction with advanced contextual text generation models that can be used to design and developed systems capable of producing highly readable summaries of long text as obtainable in text mining. Many financial companies have been using reinforcement learning algorithms to enhance trading and equity. This is often called algorithmic trading. Reinforcement learning is very popular in the gaming industry. As a matter of fact, it is the mainstream algorithm used to solve many games and it is sometimes able to achieve superhuman gaming performances. In reinforcement learning nomenclature, the environment is everything, but the agent. In other words, it is everything that exists outside of the agent, and remember, the agent is a piece of software that explores, interact with and learns from the environment as illustrated. And the environment in reinforcement learning is where the agent sends actions, and it is what generates rewards and observation. At a risk of repetition, the agent is a piece of software or hypothetical entry which performs actions in the environment to gain some reward.

Generally, in reinforcement learning, the environment can be: real environments or simulated environment. In reinforcement learning, the choice between a real environment or a simulation always depends on the situation or the specific application. In terms of accuracy, the real environment offers a complete representation of the actual environment, making it very accurate. In terms of simplicity, using a real environment in reinforcement learning eliminates the need to create and validate a model of the environment. Practical development and validation of models is always time-consuming. In terms of necessity, it might be necessary to use the real environment to build and train the agent, particularly if the environment is constantly changing or difficult to model accurately or precisely. In terms of speed, simulated environments allow simulations to run faster than real time or even to be parallelised to speed up a slow learning process. In terms of simulated conditions, it's much easier and more efficient to model scenarios or situations that would be difficult to test in reality.

In terms of safety, in simulated environments, there is no risk of damage to hardware. Take for instance, simulations can be used to design reinforcement learning-based autonomous robots or drones instead of the physical robots or drones, which may suffer from physical damage during in tests and trials. The agent. Again, the agent is a piece of software in reinforcement learning that determines how to map the states of the dynamic environment to corresponding actions in the dynamic environment. The agent is not explicitly told which actions to take in reinforcement learning. Rather, the agent must discover which actions yield the most rewards by trying, that is via exploration and exploitation of the environment. The first step in the modus operandi of the agent in reinforcement learning is observing the current state of the environment. The second step is, using the observed state, the agent decides which action to take. In the third step, the dynamic environment changes state and produces specific reward for specific actions generated by the agent. The reward and the change of states, that is the new observations are both received by the agent. And following on from the third step, the new information, that is both the rewards and observations receive from the dynamic environment are used by the agents to: determine what specific action taken to obtain specific reward was good

and should be repeated, or if otherwise, that is, if it was bad, it should be avoided.

The policy. Within the agent in reinforcement learning, a function takes in the state observations, that is the inputs and maps them to actions, that is the outputs. This function is called the policy. Given a set of observations, the policy decides which actions to take as illustrated. In reinforcement learning, a perfect or ideal policy would optimally generate the correct actions that yield the optimal rewards. However, for most practical situations, a perfect policy is very difficult to achieve. Even if a near-perfect policy is available, the dynamic nature of the environment, that is any changes it undergoes over time, would still make a near perfect policy based on static mapping to become inefficient over time.

Reinforcement learning algorithms to be discoursed in the next lecture updates to policy based on the actions taken, the observations from the environment and the amount of reward collected.

The agent employs reinforcement learning algorithms to learn the optimum policy as it explores, interacts and learns from the dynamic environment so that, given any state, it will always take the most optimal action, that is the action that will yield the most reward in the longer run. In this video, we have looked at a recap of machine learning, we've discussed what is reinforcement learning. We've looked at some applications of reinforcement learning, such as robotics, text mining, trade execution and gaming. We've discussed the environment in the context of reinforcement learning, that is the real environment and the simulated environment. We've looked at the agent, the is the piece of software or a hypothetical entity which is used to explore, interact with and learn from the environment. And we've looked at the policy, which is a function within the agent.