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SURVEY ON ARTIFICIAL INTELLIGENCE IN 5G

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Abstract- *Cellular technology 4G has been deployed from many years and reaching all the areas in aim of connecting all the areas to the network. 4G requires additional hardware for each incremental update for the ever increasing need for the network demand as the ICT industry is experiencing overblown need with smart phones. 5G aims at giving solutions to this problem with the use of traffic learning and prediction to increase the bandwidth and performance. To meet the future requirements and needs employing AI will give the network more capability to handle traffic volumes for radio resource management, orchestration. In this survey paper a few approaches of using AI technology in 5G in mentioned which increase the efficiency.*

Index Terms- *5G, Artificial intelligence, sensing, mining, Prediction, Reasoning*

I. INTRODUCTION

The effective use of Information and communication Technology (ICT) is becoming more important for the cellular and wireless technology being used today to improve the world communications. Thanks to annual visual network index(VNI)[1] released by cisco indicates that the data explosion is real and happening, meaning the incremental update of 4G LTE will not be sufficient to meet the demands in 2020. The European mobile observatory (EMO) [2] also has published that mobile communication industry had a total of $170 billion revenue in 2010.

Currently 4G technology is the preliminary interest and discussion in ICT. In just past year 5G has grown into a full fledged solution which has captured imagination of the researchers and engineers. Recalling, Second generation (2G) which came in 1991, aimed at providing digital telephony. Third gen cellular network (3G) which came in 2001, provided mobile internet solutions. Then came the 4G network provisioning an all IP (internet protocol) broad band connectivity.

First, Nowadays due to the randomly changing ICT industry the aggregate throughput by 2020 at link level is expected to be 10 times more than the present threshold. Second, an increasing number of objects are being digitalized to form the internet of things which requires for more strict latency, bandwidth, battery lifetime. [3] This is the necessity to satisfy the enhanced and diversified needs to revolutionize the cellular networks with state of the art technologies.

From the very start, Cellular technology 5G is assumed to be the key enabler of ICT. 5G provides mainly proved three types of services: Extreme mobile broadband (eMMB) with bandwidth and throughput to provide ultra-reliable low latency service (URLLC) and massive machine type communication (mMTC). Although technologies such as massive multiple-input multiple-output (MIMO) is required to increase the capacity of 5G, it is expensive to deploy it. Instead, 5G mainly depends on artificial intelligence to boost the spectrum efficiency (SE) and energy efficiency (EE) providing alternative for radio resource management (RRM), mobility management (MM) and management and orchestration (MANO), and service provisioning management (SPM) mechanisms. Hence it is no longer needed to create dedicated networks for the each and every service. It will be easier to provide varied network slices to end to end devices to parallely satisfy diversified requirement to provide ultra low latency and ultra-high throughput.

There is no doubt in saying that 5G will cater to different services to provide a way to service all of them. It is till challenging and time consuming for the 5G cellular network technology to satisfy the ever increasing demand for the network efficiency. 5G technology combined with intelligence will give the ability to interact with the environment. Hence it is promising the apply AI to 5G to deal with new and emerging complex requirements and deal with new issues. [4]

This survey paper contains a few AI approaches that can be applied in 5G to increase bandwidth and throughput to manage traffic load and differentiated services.

II. APPROACHES

AI can be used for enhancing the performance of the celluar networks by taking note of the key parameters.
The first approach is use of hidden Markov model (HMM) and logistic regression (LR) for sensing. AI makes it possible to sense the variations in network traffic, user demands and possible threats to make better utilization. LR is more suitable for heavy traffic conditions with strict and accurate requirements. HMM is used to detect the status of probability to calculate the future occurrence of anomaly. This helps to detect the network anomaly for events driven by multiple data from hybrid sources.

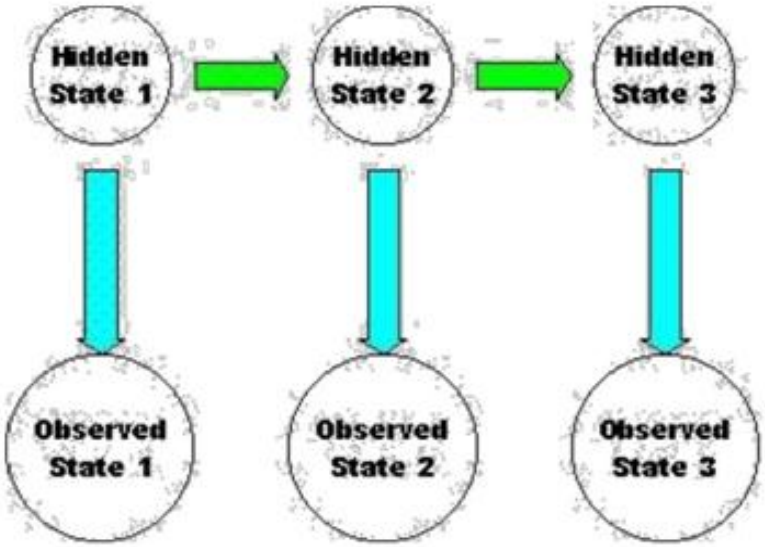

Fig.1. Hidden Markov Model

The second approach is use of AI in mining using supervised learning. Supervising algorithm include spectral clustering, one class-SVM, Replicator neural networks (RNN). Supervising learning depends on labeling quality and accuracy of data to classify services according to the required mechanism and services. For eg, bandwidth, latency, error rate.

Third, Using AI in prediction using Kalman filtering (KL), Auto-Regressive Moving Average (ARMA), Recurrent Neural Networks (RNN), Compress Sensing (CS). KL/ARMA/ARIMA may capture the variations of one time sequence and also have the capacity to find embedded characteristics and leverage the long term dependency sequence. CS is dedicated tool to find the spatial sparsity in mobile traffic and base stations.

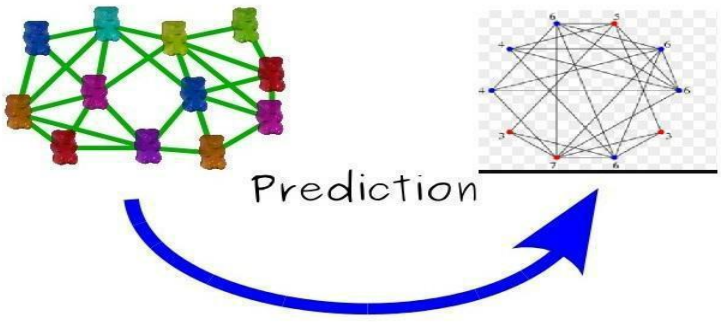

Fig.2. Prediction for network traffic load

Fourth approach is use of AI for reasoning, for configuration of parameters to adapt to services using branch and bound algorithm and actor critic methods. Reinforced learning and transfer learning is also used for the yield of superior results.

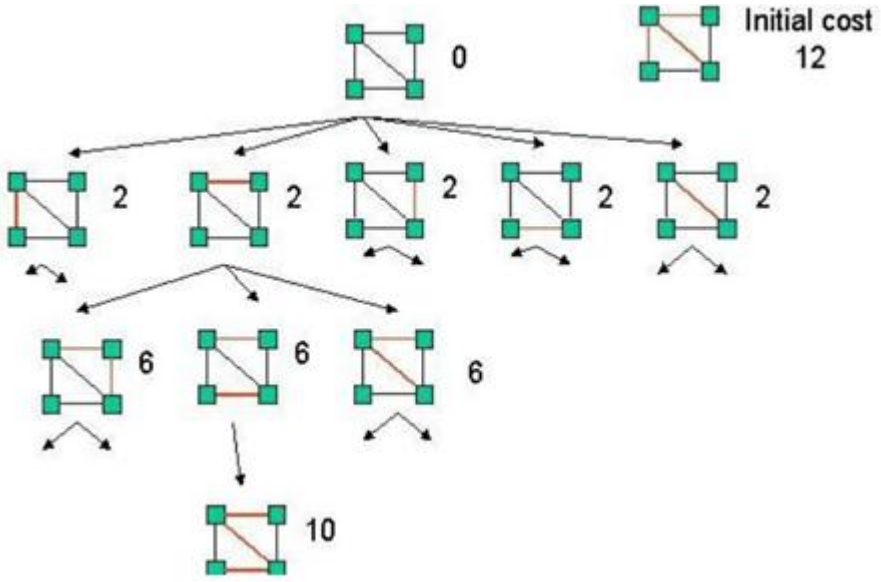

Fig.3.Branch and bound algorithm

Even though dynamic programming is very generalized, AI can exploit it to solve the Bellman equation, based on the complete knowledge of the environment.

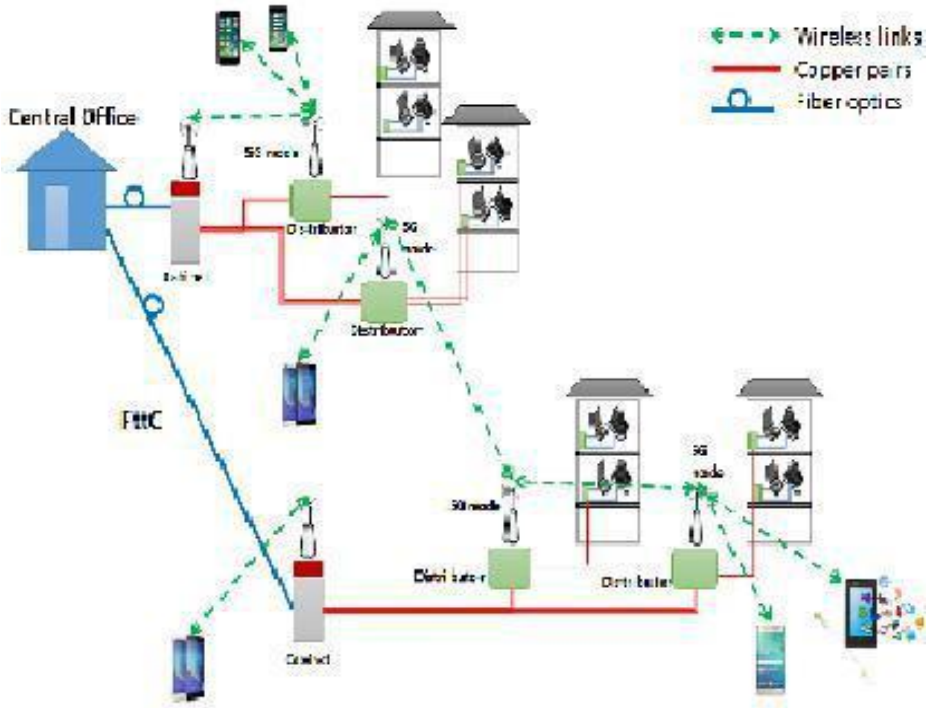

Fig.4.The diagram for mining in 5G

On the other hand reinforcement learning can arrive at the approximate optimal solution for the Bellman equation for without known any knowledge of the surrounding environment prior, by iteratively upgrading, updating its policies and value of the functions.

Using Artificial intelligence in celluar to networks can used implement the following:
1. Service aware for provisioning for differentiated services.
2. UE specific on demand for radio resource management.
3. Location tracking and location awareness for mobile devices
4. Self organization and trouble shooting ability for management and orchestration depending on the need of operator.
5. Network slice auto allocation for end to end networks for service provisioning management.

AI deployed in 5G cellular network will works as an application over the centre of the independent network which will interact with the software defined network (SDN) with open interface. AI will be able to read the service level agreements (SLA), Quality of service (QoS), User end level information, network level information and network infrastructure information from SDN to get in touch with traffic volume. AI will use the modules for sensing, mining, prediction and reasoning. This will provide the 5G network to work under the potential damages compared to the conventional SDN to handle the emergency situations. Thus AI combined with SDN will make it for a multi-tier decision making cellular technology.

III. ADVANTAGES OF 5G WITH AI

5G with AI provides higher reliability in comparison to the traditional RRM by mitigating the weaknesses of traditional 4G in two ways: 1) it prevents the failure by predicting the traffic volumes in the zone for longer time 2) it prevents from simultaneous failures by increasing the throughput compared with traditional SDN

5G uses a special architecture to separate the indoor and outdoor so that penetration loss through walls and objects can be minimized. Using AI following can be done:

1. Minimize the base station energy use when low trafiic is present and increase as per demand

2.Using branch and bound algorithm base station switching can be done efficiently for energy efficiency.

3.AI can used in case of overloading of cellular network, internetworking of heterogeneous networks and supporting subsystems decision making. Thus 5G with AI can satisfy the expected performance along with the technical challenges.

IV. CONCLUSIONS

With the AI paradigm being developed over the past few years to automate 2G, 3G, 4G, we know why it does not meet the requirements of the future needed 5G technology. Mainly because of the proactive design and no knowledge of the end to end devices. With AI empowered 5G cellular networks we can harness the untapped potential of the cellular technology. Depending on the traffic volumes of the network, the AI

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