**Faisal Shehzad**

**SP19-RCS-013**

**Report**

Neural network

A neural network is a series of algorithms that are try to identify hidden data pattern in a given datasets by copying the human brain mechanism. Neural network is a system of neurons where they are connected to each other. This system contains input layer, hidden layer and output layer. Input and output layers are single layer but where hidden layers have multiple layers. For complex task, neural network contains multiple layers where each layer performs computation on input data and give output to next layer. However, complicated neural network requires more time and computation resources for training.

**Output layer**

**Hidden layer**

**Input layer**

This is simple diagram of neural network. It has applications in many areas like financial operation, classification of data, product and maintenance and planning. It also has broad applications in prediction and forecasting areas like stoke exchange market and weather forecasting.

**Reinforcement learning**

Reinforcement learning is a machine learning mechanism where we provide training to agents to make decisions in sequence. We place the agent into real environment for training and give reward or punishment in each action. Agent performs actions to reach the goal. It pays penalty or gets reward on each action. We design policy for reward and punishment according to environment nature. Reinforcement learning uses in many areas like automobiles, gaming and many more. Our goal is to maximize the reward to reach the goal.

**Problems with Reinforcement learning**

* **Simulator problem.**

It is easy to create simulation environment for the simple tasks like Go, Atari and Chess games where we do not require any type of safe environment but when we comes human beings and automobiles then safety more important. It is very difficult to create a simulator which works like real environment.

* **Local Optima problem**

It is also major problem in training agent where agent stuck into local optima and think this is global optimal point in learning environment.

* **Reward and plenty mechanism**

We have no other mechanism to train the model. In reinforcement learning, every task uses the concept of reward and punishment mechanism to train model. So that model learns patterns through actual environment.

Turning Machine

Turning machine is a mathematical model which contains infinite length tape on which input given to machine. Machine follows a sequence according to input and reject or accept the input. It has header which move left and right and write anything on tape. It has unlimited external memory to learn desire sequence to reach the final state. In simple words, it follows the sequence to perform actions / pattern. This machine introduced by Alan Turing in 1930. Power of turning machine is equal to now a days computers.

Relationship between turning machine, reinforcement learning and neural network

A turning machine is a subset of computational models. It gives the answer of two questions:

* Is there any machine that determine continue or stops to writing its function on memory tape
* Is there any machine which determines any another machine print symbols on its tape

**Computational Complexity**

**Computational problems**

**Turning machine**

**Problems Aspects**

**Computational Models**

Neural computation is a research area where we analyze the human brain working mechanism. This system applies different sensors on data which codifies the data. We store this codify this data into different memory models like STMT, LTM. All of these computation performs in sequence. Neural turning machine is a recurrent neural network. In recurrent neural network, logical weights are updates on each steps to make improvements in computations which makes this equal to turning machine. As we know in turning machine we performs computations in sequence and result of this computations store in memory. Some researchers suggest that working of turning machine is just like human brain but some oppose this idea.

LSTM is another examples of neural network where just like turning machine we perform computations in sequence and information of these step memory to learn the pattern in data.

Reinforcement Learning Neural Turning.

As in previous sections discussed, turning machine is a concept that is used to designing different models. Reinforcement learning is a machine learning model which use the concept of turning machine. The external memory source likes memory, database, and search engine makes it more powerful. It is prefect turning machines that follows all concept of turning machine. It does not mean it only trained for complex task. Most of hard problems need lengthy and multi-step connections to external environment like gaming, robotics, automobiles and stock exchange market where all steps are performed in sequence and all these learn patterns save in external database.

Computability, Complexity, and Formal Languages

In theory of computation, we talk about finite state, push down automate and turning machine along with formal language which are recognized by all of these machines. Computability and complexity of turning machines depends upon problems which are solved these machines. If we talk about single layer neural network where we require less computational power to solve the problems because single layer network has low complexity. Recurrent neural network, reinforcement learning are neural network model where network has multiple hidden layers. Each hidden layer performs computation on incoming output from previous layer. After computation, forward output to next layer and this working mechanism carry on. All of these steps require high computation to solve these problems. Deep learning neural network (CNN, RNN, LSTM, RL) uses concept of forward and backward probation where high computation power required to perform these task. In 1960, people stops work on neural network because these model has complexity and require high computational power. Then researcher gives concept of GPU which have high computational power to solve the complex task. Theory of computation discuss all these concepts and presents ideas how to solve all of these problems that have high complexity and require high computational power.

Future work

ML – agent is a new plug in **Unity** which is introduced how to use machine learning and artificial intelligent in unity platform. Robotics and self-driving vehicles have big challenge how to train in a real environment where safety is more crucial. Unity introduces this platform so that researchers design virtual environment in unity simulator. This environment just likes the actual environment where training goes in excellent way.

I am going to make simple unity game where agent moves in room and find red carpet. Room environment contains hurdles. If agent views a small wall then take jump and cross the wall. If wall is high then ml-agent ride box and try to cross the walls. For training purpose, we reward or punishment to agent. If agent performs good action then agent gain reward otherwise pay the penalty. This is overall working mechanism in future.

GitHub link for Penguin tutorial implementation

I implement the penguin tutorial following the steps in mention tutorial. During implementation, I stuck many times but Allah Almighty and your guidance helps me.

Below GitHub link which contains implementation tutorial, WebGL file and Report.

* <https://github.com/Faisalse/Assigment4>