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Machine Learning Techniques for 5g And Beyond

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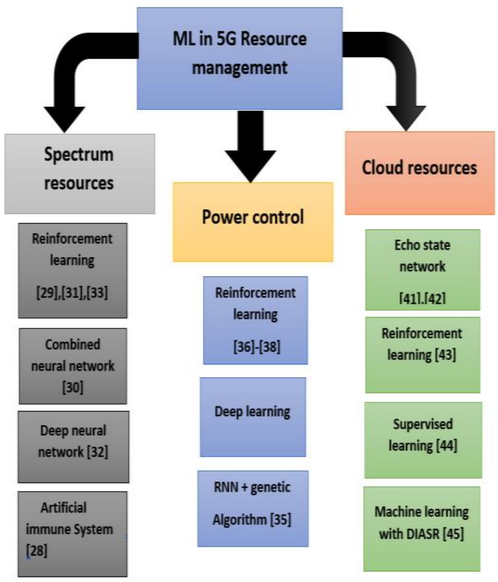
Abstract: *In today's world, wireless communication systems are extremely important for applications related to entertainment, business, commerce, health and safety. These systems continue to advance from generation to generation and at this time, fifth generation (5G) wireless networks are being deployed globally the globe. Beyond 5G wireless systems, which will represent the sixth generation (6G) of the evolution, are already being discussed in academia and industry. The application of artificial intelligence (AI) and machine learning (ML) to such wireless networks will be one of the primary and essential elements of 6G systems. According to our present understanding of wireless technologies up to 5G, every component and building block of a wireless system, such as the physical, network, and application layers, will involve one or more of them.*

Keywords: *Fifth generation (5G), sixth generation (6G), artificial intelligence (AI), machine learning (ML), deep learning (DL), reinforcement learning (RL), federated learning (FL), Random Neural Network(RNN).*

1. INTRODUCTION

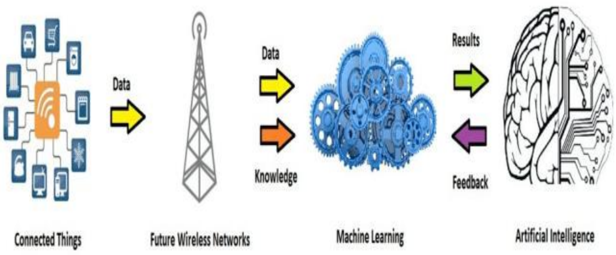
Sixth Generation (6G) wireless technology is a fresh field of study for many academics and researchers. The key benefits of 6G are that they will be made available to users and wireless networks alike. With the aid of AI and ML, 6G will also offer improvements in technical measures like fast throughput, support for new, high-demand apps, enhanced radio frequency spectrum use, and many more. DL is one of the main ML technologies anticipated as a crucial technology for 6G because to its significant applications in accomplishing learning from more human-like settings. Determining which 6G access point to connect to and which resource controller has more resources available, for instance, is up to DL. Wireless technology is constantly developing and improving to help consumers with more sophisticated needs with more and more useful applications. In the 5G mobile communication system, there is an increase in data rates, a decrease in energy consumption of devices connected with latency and energy, coupled with more precise location. Many researchers have been polled about the need to focus more on achieving latency and energy goals by improving the current wireless system from various angles due to the current increase in data size and usage.



2. RELATED WORK

The existing literature has examined a number of security facets of networks, including 5G and beyond, in general, as well as more recently, the possibilities and applications of machine learning for 5G network security. One of the main technologies that will enable 5G and future networks is AI. In order to collect data from the network and construct a system that is effective at improving network performance, ML algorithms are also employed in conjunction with SDN and NFV.

5G networks security: In its release 14, the 3GPP technical specifications group for services and systems aspects identified the 17 key dangers, problem areas, and potential remedies for the security architecture of 5G networks. In June 2019's release 15 (R15), the security architecture, protocols, and specifications for 5G systems were developed. While the future R16 and R17 will concentrate on standalone and non-standalone Enhanced Mobile Broadband situations, the R15 covers security criteria for both.



Machine learning: Although the idea of machine learning (ML) for security and privacy is not new, it has recently attracted attention due to its viability and performance advantages. The majority of techniques used prior to the creation of DL were intended to mimic attack patterns with particular, unreliable properties. However, it is anticipated that systems will become more resistant to new, sophisticated threats and attacks with dynamic deep learning and AI.

Securing 5G networks with machine learning: Most ML techniques are data-hungry, which implies that in order for the model to work properly, data must be used to train it. Data generation, storage, and administration are not challenging in the 5G future because of our high computing power, exponential data expansion, and data sources. Using AI and ML, the network can be tracked, looked into, and analysed for potential threats, assaults, and vulnerabilities with less expensive computers and equipment. Additionally, ML techniques for classification.

3. REVIEW OF ML TECHNIQUES

The discriminative properties of a system that cannot be modelled mathematically are learned using machine learning (ML) models, which are computational systems Regression, categorization, and interactions between an intelligent agent and its environment are frequent activities that make use of these models. Once a model has been trained on the provided data, it can successfully make decisions based on unknown data and carry out activities requiring mathematical computations. This would enable ML modelling for network communication management based on 6G data and improve and automate network performance management in order to maintain existing Key Performance Indicators (KPIs) within predefined thresholds. ML also allows the management of 6G mobile networks with smart adaptive cells.

4. MAIN FEATURES OF THE 5G SYSTEM

A new radio connection idea has served as the foundation for all mobile generation developments to date, which have resulted in an increase in peak data rate of roughly two orders of magnitude. The 5G system must fulfil the demands for reduced latency, greater rate, and capacity needed after 2020.The 5G system will be the wireless backbone for the Internet of Things and must support a variety of machine-type communications with very varied needs in addition to human users. In comparison to present mobile broadband (MBB) technologies, the overall range of requirements will expand. For high-definition video, the data rates will be quite high whereas sensor data will have very low rates. For safety-critical applications, latency will be incredibly minimal, but for other applications it won't really be a problem. Packet sizes can range from little for things like smartphone apps to huge for things like file transfers.

Features of 5g technology:

- 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.
- The advanced billing interfaces of 5G technology makes it more attractive and effective.
- 5G technology also providing subscriber supervision tools for fast action.
- The high quality services of 5G technology based on Policy to avoid error.
- 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.

- 5G technology offer transporter class gateway with unparalleled consistency.
- The traffic statistics by 5G technology makes it more accurate.
- Through remote management offered by 5G technology a user can get better and fast solution.
- The remote diagnostics also a great feature of 5G technology.
- The 5G technology is providing up to 25 Mbps connectivity speed.
- The 5G technology also support virtual private network.
- The new 5G technology will take all delivery service out of business prospect
- The uploading and downloading speed of 5G technology touching the peak . The 5G technology network offering enhanced and available connectivity just about the world.

5G Frequency Spectrum: One of the significant differences between 5G and older generations of wireless networks is the frequency of electromagnetic spectrum utilized by the latest standard of wireless technologies. Data throughput in a mobile network is limited by the channel bandwidth (the difference between highest and lowest signal frequencies) available for the technology to use. On the frequency spectrum, narrower channel bandwidths are available at lower frequencies, whereas at higher frequencies, wider channel bandwidths are available. While digitization, multiplexing techniques and software-based data compression algorithms allow us to cram more data in the same channel bandwidth, at one point the laws of physics constrain any further improvements. In order to provide a greater channel bandwidth, 5G is planned to operate in three different frequency ranges: Low-band, Mid-band, and Millimeter Wave (mm Wave). Low-band 5G uses the same frequency range as 4G, which is typically below 3GHz. It offers slightly better data speed than 4G at up to 250 Mbit per second ("Mbps"). Mid-band 5G uses a frequency range up to 6 GHz, typically used by Wi-Fi, to provide a downlink speed of up to 1 Gbit per second ("Gbps"). Millimeter wave 5G uses a much higher frequency range between 24GHz and 300 GHz to provide high-speed data at a downlink speed of 2 Gbps, which can even go up to 20 Gbps.

5. 5G APPLICATIONS

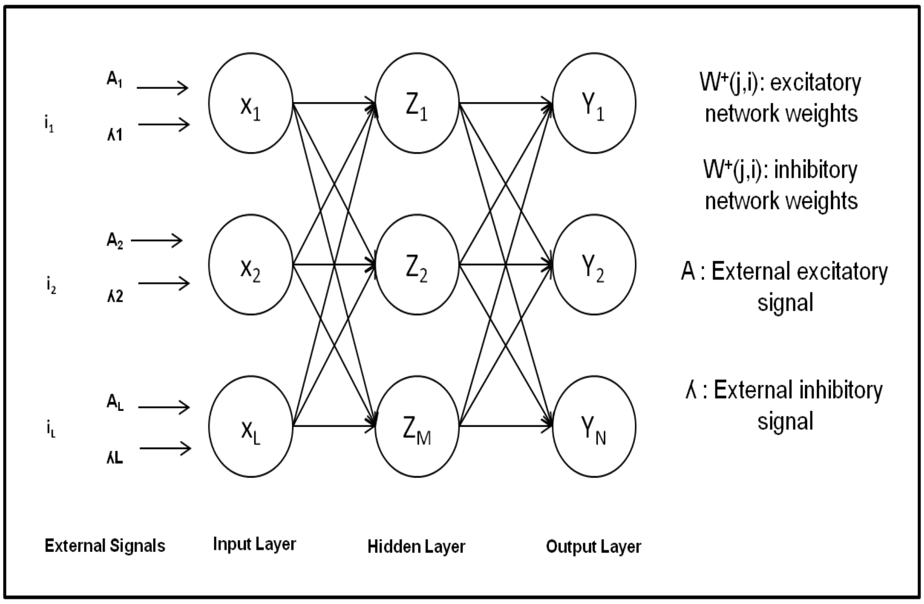
5G is faster than 4G and offers remote-controlled operation over a reliable network with zero delays. It provides down-link maximum throughput of up to 20 Gbps. In addition, 5G also supports 4G WWWW (4th Generation World Wide Wireless Web) [5] and is based on Internet protocol version 6 (IPv6) protocol. 5G provides unlimited internet Sensors 2022, 22, 26 10 of 32 connection at your convenience, anytime, anywhere with extremely high speed, high throughput, low-latency, higher reliability, greater scalablility, and energy-efficient mobile communication technology. There are lots of applications of 5G mobile network are as follows:

High-speed mobile network: 5G is an advancement on all the previous mobile network technologies, which offers very high- speed downloading speeds 0 of up to 10 to 20 Gbps. The 5G wireless network works as a fiber optic internet connection. 5G is different from all the conventional mobile transmission technologies, and it offers both voice and high-speed data connectivity efficiently. 5G offers very low latency communication of less than a millisecond, useful for autonomous driving and mission-critical applications. 5G will use millimeter waves for data transmission, providing higher bandwidth and a massive data rate than lower LTE bands. As 5 Gis a fast mobile network technology, it will enable virtual access to high processing power and secure and safe access to cloud services and enterprise applications. Small cell is one of the best features of 5G, which brings lots of advantages like high coverage, high-speed data transfer, power saving, easy and fast cloud access, etc.

Entertainment and multimedia: In one analysis in 2015, it was found that more than 50 percent of mobile internet traffic was used for video downloading. This trend will surely increase in the future, which will make video streaming more common. 5G will offer High-speed streaming of 4K videos with crystal clear audio, and it will make a high-definition virtual world on your mobile. 5G will benefit the entertainment industry as it offers 120 frames per second with high resolution and higher dynamic range video streaming, and HD TV channels can also be accessed on mobile devices without any interruptions. 5G provides low latency high- definition communication so augmented reality (AR), and virtual reality (VR) will be very easily implemented in the future. Virtual reality games are trendy these days, and many companies are investing in HD virtual reality games. The 5G network will offer high-speed internet connectivity with a better gaming experience.

Internet of Things: Connecting everything the 5G mobile network plays a significant role in developing the Internet of Things (IoT). IoT will connect many things with the internet like appliances, sensors, devices, objects, and applications. These applications will collect lots of data from different devices and sensors. 5G will provide very high speed internet connectivity for data collection, transmission, control, and processing. 5G is a flexible network with unused spectrum availability, and it offers very low-cost deployment that is why it is the most efficient technology for IoT.

6. PROPOSED WORK



Structure of random neural network

Cryptographic concepts form the basis for block chain and can also be used with Neural networks. The Big data or information is stored in the block chain in forms of blocks with parameters like previous block hash, count of attempts to mine the block and timestamp. To validate the current block, the hash is calculated using the decentralized miners. The block chain in the smart city information will hold details of the transaction that are authenticated with the aid of smart city destination, transaction origin and private key.

7. Random Neural Network Model

The following components make up a random neural network: decentralised data, neural chain network, validation and data, and private key. The digital credentials associated with an application or user that are assigned to a specific user make up the private key, which is represented as Y. This will include biometrics and call for encryption using a suitable algorithm, such as the Advanced Encryption Standard's 256-cipher version (AES).

The private key can be represented as Y = (y1, y2,..., yN) and updated as and when needed by validating user credentials. The data are validated using V(t) = (V1,V2,..., VN), where D = (d1, d2,..., dN) using I-vectors and no = (i1, i2,..., iI) where the dimensions are specified using I. The first validation V1 for an input state X = xI can be found. Using a decentralized network, the calculated neural network weights $w-(x, y)$ and $w+(x, y)$ are saved and can be recovered during mining process. Similarly the next validation $V2$ is connected to $X = xI$, the input state which is related to the hidden layer ZM , the chain and $d1$ of the first validation $V1$, along with additional data $d2$. The value of neural chain for the upcoming transaction is identified using the hidden layer $Z = zN$ and the user private key using the output state$Y = yN$. As the data inserted increases, the process also iterates. Based on selection of neurons, the values associated with the hidden layer neurons and a combination of stored neural weights from the private key, the neural chain can be formulated. Using neural network weights $w-(x, y)$ and $w+(x, y)$ in Random neural network output determination, data can be mined or validated, at random inputs of$X = xI$. Hence this process will also be similar to that of traditional blockchain where the hash tag has to be found by the miners. When the input is discovered, such that the output Y can be decoded with an error lesser than a predefined limit that can be used for recovering the weights, mining of random neural network with block chain configuration takes place.

where yn is the private key or application or user, $X = xI$ is the random input and $y'n$ is the random neural network output, Ek is the threshold or minimum error value. On adjusting the value of Ek we can tune the mining complexity. When the final solution is mined or found, the data of application or user will be processed. Similarly $Z = zN$ which will be a potential neural hidden layer value will be added to the existing values to develop a neural chain which will act as the next transaction's input, in addition to the user new data. As the last step, S gradient descent learning algorithm is used to determine the random neural network for a new pair with weights of the neural network fixed to be w-(x, y) and$w+(x, y)$. As the number of new users increases, the mining process will also increase simultaneously.

8. RESULT

In future years rapid mobile traffic growth; anticipated high QoE standards; and innovative use-cases that necessitate flawless performance. Beyond the limitations of the current 5G standards, 6G opens up new possibilities in terms of peak data rate, user-experience data rate, latency, mobility, connection density, energy efficiency, peak spectral efficiency, and area traffic capacity. By two orders of magnitude, or 99.99999%, more reliability is anticipated with 6G. The 6G signal bandwidth should support up to 1 GHz or greater, reaching THz communications. This is true for both single- and multi-RF carriers. In comparison to 5G, which only achieved meter-level positioning accuracy, 6G is expected to achieve centimeter-level positioning accuracy, which is essential for many industrial applications, particularly those that take place indoors. There are a lot of possible enabling technologies out there. The physical spectrum, networking conceptualizations, and the incorporation of various paradigms into network communication are just a few of the potential enabling technologies that may come into play in order to actualize 6G.

Future Vision of 6gAndCurrent Technologies: The need for next-generation mobile communication systems is arising due to the scalable deployment of 5G wireless networks. Many pieces of research [32] are focusing on the future of 5G that leads to 6G. The author's future vision of 6G with disruptive techniques, cell-less networks, intelligent connectivity, seamless coverage, distributed antenna system.

9. CONCLUSION

In addition to discussing the impact of machine learning (ML) on automation and threat intelligence, this paper also discussed the threat landscape across 5G networks. A relatively strong, flexible and completely automated security framework is necessary for 5G and beyond networks due to the extremely dynamic traffic patterns, service-based network architecture, dispersed network operations, and authentication over numerous servers. The suggested study involves implementing a random neural network in 5G and IoT for smart cities, where the neurons would gradually increase as user data validation rises. An integrated 5G node authentication method and the findings showed that mining should occur gradually in a decentralised network with encrypted data in order to develop a neural network that supports smart city infrastructure.

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