Leveraging Deep-Learning for an holistic understanding of soil moisture dynamics as affected by plant diversity

Gideon Stein, Maha Shadaydeh, Yuanyuan Huang,
Anne Ebeling, Nico Eisenhauer, Joachim Denzler

Computer Vision Group, Friedrich Schiller University Jena, Germany

MOTIVATION

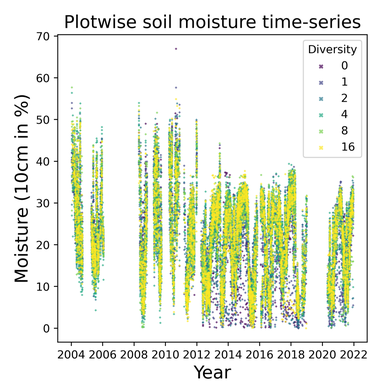
- Soil Moisture plays a crucial role in a plethora of ecosystem processes.
- Soil moisure is however often only measured with low temporal resolution.
- Machine Learning approaches (in comparison to linear models) can be used to estimate high-resolution interpolations, given a number of relevant covariates.

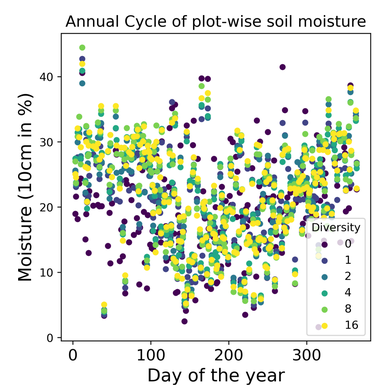
We estimate a **plotwise high-resolution soil moisture** product for the Jena Experiment and analyze which **covariates** are **important**.

Interested? Feel free to contact me!

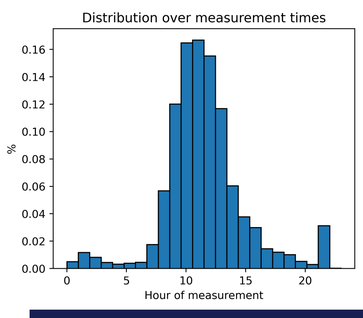
DATA SITUATION

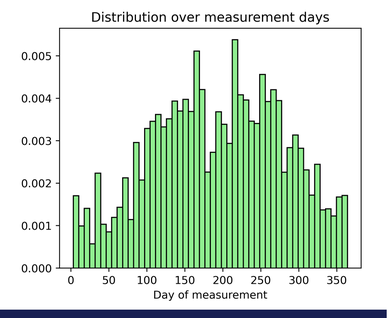
- At the Jena Experiment field site, plot-wise soil moisture is measured every 7 to 14 days.
- Ideally, we would like to have daily mean and standard estimations.
- Luckily, many other variables are measured that likely hold information concerning soil moisture:

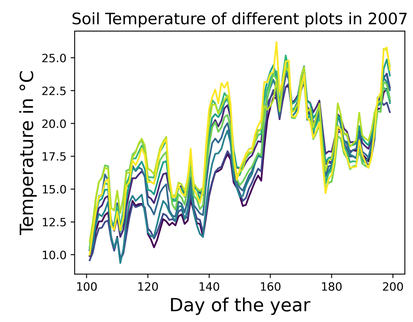


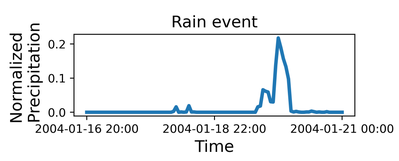


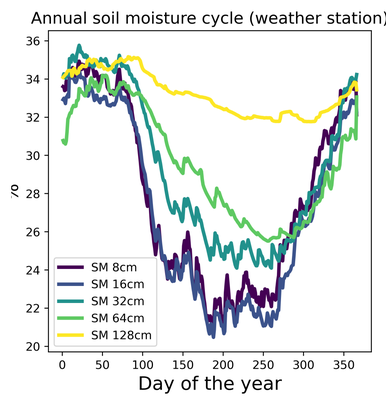
Biased measurement dates make estimations hard.

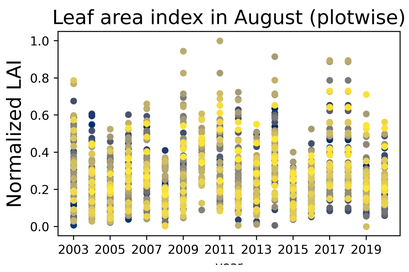






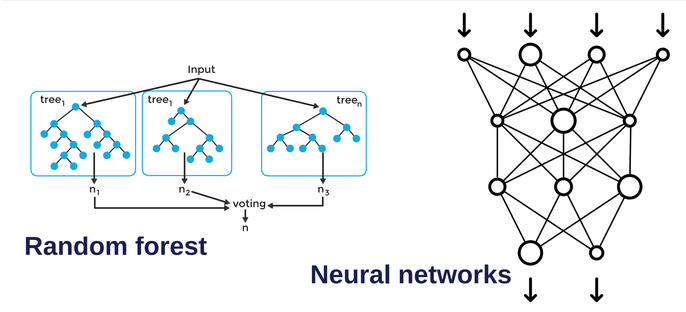






In total, we consider arround 80 variables, including annual data as well as high-resolution time series to estimate plot wise soil moisture.

Methods

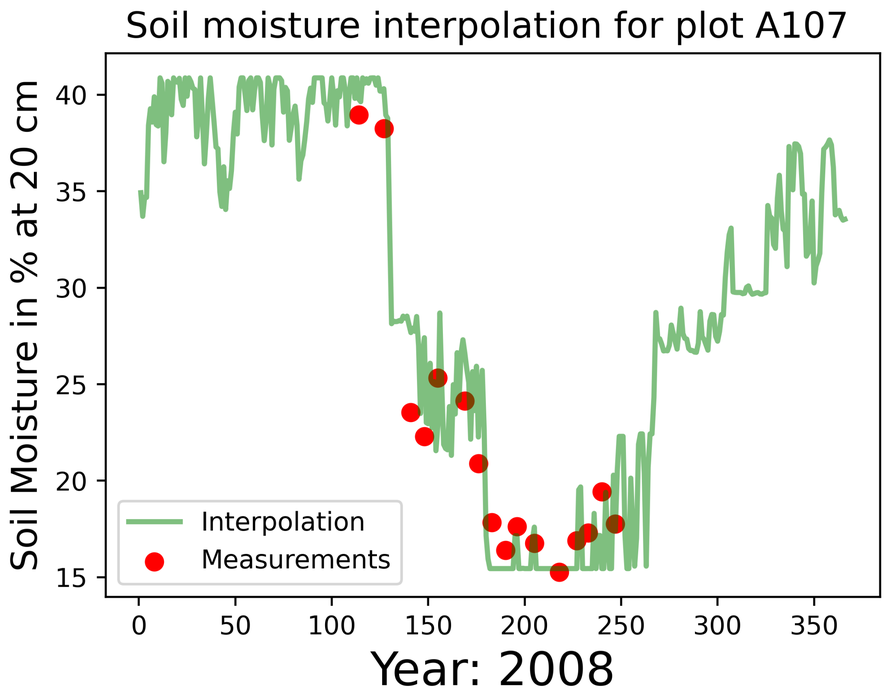


Next to linear models, we consider machine learning approachs such as Random Forests or Deep-Learning to produce soil moisture estimates.

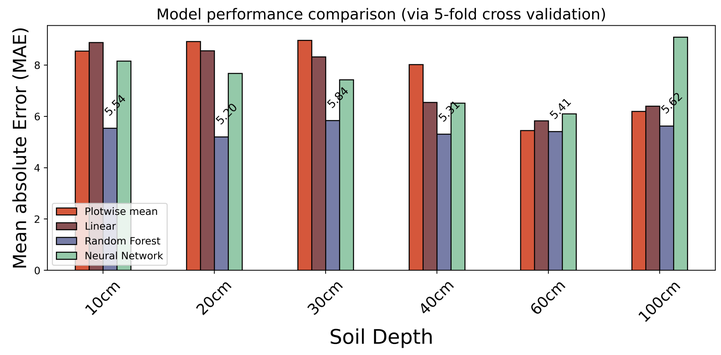
RESULTS

- We found that especially **Random Forests** can improve the accuracy of predicting unseen soil moisture values strongly in comparison to a linear model.
- A fitted Random forest can be used to estimate soil moisture at any other arbitrary date and time.

	Normalized feature importance
Diversity	0.00
Target flowering in May	0.00
Respiratory quotient	0.01
Hour	0.01
Rain	0.02
Temperature	0.02
Albedo	0.02
Relative Humidity	0.03
Day	0.12
Soil Temperature 15cm	0.13
Year	0.60



We further analyzed feature importance of of the final model to understand which covariates are especially important.



FUTURE WORK

- More sophisticated Deep-Learning architectures will be used to improve accuracy further.
- A causal analysis of the most important covariates is necessary.
- This is work in progress. If you are interested in the product contact me!

FRIEDRICH-SCHILLER-UNIVERSITÄT JENA

iDiv

Computer Vision Group