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# MACHINE LEARNING IMPLEMENTATIONS IN 5G ANDBEYOND


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**ABSTRACT:**

5G is the fifth generation of wireless communication and the future wireless technology paradigm, with the aim of ubiquitous connectivity. In this regard machine learning (ML) is recognized and explored as a promising technology for 5G.The classical and recent ML algorithms based on the method of learning are classified. The paper summarizes and presents the role of ML algorithms in various aspects of 5G and reports their applicability in 5G solutions through individual.



**KEYWORDS:**

**MACHINE LEARNING, 5G, D2D, MM-WAVE, REINFORCED LEARNING, SUPERVISED LEARNING, UNSUPERVISED LEARNING, 6G.**


## INTRODUCTION

Today, 5G wireless technologies are being used in commercial applications all around the world. Academies and businesses have both expressed a lot of interest in 5G advanced technologies.

Inorderto serve a variety of cutting-edge applications like autonomous driving, virtual reality,e-health and sophisticated 5G wireless technologies are constantly evolving. Therefore, it is critical to investigate cutting-edge technologies that could lead to the breakthrough 5G upgraded wireless systems. Artificial intelligence (AI) technology has been widely used in recent years to create new possibilities for challenging issues that can't be resolved with conventional techniques. By learning from prior data and extracting features, machine learning (ML), an important subfield of AI, is able to handle challenging issues. Therefore, there is a lot of curiosity among researchers worldwide [1]. Fig.1. Evolution of the wireless communication throughout the generations,

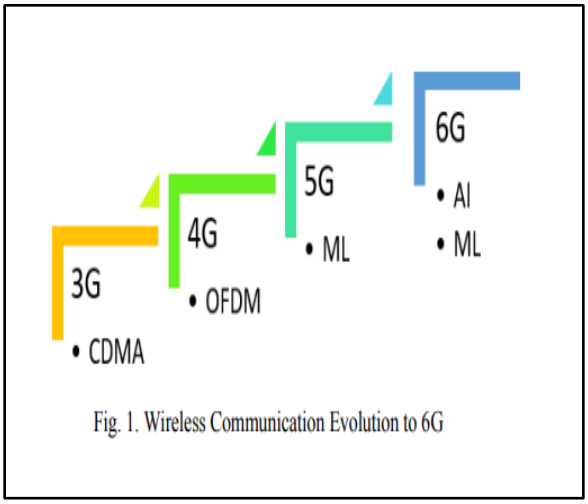


Fig. 1. Wireless Communication Evolution to 6G

## MATERIALSAND METHODS:

### A. CODING AND ADAPTIVE MODULATION

Adaptive Modulation and Coding (AMC) is a potential wireless technology that may modify channel to adapt to fading channel fluctuations, change the modulation order and/or coding rate. However, current AMC implementations are either erroneous due to model-based approximations or difficult due to the vast size of lookup tables. ML has been recommended as a promising choice for optimizing AMC-assisted wireless systems.

The supervised and reinforcement learning are commonly used to build ML-based AMC. k-nearest neighbor (k-NN), support vector machine (SVM), decision trees, and neural network (NN) are the most often used supervised learning techniques.

### B. EQUALIZATION OF CHANNELS

Channel equalization is the most important method for reducing inter symbol interference (ISI) and nonlinear distortions in Communications via wireless means. Because ML can perform adaptive signal processing, ML based equalizers are proposed to improve the performance of classical equalizers. NN-based channel equalizers may extract the key features of time-varying wireless channels and minimize ISI.

[1] Developed an adaptive equalizer based on multilayer perceptron (MLP) that was primarily utilized to decrease ISI for real-valued and bipolar signals over linear channels.

[2] Improved an MLP-based equalizer to equalize complicated signals with nonlinear distortion. Because it lacks hidden layers, functional link artificial NN (FLANN) has lower computational complexity than MLP.

As a result [2] a FLANN-based channel equalizer was presented. A recurrent neural network (RNN) can model a

nonlinear filter with unlimited memory. As a result, it can be used to reduce the nonlinear distortion generated by the channel. [3] demonstrated an adaptive equalizer based on RNN that was applicable for both linear and nonlinear channels.

### C. CHANNEL CODING

Channel coding is used to repair faults and solve the problem of poor wireless channels. Turbo has grown in popularity in recent years. LDPC code and polar code have all received a lot of attention. The channel coding research trend is shifting from minimizing delay to achieving error correction with high accuracy. Deep learning is currently being extensively researched in order to promote the development of channel coding and create a universal encoder or decoder. The original information bit sequence is changed to an encoded sequence in classical communication systems via channel encoding. This mapping is learnable by DNN, implying that DNN can replace traditional decoders. In [6], a DNN-based polar code decoder was proposed. Additionally, DNN can be utilized for joint channel equalization.

### D. BEAM FORMING

5G enhanced wireless communication is expected to boost data rates. As a result, millimetre wave (mmWave). To address the restricted spectrum and severe attenuation, massive multiple input multiple output (M-MIMO) is used. For M-MIMO systems running at mmWave carrier frequencies, hybrid beam forming is a viable approach [3]. [4] Presented a joint spatial division and multiplexing (JSDM) technique for M-MIMO.

Fuzzy NN-based equalizers can efficiently create decision boundaries using received signals [4]. Deep learning neural network (DNN) equalizers have strong representation capabilities and can support robustness in equalization [5].

### E. LOAD FORECASTING

Because 5G advanced wireless networks will employ higher frequencies to meet strict application demands, there will be more to cover the same region as 4G, base stations will be deployed. As a result, energy conservation has emerged as a critical issue in addressing the high energy consumption caused by crowded base stations. However, standard energy-saving measures based on current load rather than future demand are insufficiently accurate, which may result in the Ping-Pong effect. As a result, load prediction is required to increase energy-saving performance. The cell activation and deactivation system based on load prediction has piqued the interest of researchers, and it is a helpful method for achieving energy savings [5].When a specific cell's projected traffic load is less thanthe application of ML algorithms in load prediction has grown over time. The ARIMA approach, which uses an auto regressive integrated moving average, makes load prediction easyand it has been used frequently. To achieve prediction, this plan is mostly on time series analysis.

[4] Presented an energy-saving cell switch method based on ML-based load prediction. The simulated power consumption results given in the bar chart has been demonstrated, using this technique can greatly minimize cell switch-off duration and energy usage.

In other words, utilizing ML algorithms can enhance load prediction accuracy and shut off cells in time to accomplish energy savings, this design produces satisfactory performance with little impact on the indicators.

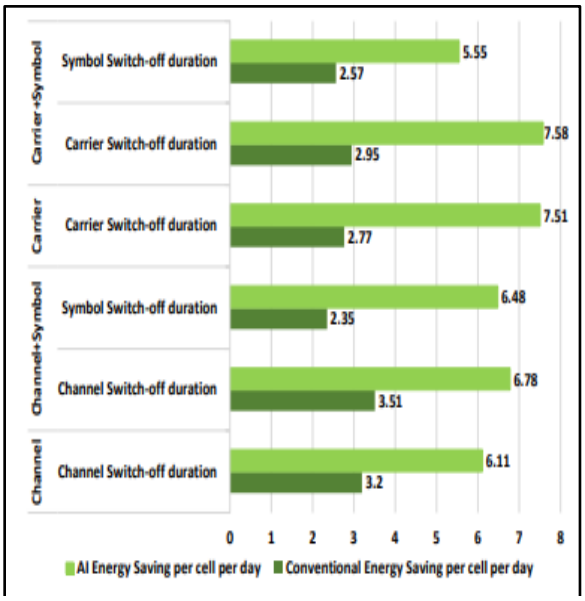


**FIG.1.SIMULATED POWER CONSUMPTION RESULTS**

Similar to the ARIMA model, the model can also be used to anticipate load. Decision tree learning-derived load prediction can be improved with the help of random forest (RF), which can choose specific features. ARNN-based architecture with several memory cells, long short-term memory (LSTM), is appropriate for load prediction. Multiple models can be linearly combined through ensemble learning (EL) to create an ensemble model with high predictive power. The load forecast performance comparison from simulation is shown in Fig. 2.

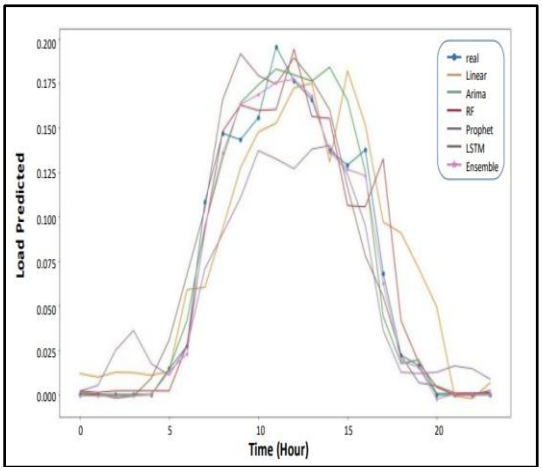


**FIG.2.COMPARISON OF LOAD PREDICTION USING DIFFERENT ML ALGORITHMS**

### F. TRAJECTORY PREDICTION

To support the dense base stations for 5G advanced wireless systems, a lot of tiny cells are needed, which will result in a rise in handover frequency. Users might frequently need to switch between cells, which would result in high latency and reduced throughput, which will eventually damage network performance and load to user discontent. Therefore, in order to improve network management and resource allocation as illustrated in Fig.3, it is essential to achieve trajectory prediction of users. The target base station can optimize network setup and resource allocation for the incoming user to increase service quality and resource utilization rates if accurate trajectory prediction is supported by the network.

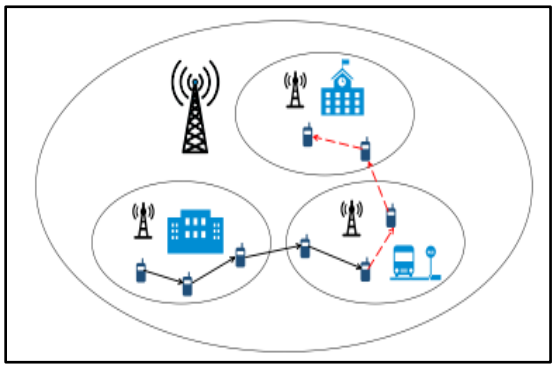

**FIG.3.NETWORK MANAGEMENT AND RESOURCE ALLOCATION**

### CONCLUSIONS AND FUTURE DIRECTIONS:

In this paper, we discuss the applicability of ML in successful 5G deployment. We present a classification of the ML algorithms into three principal categories, based on the training method. Further, we comprehensively present the relevance of ML algorithms and their applications in 5G to achieve improved performance. Relevance of ML to sustain the network technology goals of 5G is indicated in the paper.

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