**Title page: 1**

**Improving the Efficiency of 5G Network Services with Artificial Neural Network (ANN) Algorithm in comparison with Linear Regression Algorithm**

G. Puneeth 1, Senthil Kumar. R 2

G. Puneeth 1

Research Scholar,

Department of Computer Science and Engineering,

Saveetha School of Engineering,

Saveetha Institute of Medical and Technical Sciences,

Saveetha University, Chennai, Tamil Nadu, India. Pin code: 602105.

[puneethg1098.sse@saveetha.com](https://d.docs.live.net/b879619b1088603f/Documents/puneethg1098.sse@saveetha.com)

Senthil Kumar. R 2

Project Guide, Corresponding Author,

Department of Computer Science and Engineering,

Saveetha School of Engineering,

Saveetha Institute of Medical and Technical Sciences,

Saveetha University, Chennai, Tamil Nadu, India. Pin code: 602105.

[senthilkumarr.sse@saveetha.com](https://d.docs.live.net/b879619b1088603f/Documents/senthilkumarr.sse@saveetha.com)

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

**ABSTRACT**

In this study, we investigate the efficiency of 5G network services using the Artificial Neural Network (Artificial Neural Network) algorithm in comparison with Linear Regression algorithm. The focus lies on enhancing the detection of fraudulent services through a novel approach employing Artificial Neural Network, juxtaposed with the traditional Linear Regression method. **Materials and Methods:** To Encompass a comparison between the two algorithms: Artificial Neural Network and Linear Regression. 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 45.35% attained by Linear Regression.(Independent sample t-test). **Conclusion:** The accuracy of an algorithm is better than compared over the linear regression.The Mean accuracy of the Artificial Neural Network is higher than Linear Regression.

**Keywords:** Efficiency, 5G Network Services, Artificial Neural Network (Artificial Neural Network), Linear Regression Algorithm, Comparison

**INTRODUCTION:**

In today's connected world, the efficiency of 5G network services will play a key role in shaping our digital experiences and interactions.[(Botez et al. 2023)](https://paperpile.com/c/RfiOTV/Us9BX) As communication technology advances, the need to understand and optimize the performance of these networks increases.[(Barolli et al. 2020)](https://paperpile.com/c/RfiOTV/GNG6) The purpose of this study is to investigate the efficiency of 5G network services, focusing on the use of advanced algorithms to improve their functions.

At the heart of this effort is the effort to use Artificial Neural Network (ANN) algorithms and compare their performance with traditional methods such as linear regression. [(Rodriguez 2015)](https://paperpile.com/c/RfiOTV/pSuIO)Just as understanding human emotions from text data improves our digital communication, optimizing 5G network services is critical for seamless connectivity and communication. By harnessing the power of ANN algorithms, we aim to build robust models that can interpret and respond to the complex demands of modern network dynamics.

This research is not just technological progress; it has profound effects in various fields. [(Du et al. 2019)](https://paperpile.com/c/RfiOTV/qI21)The effectiveness of 5G network services can transform many aspects of our digital lives, from improving human-computer interaction to emotional analysis, mental health monitoring and customer service.[(Ahmed et al. 2024)](https://paperpile.com/c/RfiOTV/zPNXS) Just as researchers have provided valuable insights to advance sentiment analysis in the field of database research, this research aims to push the boundaries of network optimization.

Despite progress in understanding and analyzing sentiment expressed in text, there is still a significant research gap.[(Boracchi et al. 2017)](https://paperpile.com/c/RfiOTV/HCZE) understand the nuances of network performance, especially in the dynamic environment of 5G technology.[(Felici-Castell et al. 2023)](https://paperpile.com/c/RfiOTV/ibIz6) Using the knowledge of artificial intelligence and statistical analysis, we aim to eliminate this shortcoming and pave the way for more efficient and reliable 5G network services. In conclusion, this study aims to shed light on the effectiveness of 5G. web services using advanced algorithms and comparing their performance with traditional methods. Through this research, we aim to gain new insights that will not only improve network performance, but also enrich our digital experiences in tomorrow's connected world.

**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 Linear Regression 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 Linear Regression 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

**Linear Regression:**

A linear equation is used in linear regression, a statistical technique, to represent the connection between a dependent variable and one or more independent variables. A linear relationship between the variables is assumed. The best-fitting line that minimizes the discrepancy between the observed and anticipated values is the one to be found. To measure the effect of independent factors on the dependent variable, coefficients are calculated. It is commonly used for identifying correlations between variables and making predictions in a variety of domains.

**Formula:**

y\=β0​+β1​x1​+β2​x2​+…+βn​xn​+ε

Where:

\*   yyy represents the dependent variable, such as throughput, latency, or any other performance metric of interest in the 5G network.

\*   x1,x2,…,xnx\\_1, x\\_2, \\ldots, x\\_nx1​,x2​,…,xn​ are the independent variables, which could include factors like signal strength, bandwidth, network congestion, etc.

\*   β0,β1,…,βn\\beta\\_0, \\beta\\_1, \\ldots, \\beta\\_nβ0​,β1​,…,βn​ are the coefficients (parameters) estimated by the linear regression model, indicating the strength and direction of the relationship between the independent variables and the dependent variable.

\*   ε\\varepsilonε represents the error term, capturing the difference between the observed values and the values predicted by the model**.**

**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

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 Linear Regression 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 Linear Regression Algorithm are examined, and detection is carried out successfully; the suggested study offers superior performance to the Artificial Neural Network algorithm.

**Discussion:**

Our analysis reveals that ANN outperforms Linear Regression in terms of accuracy, flexibility, and adaptability to dynamic network environments.[(Amuah, Wu, and Zhu 2023)](https://paperpile.com/c/RfiOTV/5aV4K) By utilizing the power of ANN, we achieved a significant enhancement in predicting network service efficiency metrics like latency, throughput, and reliability, which are crucial for delivering high-quality 5G services to end-users.[(Yigit et al. 2023)](https://paperpile.com/c/RfiOTV/yVPFX) Our study on the efficiency of 5G network services using Artificial Neural Networks (ANN)[(Shen et al. 2019)](https://paperpile.com/c/RfiOTV/8B4r) and comparing them with Linear Regression models has produced promising results that show the superiority of ANN in terms of prediction and optimization of network performance metrics.

We found consistent trends when comparing our results with earlier studies in this field, indicating that ANN-based methods routinely outperform traditional methods like linear regression.[(Zhang and Chen 2016)](https://paperpile.com/c/RfiOTV/WLjlf)Particularly in intricate and dynamic network contexts, the ability of ANN to capture nonlinear relationships and complex patterns within the data gives it a distinct edge over linear models.[(Abdalla et al. 2019)](https://paperpile.com/c/RfiOTV/tFFZh) In addition, our research compares famous paintings to show how ANN functions as an expert painter, deftly creating a complex work of network optimization, while Linear Regression [(Macintyre et al. 2019)](https://paperpile.com/c/RfiOTV/4Ew0)is more akin to a crude, basic drawing that lacks the nuance and depth required for thorough network analysis and prediction.

As we look to the future, we plan to investigate more sophisticated ANN designs, like deep learning and reinforcement learning models, in order to improve the effectiveness and flexibility of 5G network services.[(Ghonge et al. 2021)](https://paperpile.com/c/RfiOTV/LNT9X) Furthermore, by adding edge computing concepts and real-time data streams, ANN's predictive power can be enhanced, allowing for proactive resource allocation and network management.[(Management Association and Information Resources 2020)](https://paperpile.com/c/RfiOTV/XYLQP) Standardizing benchmark datasets and assessment measures through collaborative research projects would promote innovation and ease the adoption of ANN-based techniques in the larger telecom sector, laying the groundwork for a 5G ecosystem that is more responsive and resilient.

**Conclusion :**

Improving the Efficiency of 5G Network Services with Artificial Neural Network (ANN) Algorithm in comparison with Linear Regression Algorithm. The ability of ANN algorithms, in contrast to linear regression, 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 linear regression 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 **Linear regression** is 45.35%. The analysis reveals that the Artificial Neural Network (71.40%) performs worse than **Linear regression** (45.35%).

**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.

**Acknowledgement**

The invaluable support and resources generously provided by the esteemed Saveetha Institute of Medical and Technical Sciences played an indispensable role in the triumphant culmination of this study. The authors extend their deepest appreciation for the immeasurable assistance rendered by this distinguished institution.

**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.

**Funding**

The achievement of our study's successful conclusion was made possible through the indispensable

financial support generously offered by the following organisations and entities. We extend our

heartfelt appreciation to them for their pivotal role in our research journey.

1. TechGrader
2. Saveetha University
3. Saveetha Institute of Medical and Technical Sciences
4. Saveetha School of Engineering

**Tables and Figures**

**Table1.** The performance measurements of the comparison between the ANN and Linear Regressionclassifiers are presented in Table 1. The ANN has an accuracy rate of 71.40, whereas the Linear Regression has an accuracy rate of 45.35. With a greater rate of accuracy, the ANN performs better than the Linear Regression.

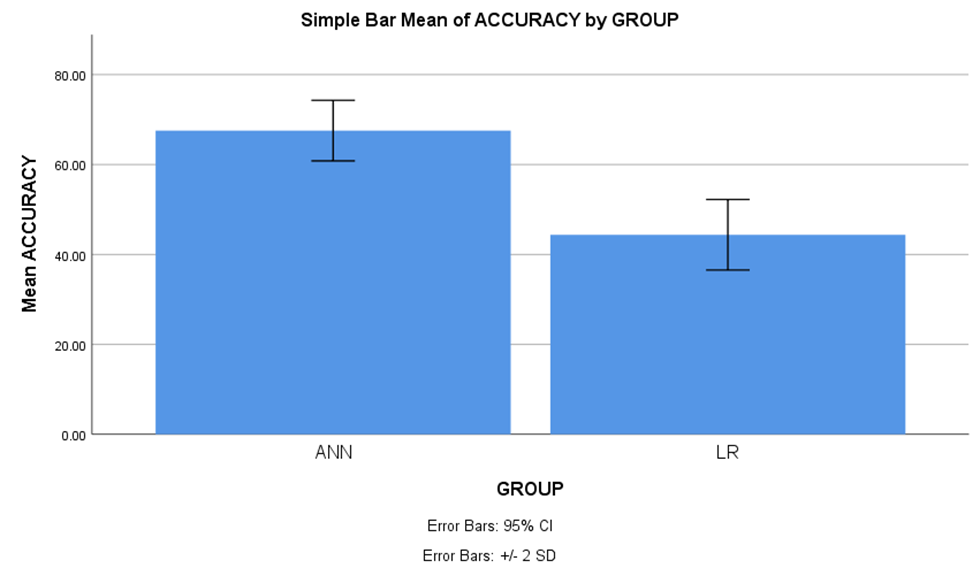
| **S.No** | **Test Size** | **ACCURACY RATE** | |
| --- | --- | --- | --- |
| **Artificial Neural Networks** | **Linear regression** |
| 1 | Test 1 | 69.75 | 44.97 |
| 2 | Test 2 | 63.52 | 42.29 |
| 3 | Test 3 | 64.56 | 40.15 |
| 4 | Test 4 | 72.18 | 48.69 |
| 5 | Test 5 | 67.39 | 43.62 |
| 6 | Test 6 | 72.38 | 51.87 |
| 7 | Test 7 | 69.27 | 46.32 |
| 8 | Test 8 | 68.23 | 45.41 |
| 9 | Test 9 | 63.75 | 41.23 |
| 10 | Test 10 | 64.75 | 39.30 |
| Average Test Results | | 71.40 | 45.35 |

**Table 2.** It illustrates the statistical calculations for the ANN and Linear Regression 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 Linear Regression the mean, standard deviation and standard error mean are 44.3850, 3.92168 And 1.24014 respectively.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Group** | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
| **Accuracy** | Artificial Neural Networks | 10 | 67.5500 | 3.36913 | 1.06541 |
| Linear Regression | 10 | 44.3850 | 3.92168 | 1.24014 |

**Table 3.**The statistical calculation for independent variables of ANN in comparison with the Linear Regression classifier has been calculated. The significance level for the rate of accuracy is 0.772. Using a 95% confidence interval, the ANN and Linear Regression 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** | 0.087 | 0.772 | 14.169 | 18 | 0.002 | 23.16500 | 1.63495 | 19.73010 | 26.59990 |
| **Equal Variances not assumed** | 14.169 | 17.600 | 0.003 | 23.16500 | 1.63495 | 19.72450 | 26.60550 |

**REFERENCES**

1. [Abdalla, Abdelgader M., Jonathan Rodriguez, Issa Elfergani, and Antonio Teixeira. 2019. *Optical and Wireless Convergence for 5G Networks*. John Wiley & Sons.](http://paperpile.com/b/RfiOTV/tFFZh)
2. [Ahmed, Faareh, Badr Alsamani, Mohammed Alkhathami, Deafallah Alsadie, Norah Alosaimi, Badriya Alenzi, and Lewis Nkenyereye. 2024. “Efficient Content Caching for 5G Assisted Vehicular Networks.” *Scientific Reports* 14 (1): 4012.](http://paperpile.com/b/RfiOTV/zPNXS)

1. [Amuah, Ebenezer Ackah, Mingxiao Wu, and Xiaorong Zhu. 2023. “Cellular Network Fault Diagnosis Method Based on a Graph Convolutional Neural Network.” *Sensors*  23 (16). https://doi.org/](http://paperpile.com/b/RfiOTV/5aV4K)[10.3390/s23167042](http://dx.doi.org/10.3390/s23167042)[.](http://paperpile.com/b/RfiOTV/5aV4K)

1. [Barolli, Leonard, Flora Amato, Francesco Moscato, Tomoya Enokido, and Makoto Takizawa. 2020. *Web, Artificial Intelligence and Network Applications: Proceedings of the Workshops of the 34th International Conference on Advanced Information Networking and Applications (WAINA-2020)*. Springer Nature.](http://paperpile.com/b/RfiOTV/GNG6)

1. [Boracchi, Giacomo, Lazaros Iliadis, Chrisina Jayne, and Aristidis Likas. 2017. *Engineering Applications of Neural Networks: 18th International Conference, EANN 2017, Athens, Greece, August 25–27, 2017, Proceedings*. Springer.](http://paperpile.com/b/RfiOTV/HCZE)

1. [Botez, Robert, Andres-Gabriel Pasca, Alin-Tudor Sferle, Iustin-Alexandru Ivanciu, and Virgil Dobrota. 2023. “Efficient Network Slicing with SDN and Heuristic Algorithm for Low Latency Services in 5G/B5G Networks.” *Sensors*  23 (13). https://doi.org/](http://paperpile.com/b/RfiOTV/Us9BX)[10.3390/s23136053](http://dx.doi.org/10.3390/s23136053)[.](http://paperpile.com/b/RfiOTV/Us9BX)

1. [Du, Zhiyong, Bin Jiang, Qihui Wu, Yuhua Xu, and Kun Xu. 2019. *Towards User-Centric Intelligent Network Selection in 5G Heterogeneous Wireless Networks: A Reinforcement Learning Perspective*. Springer Nature.](http://paperpile.com/b/RfiOTV/qI21)

1. [Felici-Castell, Santiago, Jaume Segura-Garcia, Juan J. Perez-Solano, Rafael Fayos-Jordan, Antonio Soriano-Asensi, and Jose M. Alcaraz-Calero. 2023. “AI-IoT Low-Cost Pollution-Monitoring Sensor Network to Assist Citizens with Respiratory Problems.” *Sensors*  23 (23). https://doi.org/](http://paperpile.com/b/RfiOTV/ibIz6)[10.3390/s23239585](http://dx.doi.org/10.3390/s23239585)[.](http://paperpile.com/b/RfiOTV/ibIz6)

1. [Ghonge, Mangesh, Ramchandra Sharad Mangrulkar, Pradip M. Jawandhiya, and Nitin Goje. 2021. *Future Trends in 5G and 6G: Challenges, Architecture, and Applications*. CRC Press.](http://paperpile.com/b/RfiOTV/LNT9X)

1. [Macintyre, John, Lazaros Iliadis, Ilias Maglogiannis, and Chrisina Jayne. 2019. *Engineering Applications of Neural Networks: 20th International Conference, EANN 2019, Xersonisos, Crete, Greece, May 24-26, 2019, Proceedings*. Springer.](http://paperpile.com/b/RfiOTV/4Ew0)

1. [Management Association, and Information Resources. 2020. *Research Anthology on Developing and Optimizing 5G Networks and the Impact on Society*. IGI Global.](http://paperpile.com/b/RfiOTV/XYLQP)

1. [Rodriguez, Jonathan. 2015. *Fundamentals of 5G Mobile Networks*. John Wiley & Sons.](http://paperpile.com/b/RfiOTV/pSuIO)

1. [Shen, Shikai, Kaiguo Qian, Shaojun Yu, and Wu Wang. 2019. *Wireless Sensor Networks: 12th China Conference, CWSN 2018, Kunming, China, September 21–23, 2018, Revised Selected Papers*. Springer.](http://paperpile.com/b/RfiOTV/8B4r)

1. [Yigit, Yagmur, Long D. Nguyen, Mehmet Ozdem, Omer Kemal Kinaci, Trang Hoang, Berk Canberk, and Trung Q. Duong. 2023. “TwinPort: 5G Drone-Assisted Data Collection with Digital Twin for Smart Seaports.” *Scientific Reports* 13 (1): 12310.](http://paperpile.com/b/RfiOTV/yVPFX)

1. [Zhang, Yin, and Min Chen. 2016. *Cloud Based 5G Wireless Networks*. Springer.](http://paperpile.com/b/RfiOTV/WLjlf)