Project Synopsis

on

**Optimizing Resource allocation in 5G network Using ML**

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in

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**Submitted by**

Apoorva Singh (2000290120038)

Aayushi Saini (2000290120005)

Ayush Siloiya (2000290120055)

**Under the Supervision of**

Ms. Neha Shukla

Assistant Professor in Computer Science Department

**KIET Group of Institutions, Ghaziabad**

**Department of Computer Science**

**Dr. A.P.J. Abdul Kalam Technical University**

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**DECLARATION**

We hereby declare that this submission is our work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

Signature of Students

Name: Apoorva Singh, Aayushi Saini, Ayush Siloiya

Roll No: 2000290120038, 2000290120005, 2000290120055

Date: 24/02/24

**CERTIFICATE**

This is to certify that Project Report entitled “Blind Image Restoration and Data Augmentation” which is submitted by Nandini Tyagi, Piyush Gupta, Avishi Tayal in partial fulfilment of the requirement for the award of degree B. Tech. in Department of Computer Science of Dr A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

Date: Ms. Neha Shukla

Assistant Professor

Department of Computer Science

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Signature:

Date: 24/02/24

Name: Apoorva Singh, Aayushi Saini, Ayush Siloiya

Roll No: 2000290120038, 2000290120005, 2000290120055

**ABSTRACT**

A new era of wireless communications has begun with the introduction of 5G technology, which promises incredible data rates, extremely low latency, and extensive device connectivity. However, efficient resource allocation is crucial to maximizing the promise of 5G networks. This study investigates machine learning techniques to optimize resource allocation in the 5G network, particularly linear regression, support vector machines (SVM), and k-nearest neighbor (KNN) models. In some research, we find that prior work trained the model to assess incoming traffic and predict the network slice for an unknown device type using KPI (key performance indicators). To maximize the utilization of resources, we present and contrast three machine learning models in this study: linear regression, SVM, and KNN. To forecast the optimal allocation of resources, these mathematical models are trained using previous network information and user trends. Whereas SVM and k-NN offer more sophisticated and adaptive models, linear regression provides a plain and straightforward technique. In 5G network conditions, machine learning-based resource allocation beats traditional techniques in terms of bandwidth efficiency, user satisfaction, noise reduction, and signal strength, with parameters taking accuracy, scalability, and distribution of resources according to various application types. By illustrating the importance of machine learning techniques, this study improves our understanding of allocating resources in 5G networks. It provides a comprehensive insight into the benefits and drawbacks of linear regression, SVM, and machine learning KNN models for 5G network resource allocation. The results of this study may help network operators and researchers make conclusions on resource allocation strategies that can " enhance the overall performance and efficiency of 5G networks" as the networks continue to evolve and adjust to various use cases.

**CHAPTER 1: Introduction**

* 1. **INTRODUCTION**

5G networks represent a revolutionary advancement in wireless communication technology, promising exceptionally high data rates, minimal latency, and the ability to connect a vast number of devices simultaneously. These transformative features make 5G a pivotal enabler for a wide array of applications, ranging from ultra-high-definition streaming to real-time IoT (Internet of Things) deployments. However, these remarkable capabilities also introduce a significant challenge: efficiently managing and allocating the abundant resources within the 5G network. Traditional approaches may struggle to adapt to the dynamic and diverse demands imposed by various applications and users in real time. To overcome this challenge and fully unlock the potential of 5G, it's imperative to implement an intelligent and adaptive resource allocation system. The goal is to ensure that the network allocates resources optimally, aligning with the precise requirements of each application and user. This efficiency not only enhances the user experience but also contributes to cost savings and facilitates seamless integration into our rapidly evolving digital landscape. In response to this need for effective resource management in 5G networks, this invention leverages the capabilities of machine learning. Machine learning algorithms, with their ability to analyse and learn from data patterns, offer a promising approach to dynamically optimize resource allocation within the 5G network. By integrating machine learning into the resource allocation process, we aim to enhance the network's responsiveness and efficiency, ultimately leading to a superior and uninterrupted user experience.

**1.2 PROBLEM STATEMENT:**

The main problem being addressed in this project is the efficient allocation of resources in a 5G network to ensure a high-quality user experience across diverse applications. The 5G environment, replete with diverse use cases and their distinct resource demands, presents a formidable challenge in achieving efficiency. In this network, with its multitude of use cases and varying resource requirements, optimizing resource allocation is a complex challenge. Inefficient allocation can lead to latency, reduced bandwidth, and ultimately a degraded user experience, especially in critical applications like emergency services or online gaming.

**1.3 OBJECTIVES:**

**• Enhance 5G Resource Allocation Efficiency:**

Optimize the allocation of resources in a 5G network to ensure efficient utilization of the network's capabilities, such as high data rates, low latency, and extensive device connectivity.

**•** **Improve User Experience:**

Enhance the overall user experience by accurately predicting and allocating resources based on the unique requirements of different applications, reducing latency, and ensuring smooth data flow.

**• Enable Dynamic Resource Allocation:**

Implement a system that dynamically adjusts resource allocation in real-time, adapting to changing network conditions and application demands to maintain optimal performance.

**• Utilize Machine Learning for Predictive Analysis:**

Leverage machine learning algorithms to analyse network data and predict resource needs based on various factors like signal strength, latency, and bandwidth requirements.

**• Ensure Scalability and Adaptability:**

Design the system to scale seamlessly with the growth of the network and adapt to evolving technologies, accommodating increasing traffic and new application demands effectively.

**• Facilitate Cost-Efficient Network Management:**

Optimize resource allocation to minimize wastage and reduce operational costs for service providers, ensuring resources are allocated judiciously based on actual needs.

**• Contribute to Industry Standards and Best Practices:**

Showcase the effectiveness of machine learning-driven resource allocation to encourage the adoption of similar intelligent systems, setting new industry standards and best practices in 5G network management.

**1.4 SCOPE:**

Investigate and implement more advanced regression models, such as neural networks or ensemble methods, to further improve the accuracy of resource allocation predictions in the 5G network. Explore opportunities to expand and update the dataset over time to capture evolving network dynamics and application demands, ensuring that the models remain relevant in a rapidly changing 5G environment. Incorporate external factors (e.g., weather conditions, network traffic, or hardware status) into the models to enhance their robustness and adaptability, creating a more comprehensive resource allocation framework. Develop strategies to implement real-time resource allocation using the optimized models, enabling dynamic adjustments based on live network conditions and application requirements.

**CHAPTER 2: Literature Review**

[1]V. P. Kafle et. al. examined the relationship between machine learning and 5G network slicing. It discusses how 5G networks are becoming more complex due to an influx of connected devices and various services, highlighting the necessity of effective resource management, security, and adaptability. The author emphasized the significance of automating network operations throughout the network slice lifecycle. Along with insights into ongoing AI and machine learning initiatives within standards development organizations and industrial forums, the author has discussed various machine learning techniques applicable to automating network functions. This research outlines future research directions, mainly focusing on in-depth analyses of machine learning techniques for autonomous allocation and adjusting computing and network resources based on service requirements and network workloads. These results will intend to guide any future organizational standardization efforts.

[2] D. Sattar et. al. addresses the essential issues related to function isolation within slices and meeting end-to-end delay requirements in 5G network slicing. The author has built on previous work to develop an optimization model for allocating 5G core network slices to address these problems. The model prioritizes meeting the minimum end-to-end delay requirements and intra-slice isolation. The author assesses their optimization model using simulations on a virtualized mobile core. The results demonstrate a fascinating trade-off: CPU utilization increases when intra-slice isolation requirements are relaxed, but bandwidth demands decrease because inter-machine communications are scaled back. Stricter intra-slice isolation, on the other hand, requires more bandwidth while resulting in relatively lower CPU utilization. In conclusion, this includes advances in 5G network slicing by providing an optimization model that balances function and efficiency.

[3] F. B. Mismar et. al. aimed to improve the performance of a 5G wireless network, which promises higher data rates and better voice call reliability. The joint optimization of beamforming, power control, and interference coordination was the issue that needed to be solved to improve communication quality. Addressing this issue has focused on their effort using a non-convex optimization framework to increase the Signal-to-Interference plus Noise Ratio (SINR). It took deep reinforcement learning to find a solution to this challenging issue. Compared to industry standards, the proposed algorithm significantly improved SINR and overall capacity by differentiating between voice and data bearers in various frequency bands. Notably, the algorithm performed better than existing techniques for voice bearers in the sub-6 GHz band. It operates in the mmWave frequency range.

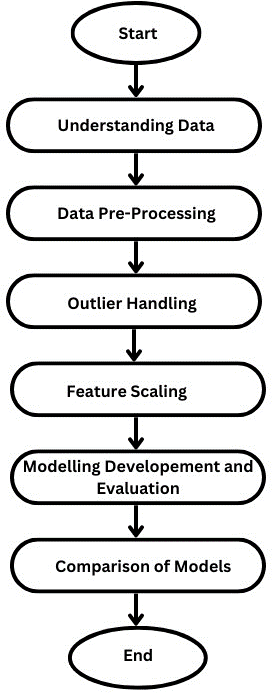
[4] F. Wilhelmi et. al. highlights ML's expanding role in future communications While acknowledging worries about Machine Learning's (ML) credibility and dependability in networking systems. In order to close the gap between machine learning and communication systems, the paper suggests integrating network simulators. Before deploying ML models in live networks, these simulators act as sandbox environments for training, testing, and validating them. Through integration, ML-aware network architectures will have more confidence in ML. The conclusion highlights the role that automated machine learning (ML) systems will play in communications in the future, but it also acknowledges the potential for instability and performance degradation. Network simulators are an essential tool to address these problems, with a real-world testbed application demonstrating their effectiveness in minimizing adverse effects on a residential network.

[5] S. Chakrabarti *et. al.* emphasizes high reliability, low latency, increased capacity, security, and quick user connectivity. It also highlights the growing demands on cellular communications, particularly with the introduction of 5G networks. It emphasizes the value of data-driven decision-making and the function of artificial intelligence (AI) in maximizing the performance of the 5G network. It introduces the idea of network slicing (NS) as a method for accommodating multiple tenants on the same physical infrastructure. The 'DeepSlice' model, a Deep Learning (DL) Neural Network, is presented in this research. By evaluating Key Performance Indicators (KPIs) and forecasting the ideal network slice for different devices, it aims to manage network load and availability efficiently. This model makes it possible to allocate resources intelligently and even decide in the event of a network failure. The conclusion highlights the importance of network slicing in 5G networks for mobile operators and companies. It emphasizes the advantages of the 'DeepSlice' model in precisely forecasting network slices based on device parameters and managing load balancing and slice failures using neural networks. The model will be expanded in future work to handle a variety of scenarios, such as handovers, caching, load prediction, resource borrowing, and application-based slice management. It will involve implementing the model in a natural 5G production environment.

[6] A. Chouman et. al. has described the diverse and demanding needs of current and future devices must be met in the rapidly changing environment of fifth-generation (5G) and beyond wireless networks. The 5G Core Network Data Analytics Function (NWDAF) must incorporate artificial intelligence to deliver high data rates, low latencies, and resolved reliability. In the context of a 5G network framework built on open-source software, this work introduces a functional NWDAF. This research also provides a real-world example of these insights' use in intelligent network management. This study also identifies the upcoming 5G network limitations, which will encourage the creation of the upcoming 6G networks. In conclusion, the NWDAF, in particular, has the potential to transform networking practices by integrating intelligence. It enhances Management and Orchestration (MANO) capabilities, enables thorough comprehension of network operations, and paves the way for proactive network management and forecasting using cutting-edge analytics models.

**CHAPTER 3: Proposed Methodology**

**3.1 Flowchart**



**3.2 Algorithm Proposed:**

**Model Definition:**

Select SVM, KNN & and LMR models & and justify based on functions and capabilities.

**Dataset Curation:**

Align the dataset with research criteria & and define inclusion/exclusion criteria.

**Analysis of ‘5G Quality Services' Dataset:**

Analyze Application type, Signal Strength, and Latency.

**Data Visualization:**

Present insights & and highlight resource distributions, latency scenarios, and signal strength.

**Consideration of Network Parameters:**

Align network parameters with application needs & and address diverse user preferences.

**Impact of Signal Strength:**

Discuss the role in user experience & and use cases like conference calls and background applications.

**Categorization of Data:**

Define models per function. & Justify categorization.

**CHAPTER 4: Technology Used**

**Data Handling and Pre-processing:**

Python with Pandas and NumPy for data manipulation. Handling missing values, encoding categorical variables, and unit conversion.

**Data Visualization:**

Matplotlib and Seaborn for creating various plots.

**Machine Learning Models:**

Linear Regression, SVM Regression, and KNN Regression implemented using Scikit Learn.

**Model Evaluation:**

Scikit-Learn for calculating metrics like R-squared, Mean Squared Error (MSE), and Root Mean Squared Error (RMSE).

**CHAPTER 5: Conclusion**

This research aimed to use machine learning models to optimize resource distribution across 5G networks, striving for stability, cost-efficiency, efficient resource allocation, and improved user experience. After studying and preparing the data, we used data visualization to discover essential insights, spotting patterns and trends that informed our modeling choices. Our insights highlighted improved user experiences, cost savings, increased bandwidth efficiency, and interference mitigation across multiple 5G network conditions to illustrate the advantages of machine learning-based resource allocation. In conclusion, this study highlights the innovative potential of machine learning in 5G resource allocation. We have made Analytical Analysis progress toward a day when 5G networks offer more significant services and required needs to meet the user's daily requirements according to the application usage. This demonstrates the value of making decisions based on signal strength, latency, and percentage of resource allocation for brightening the future of 5G networks.

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