THE BASE OF AUTOMOTIVE WORLD - REINFORCEMENT LEARNING AND APPLICATIONS

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1.**ABSTRACT:**

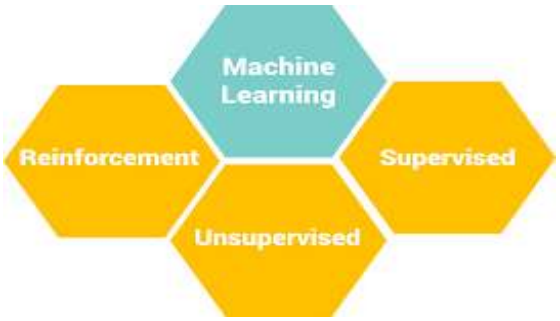
In this era of the modern automotive world, day by day things are getting more and more automatic. Humans are inventing new things to reduce their workload. Nowadays the technology has been so advanced that there are robots everywhere like the robotic arms in the industry to lift highly weighted objects, the well-known human interacting bots like Alexa, Siri, Cortana which take our voice commands as an input and do the tasks which we order them to do. In short, this is an automotive world and what is needed to make things automatic to train them to learn on their own, do the work on their own. This, in turn, gives birth to the concept of Reinforcement Learning. Training such a robot or model which learns by its own to survive or to make decisions in an environment and gives the most optimal solution as an output. This article mainly highlights what is Reinforcement learning and how it can be beneficial for us in our day to day life in this advanced world. This article also contains the applications of reinforcement learning.

2.**INTRODUCTION:**

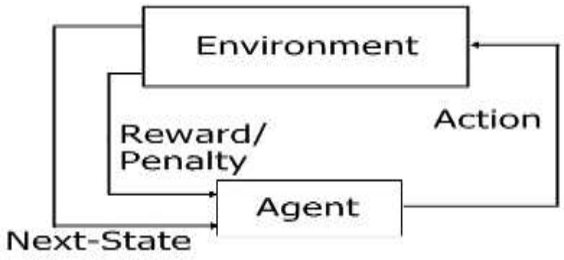
Keywords: Reinforcement Learning, neurodynamic programming, RL applications, self-learning, etc.

2.1 Definition of Reinforcement Learning?

AI says that a type of dynamic programming that trains model using a system containing reward and punishment is called Reinforcement Learning. In an environment, an RL model or agent learns to survive or to take decisions by its own. There are three types of machine learning which are Supervised Learning, Unsupervised Learning and Reinforcement Learning.



If the attempt of the model gets successful, then it gets a reward and vice versa (gets a penalty if it loses or takes wrong decisions).



In this real world, the best example where Reinforcement learning is applied is none other than The Driverless Cars. Let us have a brief idea of RL.

2.2 Reinforcement learning:

Reinforcement learning is also known as Neuro-Dynamic Programming. As the name describes itself, it mainly consists of Neural networks as well as Dynamic programming algorithms (NN + DP). What it does is, it learns how to make better decisions by inspecting their own actions taken earlier. In less anthropomorphic DP terms used in a book called RL by Richard S. Sutton and Andrew G. Barto are "observing their own behaviour" it is related with restoration and to upgrading their agents working in the environment through the mechanism of reinforcement. With the help of DP, we can achieve terms in classical DP like value and policy relation. It relates to schemes to improve the quality of the optimal-cost-to-go or Q factors or optimal policy now it is clear that using NDP is much more advisable to get better performance. As it proves that DP has many limitations which hardly result in better behaviour of the agent. Success is often obtained using methods whose properties are not fully understood. It is proved by the observation that, if once the task of estimation and computing is obtained offline then it will be easier to the agent to work accordingly as well as it turns in better performance of the agent (it gets help in making accurate and fast decisions), and which means it gives us better results in real-time.

The scientists research on the designs which can be able to solve learning problems in scientific as well as economic interest, and then they will evaluate the algorithms through the mathematical approach. And this approach is nothing but Reinforcement learning. The approach should be goal-directed and of interactive nature. The approach we explore called reinforcement learning. And our we do interactions with the environment through this approach.

The invention of a model of RL which is beneficial in solving-learning process in the scientific and economic field in which the computational, as well as the mathematical approach, is used.

With the help of a camera, it is easier to collect the real-time information offered by sensors in it. It is a better way to control traffic. This information can be useful for transportation planning and analyzing user behaviour and much more. For example, in the parking area, we can get to know which parking slot is vacant as well as nearer to our location. And this, in turn, it helps in maximization of the resource and minimization of the load in traffic. But there is uncertainty in the future development of such information (i.e. non-deterministic). However, algorithms which are used in minimal pathfinding problem should consider the new paths which are generated in the learning process.

Fig 1: Finding the best optimal place to park

Fig 2: finding an optimal-go-to path to the destination.

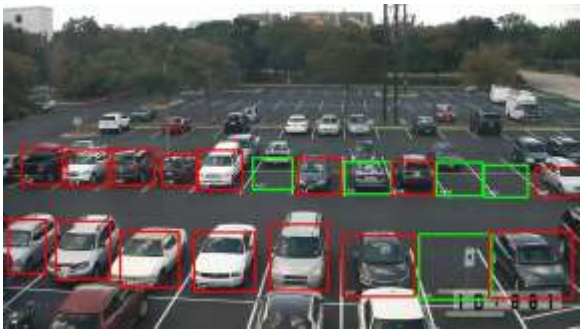


Fig 3: Locating vacant places which are eligible to park

There are two terms in RL that are, Exploration and Exploitation. Exploration is nothing but improving knowledge for long term benefit and on the other hand, exploitation is gaining knowledge for short term benefit. So as to achieve more optimization the model has to follow the static route in its reward-penalty system but when we do so then it may reduce the performance because the environment is changing continuously. To get better performance we must plan the agent's trajectory and it is advisable to calculate its action policies instead of keeping a record of its static routes. It is suggested to follow the trajectory of the agent working in a particular environment which is passed through all the adverse conditions. It is practicable to predict human behaviour on the basis of actions taken by him/her previously in the same type of situation or environment. And to compute these all things Neurodynamic approach offers many tools for such perdition as well as surveys for better results.

2.3Types of Reinforcement: There are two types of Reinforcement:

1. **Positive –**
   Positive reinforcement leads to save rewarding steps and act accordingly. Advantages of reinforcement learning are:
   - Gains better Performance
   - Saves the rewards for a long span of time.

   Disadvantages of reinforcement learning:
   - If one applies a lot of reinforcement then it may occur overloading of levels, which in turn may result in failure or it may vanish results

   2.Negative –
   Negative RL leads to saving the penalties gained by model and it tries not to take that step again which in turn results in better strength of the model.

Advantages:

- Behaviour shoot up
- It keeps resistance in performing minimum standards.

Disadvantages:

- It may result in slow and minimal performance.

- Meta-RL algorithms suffer from poor sample efficiency using on-policy data yet training meta-RL models on off-policy data introduces challenges such as a mismatch between meta-training time and meta-test time.

- To address these challenges, the researchers introduce **PEARL: Probabilistic Embeddings for Actor-critic RL**, which combines existing off-policy algorithms with the online inference of probabilistic context variables:

#What's the key achievement?

- The experimental evaluation on six continuous control meta-learning environments demonstrates that **PEARL** outperforms the previous state-of-the-art approaches in terms of:

- **sample efficiency** by using 20-100× fewer samples during meta-training.
- **asymptotic performance** with the results improved by 50-100% in five out of six domains.

3.APPLICATIONS:

3.1Various Real-life applications of Reinforcement Learning –

- RL offers a great service in the industries which are moving towards automation. As there is a robotic arm for lifting heavy loads, as well as that are tremendously used in the manufacturing industry.

Robotic arm by NVIDIA opening drawer.

- RL has implemented in most of the machine learning areas as well as data processing techniques. It can be used to learn the history of the stock market as well as stock prices of various shares, and this machine learning application can be used as a future market price predicting model.

- There is a teaching-learning system invented for students based on RL which keeps track on the performance of a student and encourages him/her to get the best output through them.

- One of the best examples we can put in our consideration is that A research was going on AI that plays chess game. And after training the model in every possible way in 1997 that robot won against the world chess champion. It was impossible without RL.

- In this modern era, Google has created the self-driving(driverless) car in 2012 which use RL model to learn in

various environments with the help of Computer vision.

3.2 WHAT ARE POSSIBLE BUSINESS APPLICATIONS?

CUBE

- The suggested approach to training an algorithm in a simulated environment might be used to train robotic hands for further applications in manufacturing and warehouse operations.

3.3WHAT'S THE KEY ACHIEVEMENT?

- The robot hand is able to successfully manipulate the Rubik's cube to a solved state:
- 20% of the time for maximally difficult starting blocks requiring 26 face switches.
- 60% of the time for simpler scrambles that require 15 rotations.
- The robot hand is robust enough to deal with perturbations during the manipulation, such as tying fingers together or putting a blanket over the cube.

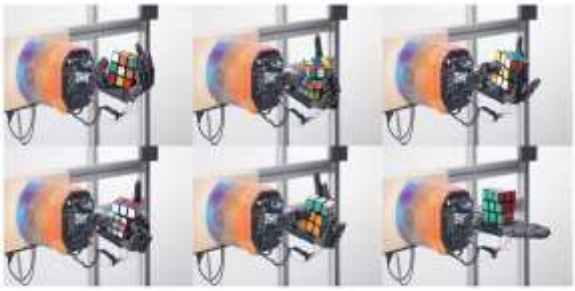


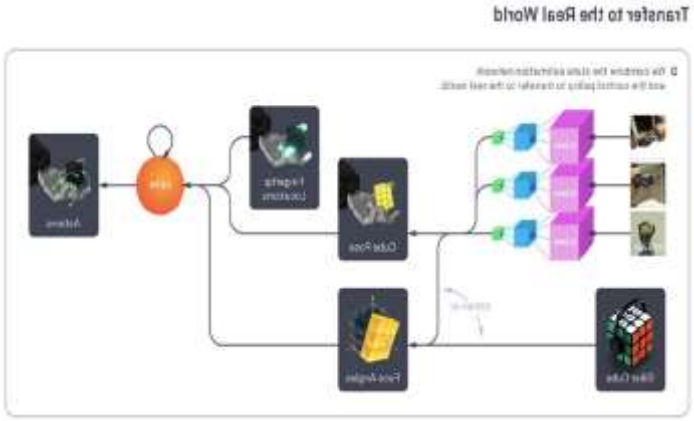
Figure 1: A five-fingered humanoid hand trained with reinforcement learning and automatic domain randomization solving a Rubik's cube.

Fig: There is a Robotic arm which is fully trained to solve the Rubik's cube. Whatever is the condition it will solve it in a few secs.

Formula used:

$$At = \text{Argmax}\,[Qt\,(a) + c.\,\text{Sqrt}\,(Lt / Nt\,(a))]$$

Exploration *Exploitation*



4.CONCLUSION AND FUTURE DIRECTIONS:

4.1Conclusion-

We have carried out this literature survey on Reinforcement Learning and Its various applications in the real world. We had a brief idea that what is The Reinforcement Learning. What is the working nature of an RL model? What are the types of RL? What is the need of RL in this new era? This review paper shows us that how imp is RL in this automotive world. And how necessary it is to adopt this technology in day to day life. This paper also focuses on the real-life applications of RL as well as Business Applications of RL. I have tried to show how interesting is this technology with various fascinating examples as well as pictures.

4.2Limitations of research in this field:

No matter how far this world has progressed, still, the machine has not been able to defeat the entire thinking capacity of the human brain.

4.3WHAT ARE FUTURE RESEARCH AREAS?

- Extending to general-purpose systems that can quickly adapt to the changing environment.
- Improving adaptation to real-world dynamics during the first few moves of the manipulation task can be done by RL.

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