**Paper 1**

**Overview**

This paper proposes a new residual ensemble learning approach for solar irradiance forecasting, addressing the need for efficient solar energy systems and sustainable power demand management. It introduces a three-module approach, focusing on data selection and analysis from neighboring locations, correlation and feature importance measures for feature selection, and a residual ensemble learning model for accurate forecasting. The research aims to predict future values of solar irradiance with improved forecast performance, providing a reliable model for solar irradiance prediction.

**Problem**

The problem addressed by the research is the need for accurate solar irradiance forecasting for efficient solar energy systems and sustainable power demand management. The research aims to overcome the limitations of traditional linear forecasting methods and develop a model capable of capturing linear and non-linear characteristics for accurate forecasting.

**Solution**

The paper proposes a three-module approach: data selection and analysis, correlation and feature importance measures for feature selection, and a residual ensemble learning model for accurate forecasting. By combining advanced neural network architectures, the model aims to predict future values of solar irradiance with improved forecast performance.

**Approach**

The research approach involves the collection and analysis of multi-site data surrounding the target location using a hexagon gridding system. It proposes correlation and feature importance measures for feature selection. Additionally, it develops a novel residual ensemble forecast mechanism inspired by hybrid forecast mechanisms, accommodating linear and non-linear characteristics for accurate forecasting.

A**rchitecture**

The proposed solution includes a data selection module for collecting and analyzing multi-site data, a feature importance analysis module for selecting relevant features based on correlation measures, and a residual ensemble model comprised of advanced neural network architectures, including Dense and Recurrent Neural Networks (RNNs), for accurate and robust solar irradiance forecasting.

**Conclusion**

The research findings demonstrate the significance of utilizing multi-site data for solar irradiance forecasting and the effectiveness of the proposed residual ensemble learning approach. The improvements in forecast performance by approximately 2.5 percent in prediction error make the proposed approach a reliable model for solar irradiance prediction. The research has the potential to advance solar energy systems and sustainable power demand management by providing accurate and stable solar irradiance forecasts.

**Paper 2**

**Overview**

This paper presents a novel deep learning forecast model for accurately predicting future values of solar irradiance based on visual information. It addresses the pressing need for sustainable power production by leveraging solar energy. The proposed model integrates convolutional and attention-based LSTM layers to enhance the forecast performance, achieving an R2 score of more than 50 percent, indicating excellent forecast capability. The study focuses on bias and variance components to ensure model generalizability and concludes with significant contributions to solar time-series forecasting.

**Problem**

The research addresses the need for accurate solar irradiance forecasting, crucial for the planning and design of solar power plants. Solar power's intermittent and chaotic behavior demands robust forecasting mechanisms. The existing methods often overlook the model's bias and variance, affecting generalizability. There's a growing demand for reliable solar irradiance predictions due to the increasing use of solar power plants.

**Solution**

The paper proposes a deep learning forecast model utilizing convolutional and attention-based LSTM layers for accurate solar irradiance prediction. By leveraging NASA's Prediction of Worldwide Energy Resources (POWER) project data, the model analyzes visual information to enhance forecast performance. The proposed bias-variance evaluation method adds to the model's generalizability, providing insights into model complexity, misspecification, and data adequacy.

**Approach**

The research approach involves visualizing solar irradiance data from the POWER project, developing a deep learning forecast model using convolutional and attention-based LSTM layers, and analyzing bias and variance components for model evaluation. The study carefully selects two locations for solar datasets and conducts experiments with comparisons against various deep learning models to ensure robust model development and evaluation.

**Architecture**

The proposed solution integrates convolutional layers for spatial feature extraction and attention-based LSTM network for temporal dependencies. The convolutional layer identifies spatial patterns, which are further processed by the LSTM network to capture temporal dependencies, enhancing the model's forecasting capability. The bias-variance components evaluate the model's learning ability and generalizability, ensuring reliable forecast performance.

**Conclusion**

The research findings demonstrate the significance of integrating convolutional and attention-based LSTM layers for accurate solar irradiance forecasting. The proposed model shows exceptional forecast performance, addressing the critical need for reliable solar irradiance predictions. The bias-variance evaluation further contributes to the model's robustness and generalizability, making it a valuable solution for real-world solar power plant planning and deployment.

**Paper 3**

**Overview**

This paper focuses on the development of forecast models based on deep learning methodologies and multiple-site data to predict the daily solar irradiance in two locations of India. The study aims to address the challenges of predicting solar irradiance for efficient integration of solar energy into power grids. The research explores various deep learning models such as LSTM, GRU, CNN, bidirectional LSTM, and attention-based LSTM to forecast daily solar irradiance data. The performance evaluation shows the promise of the proposed methodology in accurately forecasting solar irradiance, leading to potential advancements in solar energy applications.

**Problem**

The research addresses the challenges of accurately predicting solar irradiance, which is crucial for effectively integrating solar energy into power systems. The paper highlights the chaotic and intermittent nature of solar power, emphasizing the need for competent forecasting strategies. It also outlines the limitations of traditional forecasting techniques such as linear models and the complexity of capturing non-linear patterns in solar irradiance.

**Solution**

The paper presents a solution based on deep learning methodologies, utilizing multiple-site solar irradiance data from historical records. It explores various deep learning models such as LSTM, GRU, CNN, bidirectional LSTM, and attention-based LSTM to forecast daily solar irradiance data. The results indicate improved forecast performance when using multiple-site data for prediction.

**Approach**

The research approach involves the collection of historical daily solar irradiance data from NASA's POWER project database and the development of deep learning forecast models using recurrent neural networks, convolutional neural networks, and attention mechanisms. The study analyzes the feature importance of nearby locations and evaluates the forecast performance using metrics such as mean squared error, root-mean-square error, and coefficient of determination.

**Architecture**

The architecture of the proposed solution involves the utilization of deep learning models, including LSTM, GRU, CNN, bidirectional LSTM, and attention-based LSTM, to process and forecast the daily solar irradiance data. The models analyze multiple-site solar irradiance data to predict the future solar data for target locations, leading to improved forecast accuracy and reliability.

**Conclusion**

The research findings demonstrate the potential for accurate solar irradiance forecasting using deep learning methodologies and multiple-site data. The study's focus on addressing the challenges of integrating solar energy into power systems and its emphasis on accuracy, performance, and reliability underscore the significance of the research. The proposed methodology showcases promising results and signifies advancements in the field of solar energy forecasting.