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Predicting the Impact of Climate Change on Solar Power Production using CNN-LSTM Models

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Abstract

This study uses a CNN-LSTM model to assess climate change impacts on solar power. The model, trained on meteorological data, predicts future solar output under different scenarios. It shows reduced solar efficiency in cloudy and polluted regions but stable performance in arid areas. While outperforming basic LSTM and CNN models, uncertainties remain due to climate variability and data limitations. The findings emphasize the need for adaptive energy planning and offer insights for policymakers and stakeholders.

Dataset

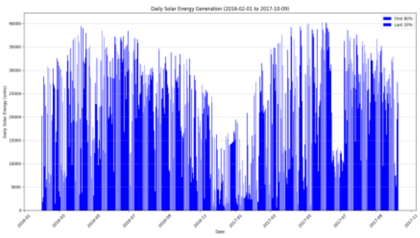

Figure 1 Daily Solar Irradiance Intensity over 682 Days (2016-2017)

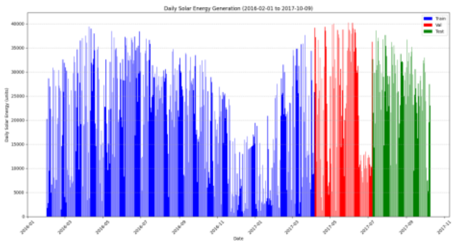

Figure 2 Dataset Division Diagram

Interpretability and significance analysis of the model

Model	MAE(KWh)	RMSE(KWh)	R^2
GRU	8388.14	9500.86	0.2
RNN	8388.14	9500.86	0.76
LSTM	**7539.03**	**9027.01**	**0.83**

Model	MAE(KWh)	RMSE(KWh)	R^2
RNN	8388.14	9500.86	0.76
LSTM	7817.07	9276.74	0.79
CNN-LSTM	7742.79	9214.10	0.83
ACTION-CNN-LSTM	**7755.86**	**9201.75**	**0.85**

By comparing the training data of RNN, GRU, LSTM, CNN-LSTM, and Acction-CNN-LSTM, it can be found that Acction-CNN-LSTM performs the best on the dataset used in this thesis.

Ensemble models

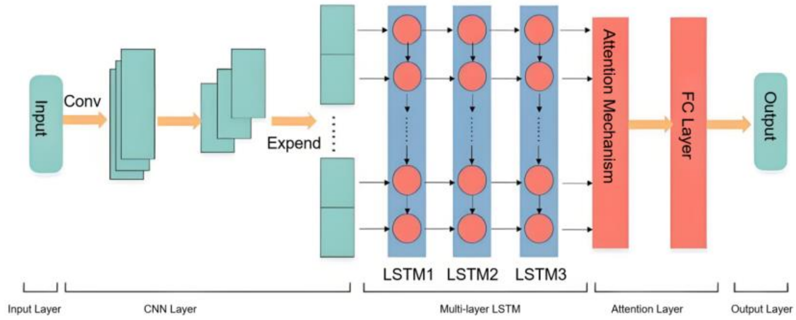

Figure 3 The entire structure of CNN-LSTM

The first layer is the input layer. It specifies the format of the input data (batch size, number of time steps, feature dimension). With the batch size set to 1 by default, the number of time steps denoted as, and the feature dimension denoted as , a single sample can be represented as a real number sequence matrix. Let be the vector representation of the data at the i-th time step in

Model evaluation

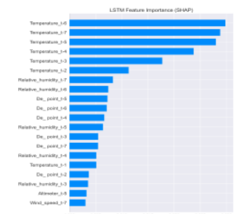

Figure 4Analysis under LSTM ModelS

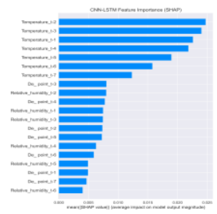

Figure 5SHAP Analysis under CNN-LSTM Models

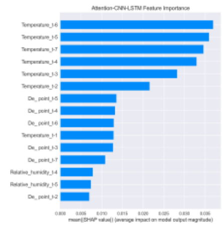

Figure 6SHAP Analysis under ACTON-CNN-LSTM Models

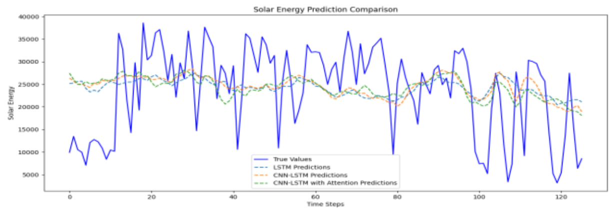

Figure 7 :Comparison of Actual Values and Predicted Values

It can be observed that the LSTM with the added attention mechanism performs the best.

WEB APPLICATION DEVELOPMENT

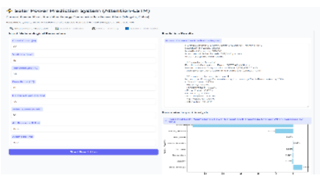

Figure8Single-Point Prediction

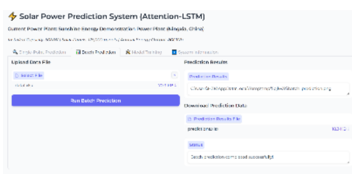

Figure9 Batch Prediction interface

The deployment runs in the browser, but only provides a web front-end interface and a JavaScript runtime environment, while the inference prediction still runs in the local terminal

Future work

1、Model Generalization Issues 2、Model Improvement for Efficiency of Diagnosis 3、Accurate Diagnosis on Specific Symptoms

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