



Title: Hybrid Machine Learning Algorithms for Solar Energy Prediction and Analysis

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Abstract:

Currently, scientists and researchers are concentrating on how to execute Sustainable Development Goal 7.3 (SDG7.3) while achieving energy efficiency for the growth of energy demand. The main problem with smart cities is to control their energy because their energy systems are so complex and to be measure. Solar energy is a crucial energy source for predicting future energy needs and achieving the two aforementioned vital goals. This research work developing hybrid machine learning algorithms namely LSTM (Long Short-Term Memory), Stacked LSTM and Bidirectional LSTM to predict incident and global solar radiation. The experiment was conducted by using real-time data which was collected in last five years and compared with various versions of LSTM algorithms being used to verify the

results. The various machine learning models are used to predict the solar radiation and compared the effectiveness of models for solar radiation prediction for the periods from 2018 to 2021. Among the 11 variants of LSTM experimented in this work, Bidirectional LSTM with tanh activation and both Adamax and Stochastic Gradient Descent (SGD) optimiser provided the best results in predicting both the global and solar radiation with RMSE of 0.12 and R^2 of 0.85. The proposed model is used to estimate solar energy for smart cities by using a hybrid LSTM model with adjustable parameters, resulting in high accuracy level.

The LSTM has an RMSE of 0.121 and further enhancements to LSTM like the stacked and Bidirectional LSTM resulted in RMSE of 0.12. One of the important elements for such a substantial improvement in performance metrics and prediction through the suggested methodology has implemented strong machine learning algorithms through high-level libraries using the Keras approach. Comparison of various models adopted worldwide gives insight into the various research methods in solar radiation prediction using LSTM. The results of the Machine Learning Models may be utilised to increase the efficiency of solar energy generation for smart cities in Tamilnadu. The models used for prediction here are not confined to the smart cities of the case study area but can be utilised elsewhere for the same applications and will produce results to the same effect.

Because of the rising demand for energy and the shortage of fossil fuels, renewable energy sources are the greatest source of energy for sustainable development. As a result, solar energy sources are efficiently used and thoroughly analysed in this research. Deep learning models were applied to predict the solar energy for few smart cities in India. Deep learning algorithms are the greatest way to forecast solar energy and can be successfully used for smart city energy management. The Sustainable Development Goal (SDG) 7.3 on energy efficiency is attained as a result of this research, and it also provides a valuable forecast for India's energy needs.

Biography

Dr. R. Rani Hemamalini is serving in the field of teaching for the past 30 years at various levels. Presently she is working as Professor and Head, Department of Electrical and Electronics Engineering at St. Peter's Institute of Higher Education and Research, Avadi, Chennai. Her area of research includes Process controls and Instrumentation, Embedded System, VLSI. She received BOYSCAST FELLOWSHIP award from DST and received Air India BOLT (Broad Outlook Learned Teacher) award from Air India. She visited United States of America, United Kingdom, Singapore, France, Greece, Switzerland, Malaysia and China in

connection with presentation of papers in the international conference through travel grants received from AICTE, CSIR and DST. Under her guidance 10 candidates completed Ph.D. and guiding 13 Ph.D. students. She carried one DST project, Two AICTE and one MoEFCC sponsored project related to control engineering with total cost of Rs. 100 lakhs. She has Organised more than 30 Seminars / Conference / workshop / FDP for engineering faculties which are sponsored by AICTE, DST, CSIR, BRNS, ICMR and DRDO. She has published more than 100 papers in the national/international journal and conferences. She is member of the Institute of Engineers (India), ISA, ISTE and IEEE.