Smart solar power (P23)

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Smart Solar Power

Project description:

- Electricity price fluctuations → Optimization of consumption
- Predicting weather and forecasting the solar intensity in the near future can help to decide when there is possible energy surplus.

Product Owner: Ott Kekišev - Proekspert AS

Team:

- Heigo Ers - Chemistry Doctoral Student, studying ionic liquids with computational and experimental methods
- Herman Klas-Ratas - Computer Science and Robotics MSc student, with experience in materials science and mechanical engineering
- Mait Metelitsa - Studying Conversion Master in IT.

Link: [https://github.com/heigoers/solarpower_ml](https://github.com/heigoers/solarpower_ml)
Datasets

Weather Data from 8 Estonian weather stations (2004 - 2020), provided by Estonian Weather Service (solar irradiance, wind speed, temperature, relative humidity, atmospheric pressure)

- Irradiance varied from 0 ... 952 W/m², mean 116 W/m²

RGB Satellite images, 6 months in 2019 (resolution 15 min) from Estonian Weather Service

- 24-hour Microphysics
- Natural Colour composition

Figure 1. Satellite image of Estonia in 24-hour Microphysics RGB composition
Approach 1:
- Predict the total solar irradiance of next hour using weather data of current hour of selected weather station
- Tested different regressions: KNN, Random Forest, Gradient Boosting, Decision Tree with preprocessing (PCA, MinMax Scaler)
- The lowest validation error: RF (68 W/m²)
- Rather poor results as RMSE remained high

Figure 2. RMSE-s of solar irradiance for validation set, shown model with smallest RMSE for each tested regressor
Approach 2:

- Based on weather data from 4 other stations predict solar power training 4 models with automated feature selection and model blending

- Using backward selection, for DT 10/19; GB 12/19; LM 19/19; RR 19/19 features were selected

Figure 3. Scheme of backward feature selection algorithm used

Figure 4. RMSE-s of solar irradiance for validation set
Approach 3:

- Predict the solar irradiance of next hour using satellite images features
- Used timeseries as input, which contained:
  - features from 8 hours of satellite images at weather station coordinates, right pixels found using transformation matrix
  - solar irradiance of next hour at selected coordinates
- Best results with Neural networks, containing LSTM layers.
- Lowest validation set RMSE: $57 \text{ W/m}^2$

Layers: LSTM(64 units) -> Batch Normalization -> LSTM(32 units) -> Dense(1)

Figure 5. Satellite image with markers showing the locations of weather stations
Conclusions

Predicting solar irradiance in near-future with good accuracy proved to be difficult

The best results out of tested models were gained with features from satellite images and Recurrent neural network with LSTM layers
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Thank You for Your Attention!