Comparative Analysis on Supervised Machine Learning Models for Future Wireless Communication Networks

Kishore Odugu, B.Rajasekar

Abstract*: *Future wireless communication networks are anticipated to backing the exceptional knowledge rates and revolutionary innovative applications, that needs replacement traditional radio technology wireless communication model. The remonstrance task is to help the wireless communication systems or networks for perspicacious dynamic learning and higher cognitive process, So disparate necessities of future wireless communication networks are often glad. Supervised Machine learning models were foremost reassuring computer science methods or algorithms, formed to backing sensible wireless communication system terminals. Upcoming sensible fifth generation (5G) mobile wireless terminals are anticipated to Independently access the foremost worthy different bands of spectrum depending on learning of elusive spectral efficiency , the transmission power is controlled, whereas impose on energy effective learning or inference and at the same time adjusting protocols for transmission depending on quality of service learning or inference. So, its needed to succinctly review the machine learning fundamental concepts and recommend their amenity within the enchanting applications of fifth generation networks, together with psychological feature radios, femto or small cells, massive MIMOs, smart grid, assorted networks, energy gathering, end-to end communications. The main aim is to backing the readers in refinement the enthusiasm, procedure of governing machine learning methods within the situation of next generation networks so that innovate into uncharted applications or services.

Index Terms: Artificial Intelligence, Machine Learning, massive MIMO, Diverse networks, SVM, Bayesian learning, Expectation maximization, HMM

I. INTRODUCTION

Next generation wireless communication requirements, mobile edge and core intelligence can only be realized by integrating fundamental notions of artificial intelligence (AI) and machine learning across the wireless infrastructure and end-user devices. Perspicacious radio that is having ability to act independently accessing different obtainable spectrum with the support of learning, altruistically monitoring transmission power for energy efficient management and also regulating the transmission rules. Next generation wireless networks needs to provide a unlimited data rates to support the new advanced applications. The fourth-generation (4G) cellular networks are being globally connected for the Internet Protocol broadband connectivity. In 1991, the second-generation (2G) global networks for GSM based mobile communications. In 2001, the third generation (3G) provides digital voice telephony and provided mobile Internet solutions. Around 30 years of great progress in wireless communications helped to transform basic cellular to rich multimedia network the transmit large quantity of video or audio data, it has greater influence on our daily and us greatly. Mobile broadcasting access has been drastically increasing more then thousand times aggregate throughput and ten times more at link level. Currently, the Internet of Things is having escalating growth because of digitalization of different communication object. the latency, battery lifetime, communication speed of network, security are vital issues to be addressed. In order to improve service provision and meet imminent differentiated necessities, therefore obligatory to transfigure wireless communication networks using the state of art technology [1]. the standardization of Fifth generation networks using advanced technologies like artificial intelligence is very much required. Fifth generation cellular communication networks will provide variety of facilities like Enhanced Mobile Broadband (EMBB) which helps in bandwidth overriding and efficiency driving necessities to massive machine-type communications (mMTC) and Ultra Reliable Low Latency Service (URLLC). the fifth generation is support with Massive Input Massive Output (MIMO) which enable for high speed communication. However, there are issue to be addressed need the advanced sophisticated technologies to standardize the network. Now, Question is what types of machine learning models and artificial intelligence is required to standardize the network as more robust[1].

II. MACHINE LEARNING MODELS FOR 5G

Next generation will provide high speed assisting innovative applications. Specially, next generation wirless communication systems are need to acquire different features of users and also human behavior, in order to autonomously determine the optimal system configurations. These smart mobile terminals have to rely on sophisticated learning and decision-making. Machine learning, as one of the most powerful artificial intelligence tools, constitutes a promising solution. Machine learning algorithms can be divided as supervised and unsupervised learning, where the adjectives "supervised/ unsupervised" indicate whether there are labeled samples in the database. The behavioral

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psychology has inspired new Machine learning technique that is reinforcement learning emerged as a advanced technologies as new sub category in Machine learning.it is concerned with an agents's reward or utility connected to surroundings via perception and action which produces an adaptation. There are different Machine learning techniques like yielding regression algorithms, instance-based algorithms, regularization algorithms, decision tree algorithms, Bayesian algorithms, clustering algorithms, association rule-based learning algorithms, artificial neural networks, deep learning algorithms, dimension reduction algorithms, ensemble algorithms, and all are different from their structure and functionality. In this paper, Major discussion about how the machine learning models can help next generation wireless communication systems in order to improve the performance of the network [1][2].the next generation wireless network several technical problems like device to device (D2D) networks, Wide scale Multiple Input and Multiple Output (MIMO) Systems, diverse networks constituted by femto-cells and small cells. This technical problems can be addressed by using different machine learning techniques [2][3].The 5G Cellular network require new technologies to provide predefined services and for the total intelligent wireless communication network. The 5G cellular networks operator are in exigent situation to meet different service requirements and solve complicated configurations as user and network are dynamic. Such a future requirement can be meet by empowering machines and systems with intelligence acts like human intelligence. it is vital to understand how Artificial intelligence can contribute to management in 5G communication network development[1][2] [3].

III. REGRESSION, KNN AND SVM MODELS FOR 5G

The relationship among the variables can be estimated using statically analysis will help regression models. The aim of regression model need to predict diverged values for a set of input variable with single or multi-dimensional. the linear regression model has a linear in nature. The logistic regression model is sigmoid curve in nature. The Support Vector Machine (SVM) and K-Nearest Neighbors algorithm (KNN) algorithms are based on object classification. In The K-Nearest Neighbors algorithm (KNN) object classification is based on k value of the object's neighbors and SVM algorithm relies on nonlinear mapping and transforming data into separable and searchable dimensions then it separates the one class from another based on optimal linear separating hyperplane[2]. The radio parameters of a particular mobile user can be predicted and estimated using KNN and SVM models. The capacity of addressing search-problems by machine learning algorithms. the high-dimensional search-problems like detection and channel estimation in massive MIMO systems solved based on Support Vector Machine (SVM) and K-Nearest Neighbors algorithm (KNN) algorithms. The Hierarchical - Support Vector Machine (H-SVM) is used for MIMO-aided wireless network find the Gaussian channel's noise level between transmit antennas and receive antennas, it contains hierarchical level consisted of a finite number of SVM classifier[5]. The handover may be frequent in heterogeneous networks constituted by diverse cells, The optimal solution for handover problem solved using Support Vector Machine (SVM) and K-Nearest Neighbors algorithm (KNN).The next generation wireless mobile user terminal's parameters like usage pattern can be used to train Support Vector Machine (SVM) and K-Nearest Neighbors algorithm (KNN) [6]. the specific users radio parameters can estimate and predicted using different machine learning models. One of the problems that effectively addressed by machine learning models are with M-MIMO (Massive Multiple Input and Multiple Output) systems which are having number of antennas for channel estimation and detection leads to high dimensional search problems. Hierarchical -SVM consist of N number of classifiers were utilized to noise level estimation in channel inside a MIMO supported wireless communication network contains a N Number of transmission and reception antennas [5]. H-SVM Models were trained for the estimation of channels noise statics by interpreting the training sets of data. In Modern cellular communication networks, the handover is frequent, SVM and KNN can be used to get Optimal handover solution in the networks.The mobile terminal's specific usage pattern can be learned by using this model. The K-Nearest Neighbors algorithm are used for the prediction of demand of Energy. The user location and energy consumption rates can be used to train the machine learning models to predict energy demand [6]. The supervised Machine Learning Models can interpret the patterns learn from the user presence and usage to efficiently subdivided the signals into Current system state for saving the energy and best user management.

IV. BAYESIAN LEARNING FOR COGNITIVE RADIO

The Bayesian learning Model estimates posteriori probability distribution of input signals. The special characteristics of next generation wireless networks would be learned and estimated by Bayesian learning. One of the problems in massive MIMO systems is pilot contamination can be addressed by estimating the channel parameters of both desired links in a target cell and interfering links of adjacent cells. The estimation of channel parameters to address the pilot contamination problem can be done by using Bayesian learning techniques. In this method, Gaussians mixture model was defined based on received signal and channel parameters with weighted sum of gaussian distribution and estimation carried by using expectation maximization[7]. The estimation of Primary user present or absent can be modeled by using two state Hidden Markov Model with two state observation space. The amount of time the available channels to perform at optimized level can be estimated by expectation maximization algorithm[8]. The prevalent parameters and interference patterns of link layer and network layer in cognitive radio can be estimated by using tomography model in Bayesian learning. The path delay and proportion of successful packer receptions in link layer and network layer of cogitative radio are estimated by tomography model.[9]

V. COMPARATIVE ANALYSIS

The supervised learning algorithms like regression models , k-nearest neighbors algorithm, Support Vector Machine (SVM), Bayesian Learning used to estimated and predict the channel parameters of next generation wireless networks[10].

Table 1: Regression, KNN models for Wireless communication Problems

Application	Regression models	KNN
Energy Learning	Used	Used
MIMO channel learning		
Massive MIMO learning		
Cognitive spectrum learning		
Pilot contamination		

In Table 1 the Energy learning and predict the energy demand can solved by using regression model like linear regression model and logistic regression model and estimate the variable relationships in system state.

In Table 2 shows that MIMO channel learning for channel noise estimation can be solved using Support Vector Machine (SVM) models. Massive MIMO systems results a large scale search problems because of Multiple input antennas and multiple output antennas results in multiple channel paths. So, Massive MIMO channel learning requires a Bayesian learning model for estimation.

The Cognitive spectrum learning is for effective allocation bandwidth by knowing available spectrum which can be addressed by Bayesian learning. Pilot contamination problem in MIMO system are addressed by Bayesian learning.

Table 2: SVM, Bayesian Learning models for Wireless communication Problems

Application	SVM	Bayesian Learning
Energy Learning		
MIMO channel learning	Used	
Massive MIMO learning		Used
Cognitive spectrum learning		Used
Pilot contamination		Used

The different supervised machine learning and their methods addressed a particular application in wireless communication. However, there other supervised learning like Decision tress and Collaborative Filtering (CF) which are used to solve major problems in next generation wireless communication Networks make the networks more robust. [11] [12][13]

VI. CONCLUSION

The supervised learning algorithms like regression models , k-nearest neighbors algorithm, Support Vector Machine (SVM), Bayesian Learning , Decision trees, Collaborative Filtering are used to effective address the problems in estimation of channel parameters in massive MIMO systems. The cognitive radio network parameters and channel parameters and network parameters at different layers can be effective addressed by Bayesian learning models.

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