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A Glance at the World Forest by Machine Learning

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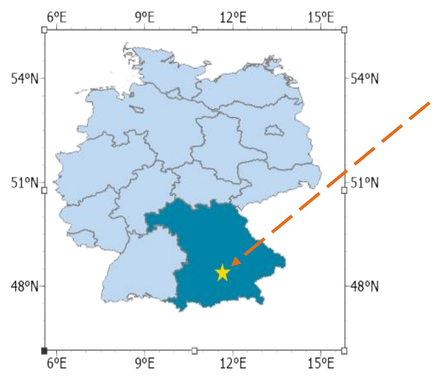
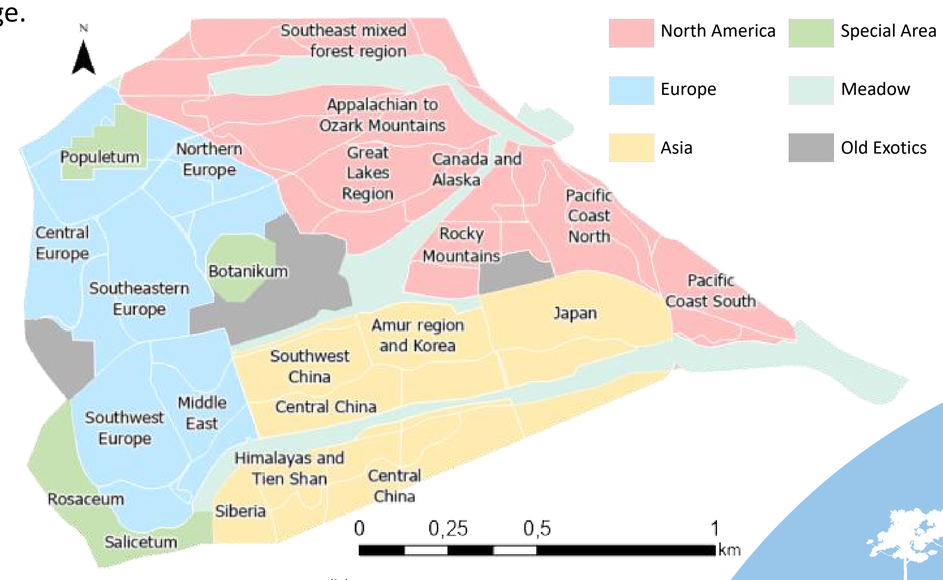
Background

The World Forest Freising is well-known for its extensive collection of tree species from all over the Northern Hemisphere. In an area of about 100 ha, more than 300 species have been planted since 1987, making the forest area a valuable resource for forest mapping and tree species studies, particularly to investigate adaption to climate change.



(a)



(b)

Figure 1: (a) The World Forest (Weltwald) is located near Freising in southeastern Germany. (b) The forest is organized in 3 main areas: North America, Europe, and Asia. Each area name represents the origin of the tree species planted there.

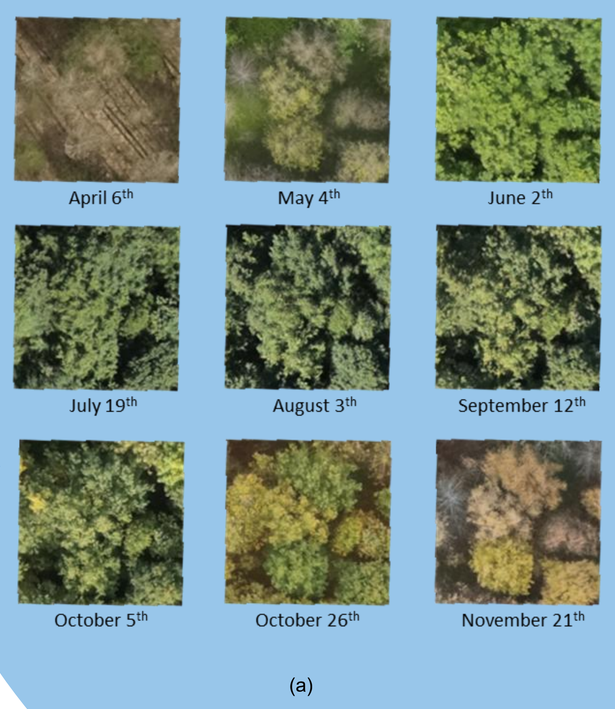
Objective

This study aims to better distinguish European tree species based on **remote sensing** datasets with **machine learning** techniques. Specifically, we want to test if a U-Net Model improves tree species detection results including phenological patterns.

UAV Data

The **UAV data** (DJI Phantom P4M; spatial resolution: 10 cm), including blue (450 nm ± 16 nm), green (560 nm ± 16 nm), red (650 nm ± 16 nm), and near-infrared (840 nm ± 26 nm) bands, were captured in the world forest (Weltwald) Freising in a series of field campaigns in the year of 2022. The field campaigns were conducted more frequently in spring and autumn (once a week) to capture the phenological changes in the forest areas. The drone flew 100 m above ground, and PIX4Dmapper pre-processed the data.

Data Sampling



(a)

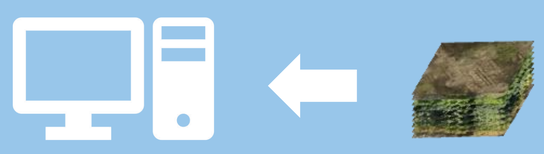
Figure 2: (a) Sample scene of phenological change of oak trees (*Quercus robur*) on the UAV images.

Sample scenes in rectangular shapes were manually selected and extracted from the original UAV images (R/G/B/NIR), where tree species were already identified by the Bavarian state forestry[1].

Images of a time series were put into a raster stack to provide the phenological information and paired with the classification.
The dataset was divided into training (80%), testing (10%), and validation (10%).

U-net Model

We will use a deep learning framework, specifically a U-net model, which was applied for species classification in the Black Forest in a recent study[2]. In contrast to classifying only time-constant UAV images, we try to take advantage of phenological patterns to better distinguish tree species for the first time to our knowledge.



(c) (b)

Figure 2: (b) Stack time series data (c) Feed the data to a U-Net model, train the model, make predictions & evaluate the accuracy of the model.

What's next

There is a high potential for applying time series UAV data containing phenological patterns for tree species classification. With this unique data set of the World Forest Freising, involving various tree species from all over the Northern Hemisphere, the study could form the starting point for identifying tree species from high-temporal and spatial resolution remote sensing imagery.

Further research is planned to focus on developing the machine learning models and to expand the mapping area thus increasing the number of species being mapped. Ultimately, the goal is to upscale the methods to be used on satellite datasets, such as Sentinel-2 or PlanetScope.

Acknowledgements

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Contact

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References

[1] Parcels of tree species planted in Weldwald in shapefile data. processed by BaySF
[2] Schiefer, F., Kattenborn, T., Frick, A., Frey, J., Schall, P., Koch, B., & Schmidtlein, S. (2020). Mapping forest tree species in high resolution UAV-based RGB-imagery by means of convolutional neural networks. ISPRS Journal of Photogrammetry and Remote Sensing, 170, 205–215.