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Enhancing Intelligent Building Energy Efficiency with Advanced Predictive Modelling: A Comparison of Random Forest and ANN Models

INTRODUCTION

- The global recognition of energy efficiency in intelligent buildings has surged, particularly with the emergence of IoT and smart appliances. Optimizing energy consumption has become not only feasible but also vital in the pursuit of sustainable practices.
- Despite widespread attention to energy conservation, there remains a noticeable gap in exploring the application of machine learning algorithms to enhance energy efficiency in buildings. While traditional methods have been extensively studied, the potential of machine learning algorithms, such as Random Forest and Artificial Neural Networks (ANN), remains relatively untapped.
- This study aims to address the gap by comparing the effectiveness of Random Forest and ANN models in enhancing energy efficiency within intelligent buildings. The objectives include assessing the performance of both models in predicting energy consumption patterns, analyzing their ability to optimize energy usage, and ultimately determining which model offers superior efficiency gains.
- The research addresses the significant disparity in resource consumption and prediction accuracy in smart building energy efficiency programs.
- The study used machine learning techniques, namely Random Forest (RF) and Artificial Neural Networks (ANN), on real-world data.

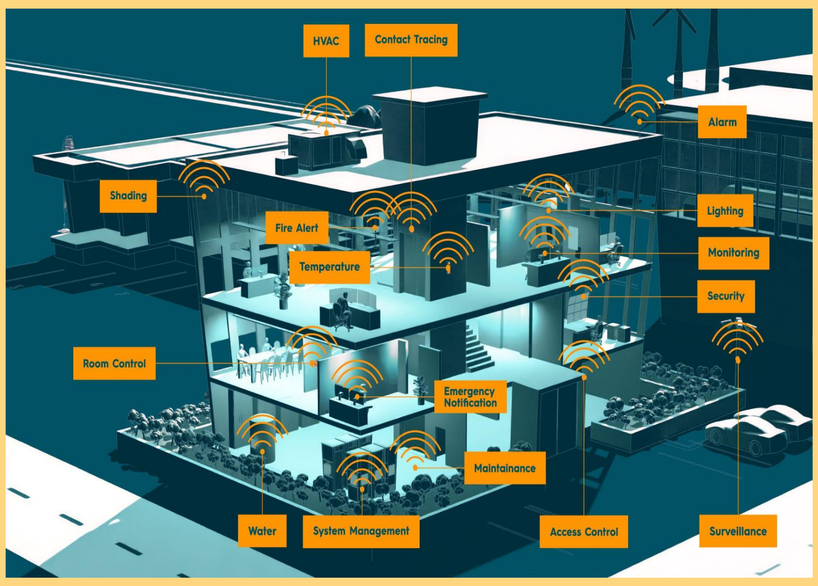
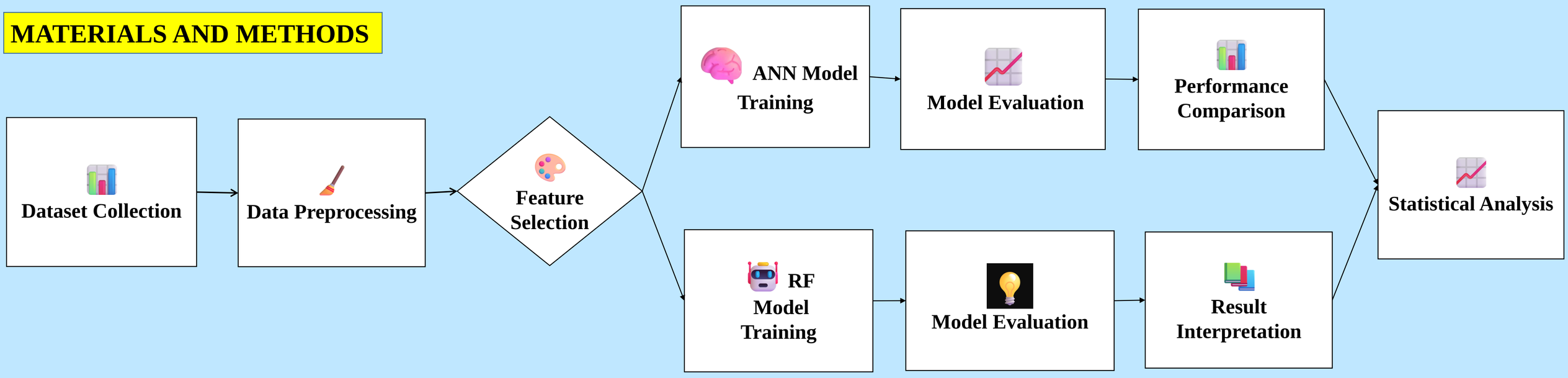


Fig. 1: Integrated Building Automation: Control and Efficiency

MATERIALS AND METHODS



Energy Consumption Optimization Journey

RESULTS

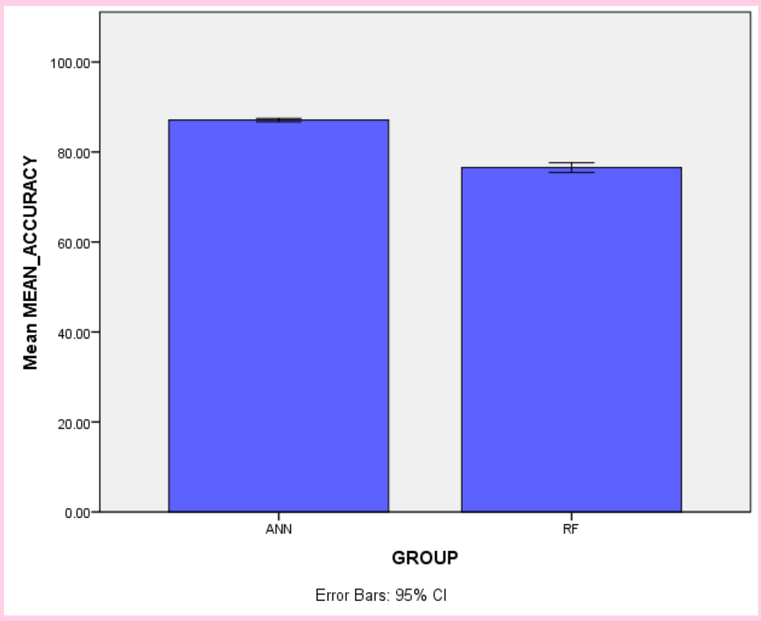


Fig. 2: Represents the Mean Accuracy of ANN and RF

Table 1: Represents the mean and standard deviation of the group and the accuracy of the existing and proposed methods

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
MEAN_ACCURACY	ANN	5	87.098	28986	0.12963
	RF	5	76.528	0.88143	39419

Table 2: Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	10.570	0.293	36.024	18.00	0
Equal variances not assumed	10.570	0.293	36.024	10.924	0

- The ANN methodology demonstrated remarkable performance with an accuracy rate of 87.10%, while the Random Forest approach showed an accuracy rate of 76.53%

DISCUSSION AND CONCLUSION

- Based on T-test Statistical analysis, the significance value of p=0.001 (independent sample T-test p<0.05) is obtained and shows that there is a statistically significant difference between group 1 and group 2.
- Overall, the accuracy of the Artificial Neural Networks (ANN) - 87.10% and it is better than the other algorithm Recurrent Neural Networks (RNN) - 76.53%.
- The ANN model was found to be highly effective in pattern recognition for smart buildings.
- The results align with existing literature that suggests the superiority of ANN models in pattern recognition tasks.
- The study concludes that while ANN's exceptional accuracy highlights its effectiveness, RF shows that it can handle large datasets with durability.
- The study was limited by the size of the dataset used. Future studies could explore the use of larger datasets and other machine-learning models.
- For instance, factors like changes in occupancy patterns, seasonal variations, and technological advancements in building systems could impact the accuracy and generalizability of the forecasting models.

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