P09 – Smart solar power

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Goals

- Forecast **solar intensity** in a small interval (**5 min** to **2 hours**) (W / m^2)
- Find amount of solar **energy** that can be produced (kWh)
- GPS **coordinate** based
- Using cloudiness and UV, weather stations data
- **Satellite** images

The idea is to know if there is going to be **enough** solar power **available** for a short period of time.

First steps

Initial weather data from the weather station in **Physicum**, University of Tartu

- Research existing solutions
- Initial data cleansing and wrangling
- First insights
- Correlation matrix

Examples of existing solutions

Prediction of Solar Power Generation Based on Random Forest Regressor Model [1]

A. Khalyasmaa *et al*.

Day-ahead forecasting using **retrospective metering data** and **open source weather information** provided by meteorological services, **93% accuracy**

Examples of existing solutions

Random forest solar power forecast based on classification optimization [2]

Da Liu, Kun Sun

Optimizing model **parameters** and **input variables** are the main ways to improve model accuracy.

PCA and **K-means clustering** algorithm combined with **random forest** algorithm optimized by Differential Evolution Grey Wolf Optimizer

Examples of existing solutions

Machine Learning methods for solar radiation forecasting: a review [3]

C. Voyant *et al.*

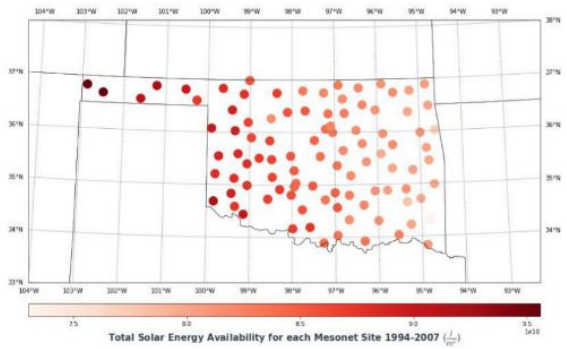
Performance ranking of forecasting methods is **complicated**.

Predictor **ensemble** methodology is **always better** than simple predictors

SVM, regression trees and **random forests**

Examples of existing solutions

Predicting Short Term Solar Energy Production



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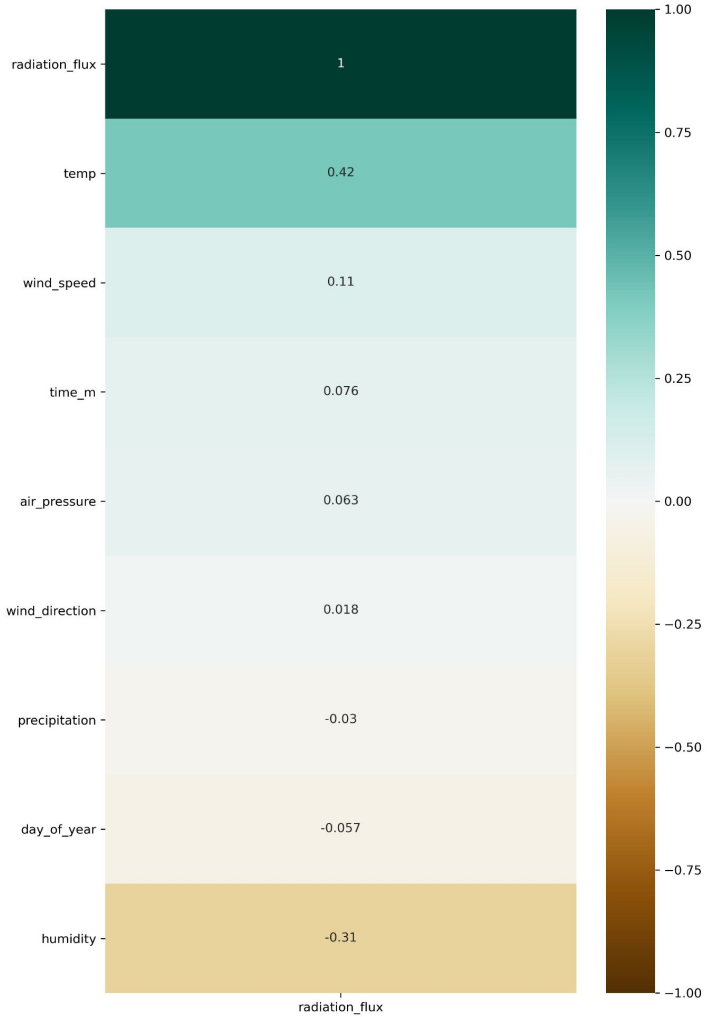
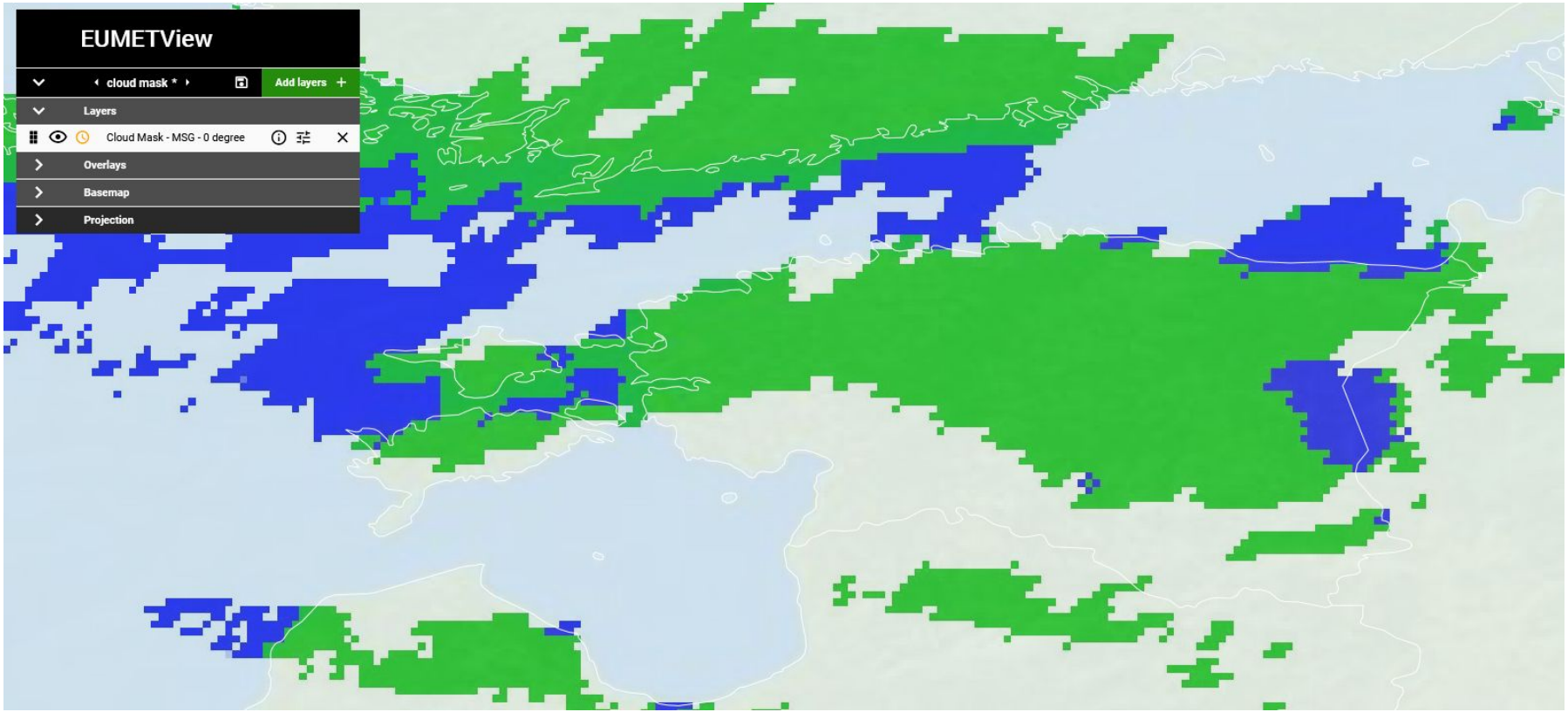
https://github.com/connormca12/Springboard-Projects/tree/master/Capstone-1

Solar Irradiation Correlation, Tartu (2013-2021)




EUMETView
cloud mask *
Add layers
Layers
Cloud Mask - MSG - 0 degree
Overlays
Basemap
Projection

Further ideas

Using coefficients from global solar map

Find solar angle manually

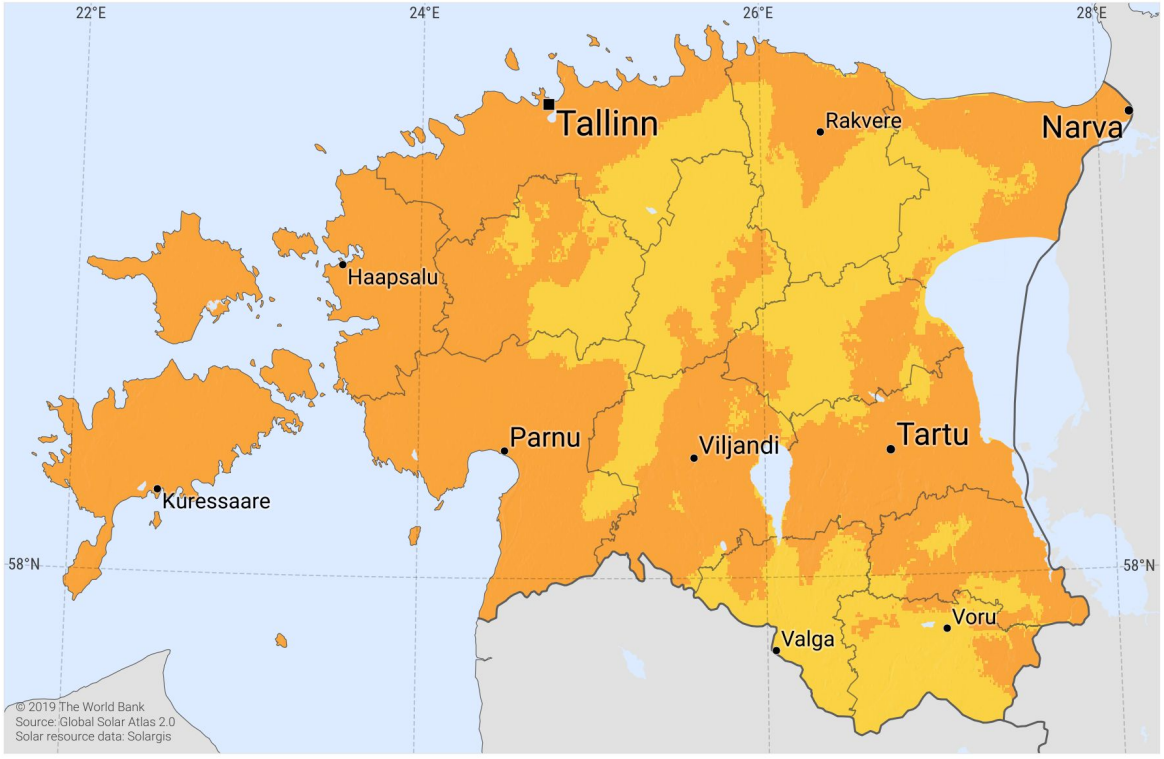
SOLAR RESOURCE MAP

PHOTOVOLTAIC POWER POTENTIAL

ESTONIA

WORLD BANK GROUP

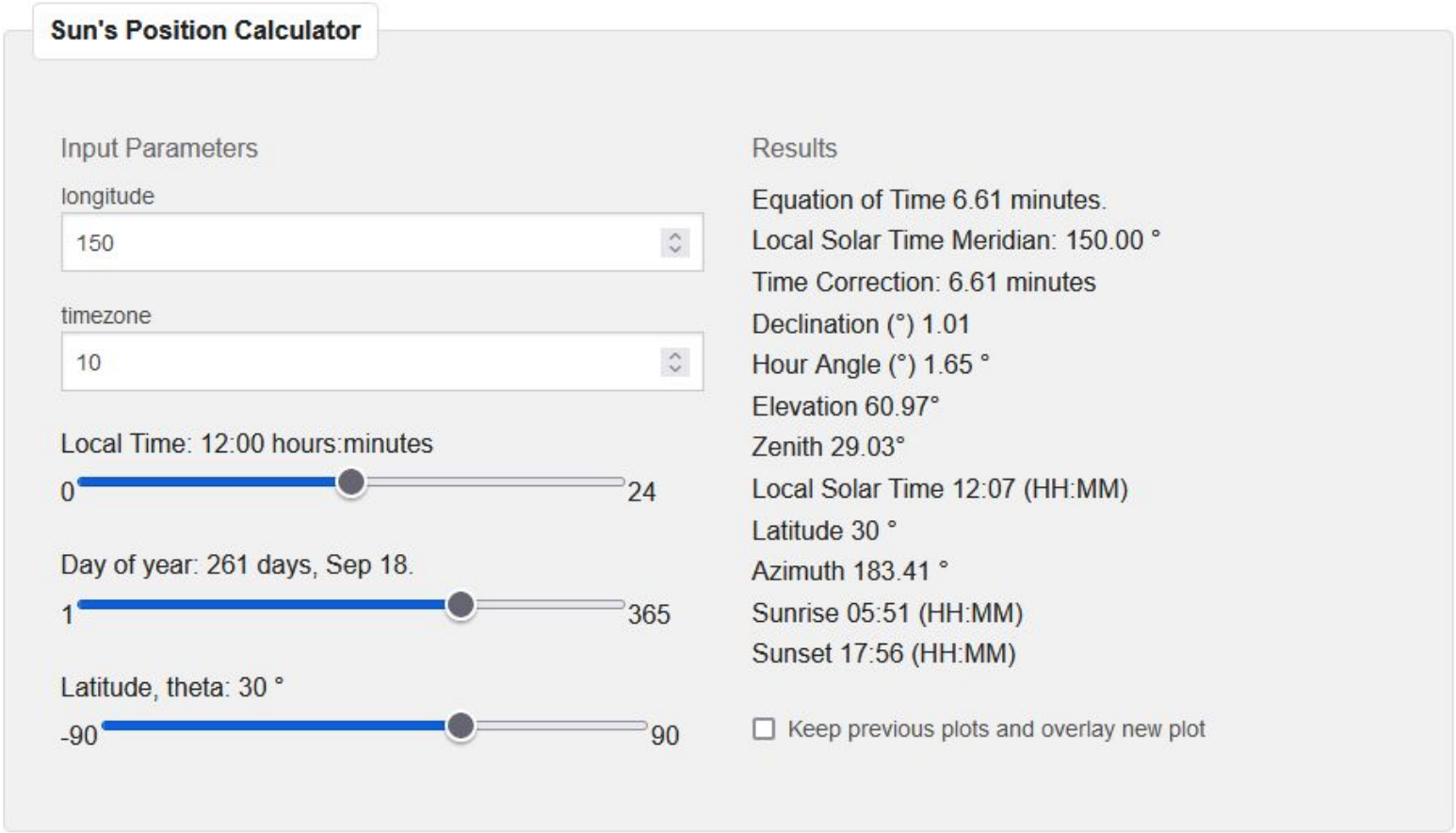
ESMAP SOLARGIS



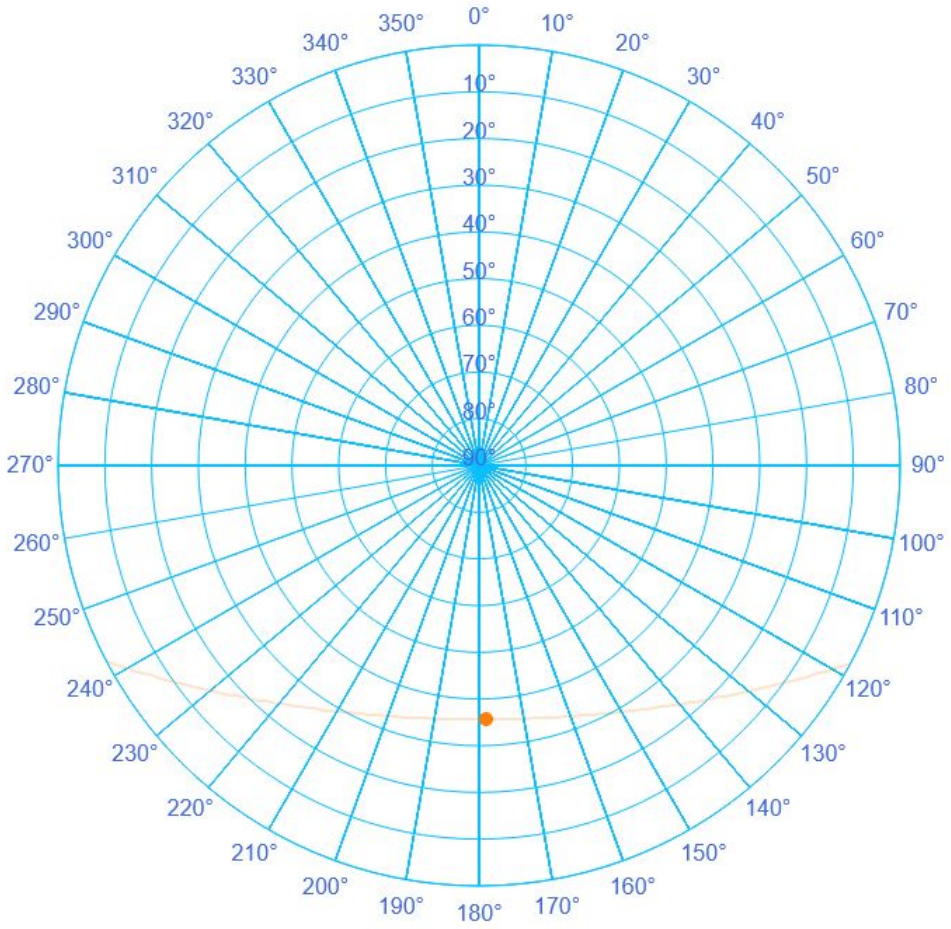
Long term average of PVOUT, period 1994-2018

Daily totals: 2.6 2.8 kWh/kWp

Yearly totals: 949 1022



Source: Sun Position Calculator,
https://www.pveducation.org/pvcdrom/properties-of-sunlight/sun-position-calculator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280°
290°
300°
310°
320°
330°
340°
350°

Initial prediction function

We are given:
$X = \{time, temperature, humidity, atmospheric\_pressure, wind\_speed, wind\_direction, precipitation\}$

We want to predict:
$y = radiation\_flux$

Using a function that maps X to y:
$f : X \to y$

First ideas:

Solar irradiation by current parameters:
$f(t_1) : X(t_1) \to y(t_1)$
Solar irradiation by past parameters:
$f(t_0) : X(t_0) \to y(t_1)$
Using new parameters:
$X_2 = \{year, month, day, hour, minute, temperature,$
$atmospheric\_pressure, wind\_speed, wind\_direction\, precipitation, snow, radiation\_flux\}$

Going further

Methods we want to try for data selection:

- PCA
- LASSO

Find a fitting model for our data

Algorithms to explore

Random forest, extreme random forest

Long short-term memory (**LSTM**)

XGboost

Linear regression

Stochastic gradient descent

Gradient boosting regressor

Adaboost

References

[1] A. Khalyasmaa *et al.*, "**Prediction of Solar Power Generation Based on Random Forest Regressor Model**", *2019 International Multi-Conference on Engineering, Computer and Information Sciences (SIBIRCON)*, 2019, pp. 0780-0785, doi: 10.1109/SIBIRCON48586.2019.8958063.
https://ieeexplore.ieee.org/document/8958063

[2] Da Liu, Kun Sun, "**Random forest solar power forecast based on classification optimization**", *Energy, Volume 187, 2019,* 115940, ISSN 0360-5442,
https://www.sciencedirect.com/science/article/pii/S036054421931624X

[3] C. Voyant *et al.*, "**Machine learning methods for solar radiation forecasting: A review**", *Renewable Energy, Volume* 105, 2017, *Pages* 569-582, ISSN 0960-1481,
https://www.sciencedirect.com/science/article/pii/S0960148116311648

[4] C. McAnuff, "**Predicting Short Term Solar Energy Production**",

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