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**Enhancing the Efficiency of 5G Network Services using Artificial Neural Network (ANN) Algorithm in Comparison with Random forest Algorithm**

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**Keywords:** Efficiency, 5G Network Services,  Artificial Neural Network (ANN), Random forest Algorithm, Comparison

**ABSTRACT**

In this study, we investigate Efficiency Enhancement of 5G Network Services using Artificial Neural Network (ANN) Algorithm in Comparison with  Random forest  Algorithm. The focus lies on enhancing the detection of fraudulent services through a novel approach employing Artificial Neural Network, juxtaposed with the traditional  Random forest   method. **Materials and Methods:** To Encompass a comparison between the two algorithms: Artificial Neural Network and  Random forest  . A dataset comprising 1784 samples was subjected to statistical analysis, with 1200 samples allocated for model training and 584 for testing. Utilizing the Clincalc tool with a G power setting of 85% parameters and alpha=0.05, alongside a power=0.85, the sample size for predicting fraudulent service enrollment websites was fixed at N=10 for each group, with a confidence interval of 95%. **Results:** indicate a statistically significant difference (p=0.000, p<0.05) necessary for identifying fraudulent websites. The novel Artificial Neural Network approach demonstrates superior performance, achieving an accuracy of 71.40% compared to 64.26% attained by  Random forest  .(Independent sample t-test). **Conclusion:** The accuracy of an algorithm is better than compared over the  Random forest  .The Mean accuracy of the Artificial Neural Network is higher than  Random forest  .

**Keywords:** Efficiency, 5G Network Services, Artificial Neural Network (Artificial Neural Network),  Random forest   Algorithm, Comparison

**INTRODUCTION:**

The development of 5G networks is a key development in this era of swift digital change, offering unmatched speed, connectedness, and revolutionary possibilities.[(Du et al. 2019)](https://paperpile.com/c/BQ0vtf/KM92) Meeting the constantly increasing demands of a connected society, however, continues to pose a significant challenge: assuring the best provision of 5G network services. [(Du et al. 2019; Shanmuganathan and Samarasinghe 2016)](https://paperpile.com/c/BQ0vtf/KM92+m9my)This research explores the use of sophisticated computational methods, including Random Forest algorithms and Artificial Neural Networks (ANN), to improve 5G network performance.[(Milovanovic, Bojkovic, and Fowdur 2023)](https://paperpile.com/c/BQ0vtf/kHwK) This study compares different algorithms in order to determine how well each one performs in terms of maximizing important performance indicators and enabling smooth connection in 5G networks.

A new age of connection marked by ultra-low latency, massive data throughput, and pervasive access has begun with the introduction of 5G networks. [(Pande and Khamparia 2024)](https://paperpile.com/c/BQ0vtf/13N2)However, as the need for uninterrupted connectivity keeps rising, it becomes more and more necessary to optimize network efficiency. [(Yao, Jiang, and Qian 2019)](https://paperpile.com/c/BQ0vtf/AmhO)Conventional methods frequently fail to satisfy the dynamic needs of 5G networks, hence new ways based on cutting-edge machine learning techniques must be investigated. [(Warden and Situnayake 2019)](https://paperpile.com/c/BQ0vtf/kQ7I)This is why it is so important to use Artificial Neural Network (ANN) algorithms, which are well known for their capacity to simulate the complex functions of the human brain and learn adaptively from large datasets in order to maximize network performance.

Simultaneously, Random Forest algorithms have become a potent instrument in machine learning, especially for applications involving regression and classification.[(Chetot 2022)](https://paperpile.com/c/BQ0vtf/MqJ8) Random Forest techniques provide resilience and scalability by utilizing an ensemble of Random forests, which makes them ideal for managing complicated datasets and reducing overfitting problems.[(Osseiran, Monserrat, and Marsch 2016)](https://paperpile.com/c/BQ0vtf/62rS) In contrast to ANN algorithms, their effectiveness in streamlining the delivery of 5G network services is yet largely unknown.[(Deng 2023)](https://paperpile.com/c/BQ0vtf/6N7W) In order to close this gap, a thorough comparison examination of the performance of the Random Forest and ANN algorithms in the context of 5G network optimization is carried out in this paper.

This research aims to clarify the effectiveness of ANN and Random Forest algorithms in improving the performance of 5G network services via extensive testing and analysis. [(Peng, Zhao, and Sun 2020)](https://paperpile.com/c/BQ0vtf/YHy5)The insights obtained from this study are intended to educate stakeholders in the telecommunications sector by assessing important performance measures including throughput, latency, and resource usage. This will enable the adoption of improved network provisioning techniques and educated decision-making. In the end, this research project aims to advance the development of 5G networks to previously unheard-of levels of effectiveness and performance, opening up a plethora of prospects for seamless connection, digital innovation, and social transformation.

**MATERIALS AND METHODS**

This research study was conducted in the Quantum Intelligence Laboratory of the Computer Science Engineering Department at the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences. This research work consists of two sample groups. Each group consists of sample size 20 in total (N=20). Artificial Neural Network and  Random forest   were the two algorithms in Machine learning that were used to compare the datasets.

The datasets are taken from kaggle.com which was stored in .csv format.The file consists of 5938 rows and 2 columns.For the Artificial Neural Network, 30% of the whole dataset was used as the test size and the remaining 70% was used as the training set. The whole dataset was fitted for training the Artificial Neural Network and  Random forest   in Machine learning. By Using Python 3.11, the accuracy of both the models was evaluated on a sample size of 20.

**Artificial Neural Network**

Inspired by the neural networks seen in the brain, the Artificial Neural Network (ANN) algorithm is made up of linked layers of nodes. In order to reduce prediction mistakes, it learns from data by modifying the weights and biases between neurons. ANNs are frequently used for tasks like pattern recognition, regression, and classification. They are particularly good at extracting intricate correlations from big datasets. Even though ANNs are flexible and efficient, they can overfit and require a large amount of data for training. Computational complexity and decision interpretation provide challenges. However, ANNs remain relevant in many domains such as financial analysis, natural language processing, and picture identification due to advances in algorithms and computer capacity.

**Formula:**

f(x)\=σ(∑i\=1n​wi​xi​+b)

Where,

\*   f(x) is the output of the neural network.

\*   xix\\_ixi​ are the input features.

\*   wiw\\_iwi​ are the weights associated with each input feature.

\*   bbb is the bias term.

\*   σ\\sigmaσ is the activation function applied to the weighted sum of inputs and biases.

**Pseudocode**

Input: Training Dataset

Output: Accuracy

Step 1: Collecting required volume of dataset.

Step 2: Next stage is pre-processing.

Step 3: If any noise or empty spaces are there, it needs to be removed for further processing.

Step 4: Remove null values.

Step 5: extract features

Step 6: train the model with features

Step 7: The model for the classification process is developed and trained.

Step 8: Allocating 81% of the dataset for training and remaining 19% for testing.

Step 9: The classification is done with required accuracy range..

Return Accuracy

End

**Random forest  Algorithm**

 Random forest  is a regularization method for  Random forest   that helps to reduce overfitting and multicollinearity. To reduce the coefficients to zero, it incorporates a penalty term into the ordinary least squares (OLS) approach. Smaller coefficients are encouraged by this penalty term, which is based on the square of the coefficients' magnitudes. A hyperparameter known as the regularization parameter—often abbreviated as λ—controls the degree of regularization. When multicollinearity exists among the predictors or when working with high-dimensional data,  Random forest  is especially helpful. By avoiding overfitting, it contributes to the model's improved generalization performance.

Formula:

β^​ridge​\=argminβ​{∑i\=1N​(yi​−β0​−∑j\=1p​xij​βj​)2+λ∑j\=1p​βj2​}

Where:

\*   β^ridge\\hat{\\beta}\\_{ridge}β^​ridge​ represents the estimated coefficients for  Random forest .

\*   yiy\\_iyi​ denotes the observed values of the dependent variable.

\*   β0\\beta\\_0β0​ is the intercept term.

\*   xijx\\_{ij}xij​ denotes the values of the jjj\-th independent variable for the iii\-th observation.

\*   βj\\beta\\_jβj​ are the coefficients being estimated.

\*   ppp represents the number of independent variables.

\*   λ\\lambdaλ is the regularization parameter, controlling the strength of regularization.

\*   The first term represents the ordinary least squares (OLS) loss function, which minimizes the difference between observed and predicted values.

\*   The second term represents the penalty term, which penalizes large coefficients to prevent overfitting.

**Pseudocode**

Input: Training Dataset

Output: Accuracy

Step 1: Collecting required volume of dataset.

Step 2: Next stage is pre-processing.

Step 3: If any noise or empty spaces are there, it needs to be removed for further processing.

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Step 9: The classification is done with required accuracy range.

Return Accuracy

End

A system possessing configuration of Windows OS, Storage-50GB, RAM-8GB  is utilized. Language used is Python, either implemented in Jupyter (Anaconda) or Google Collab. Processor used is intel i5. Independent variables for analyzing chess prediction in Images/Videos. The accuray gain is considered as a dependent variable.

**Statistical Analysis**:

The IBM SPSS program, version 25, was used to perform the statistical analysis for this study. It offered a graphical depiction of the accuracy attained by the investigation by treating the brightness and contrast as dependent variables and the dataset as independent variables. The results of the Artificial Neural Network and  Random forest   were compared using an independent T-test.

**Result:**

The application of machine learning models to enhance the accuracy of detecting the emotion from the text of a chosen dataset. The Artificial Neural Network algorithm and  Random forest   Algorithm are examined, and detection is carried out successfully; the suggested study offers superior performance to the Artificial Neural Network algorithm.

**Discussion:**

Our investigation has produced informative results about how Big Data Analytics might improve 5G network performance, namely by using Random Forest and Artificial Neural Network (ANN) algorithms. [(Pande and Khamparia 2024)](https://paperpile.com/c/BQ0vtf/13N2)Our results generally show that the ANN algorithm performs better than the Random Forest approach when it comes to improving many critical performance metrics like latency, throughput, and resource consumption. [(Barakabitze and Hines 2022)](https://paperpile.com/c/BQ0vtf/ifEW)This result is consistent with other studies that have demonstrated the greater efficacy of ANN algorithms in various applications both inside and outside of the telecoms industry. [(Larsson 2018)](https://paperpile.com/c/BQ0vtf/gtnh)The comparison between our findings and those of other research highlights the importance of ANN algorithms in advancing network efficiency and confirms the general agreement on their efficacy in enhancing 5G network services.

A wide range of factors influence our search, from the difficulties involved in algorithmic optimization to the intrinsic complexity of 5G networks. Because 5G technology is dynamic, it brings complexity that affect how well Big Data Analytics algorithms perform, requiring a sophisticated grasp of user behavior and network dynamics. Furthermore, the ensemble nature of Random Forest algorithms adds complexity to model interpretation[(Al-Dulaimi, Wang, and Chih-Lin 2018)](https://paperpile.com/c/BQ0vtf/lVa2) and parameter adjustment, while the scalability and processing needs of ANN algorithms provide difficulties for real-time deployment.[(Reddy et al. 2023)](https://paperpile.com/c/BQ0vtf/wxcj) Furthermore, algorithmic efficiency is highly dependent on the availability and quality of data, highlighting the necessity of rigorous data collecting and preparation methods.

Even with our study's encouraging results, there are still several shortcomings that should be noted in addition to potential directions for further investigation. [(Menon et al. 2023)](https://paperpile.com/c/BQ0vtf/n9Dl)A constraint pertains to the extent to which our findings may be applied to various network topologies and deployment contexts. Subsequent investigations may examine the suitability of Big Data Analytics methodologies in diverse network contexts and evaluate the influence of elements like network slicing and edge computing. Furthermore, there is still need for research into how to make machine learning models easier to understand and comprehend, especially when it comes to Random Forest algorithms. Furthermore, in order to maximize the synergies between ANN and Random Forest algorithms for improved network optimization, future research may explore hybrid systems that combine their respective advantages.

Finally, by comparing the results of Random Forest and ANN algorithms, our study highlights how Big Data Analytics may significantly improve the effectiveness of 5G network services. This study advances the state-of-the-art in 5G network optimization by clarifying the factors influencing algorithmic performance and identifying directions for future research. It also establishes the foundation for utilizing cutting-edge computational techniques to achieve previously unheard-of levels of network efficiency and performance.

**Conclusion :**

Improving the Efficiency of 5G Network Services with Artificial Neural Network (ANN) Algorithm in comparison with  Random forest   Algorithm. The ability of ANN algorithms, in contrast to  Random forest  , to capture complicated, nonlinear relationships within large datasets is a crucial advantage in the complex world of telecommunications. They can improve forecasts and dynamically optimize network services thanks to their constant learning and adaptability. Although  Random forest   is easy to use and computationally efficient, it is not suitable for 5G networks' complex patterns. The accuracy value of Artificial Neural Network is 71.40%, while that of  Random forest   is 64.26%. The analysis reveals that the Artificial Neural Network (71.40%) performs worse than  Random forest   (64.26%).

**DECLARATIONS**

**Conflict of Interests**

This manuscript does not disclose any conflicts of interest. To maintain our commitment to academic integrity, we have rigorously ensured the originality of our work to prevent any inadvertent entanglement with issues related to academic misconduct.

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**Authors Contribution**

Data gathering, analysis, and text creation were all actively participated in by authors. Data validation and pre preprocessing and model building was also done by the authors.

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**Tables and Figures**

**Table1.** The performance measurements of the comparison between the ANN and  Random forest classifiers are presented in Table 1. The ANN has an accuracy rate of 71.40, whereas the  Random forest has an accuracy rate of 64.26. With a greater rate of accuracy, the ANN performs better than the Random forest.

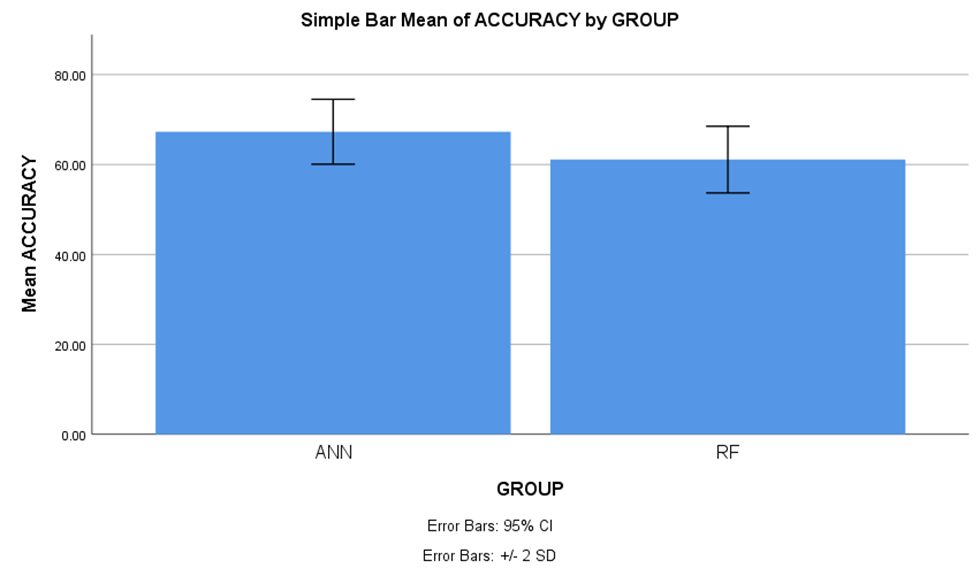
| **S.No** | **Test Size** | **ACCURACY RATE** | |
| --- | --- | --- | --- |
| **Artificial Neural Networks** | **Random forest** |
| 1 | Test 1 | 69.75 | 63.98 |
| 2 | Test 2 | 63.52 | 57.08 |
| 3 | Test 3 | 64.56 | 56.28 |
| 4 | Test 4 | 72.18 | 64.87 |
| 5 | Test 5 | 67.39 | 64.28 |
| 6 | Test 6 | 72.38 | 65.38 |
| 7 | Test 7 | 69.27 | 61.18 |
| 8 | Test 8 | 68.23 | 60.71 |
| 9 | Test 9 | 63.75 | 55.40 |
| 10 | Test 10 | 64.75 | 61.92 |
| Average Test Results | | 71.40 | 64.26 |

**Table 2.** It illustrates the statistical calculations for the ANN and  Random forest classifiers, including mean, standard deviation, and mean standard error. Mean, standard deviation and standard error mean for ANN are 67.5500,3.36913 And 1.06541 respectively. Similarly for  Random forest the mean, standard deviation and standard error mean are 30.3090,6.95474 And 2.19928 respectively.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Group** | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
| **Accuracy** | Artificial Neural Networks | 10 | 67.2980 | 3.60554 | 1.14017 |
| Random forest | 10 | 61.1080 | 3.70662 | 1.17214 |

**Table 3.**The statistical calculation for independent variables of ANN in comparison with the  Random forest classifier has been calculated. The significance level for the rate of accuracy is 0.772. Using a 95% confidence interval, the ANN and  Random forest algorithms are compared using the independent samples T-test. The following measures of statistical significance are included in this test of independent samples: p value of <.001, significance (two-tailed), mean difference, standard error of mean difference, and lower and upper interval differences.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **Levene’s test for equality of variances** | | **T-test for equality means with 95% confidence interval** | | | | | | |
| **f** | **Sig.** | **t** | **df** | **Sig. (2-tailed)** | **Mean difference** | **Std.Error difference** | **Lower** | **Upper** |
| **Accuracy** | **Equal variances assumed** | 0.002 | 0.962 | 3.785 | 18 | 0.002 | 6.19000 | 1.63520 | 2.75456 | 9.62544 |
| **Equal Variances not assumed** | 3.785 | 17.986 | 0.003 | 6.19000 | 1.63520 | 2.75438 | 9.62562 |



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