Field crops classification using Sentinel-2 image data

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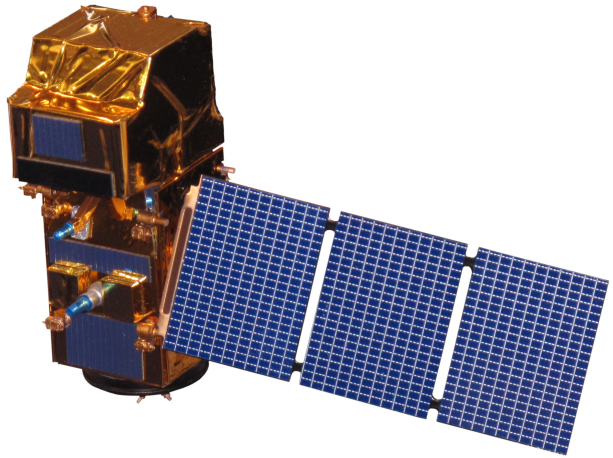
Overview

Motivation

- monitoring of land, e. g. biodiversity, droughts etc.
- classification of crops (monitoring, possible subsidies)

Sentinel-2 mission

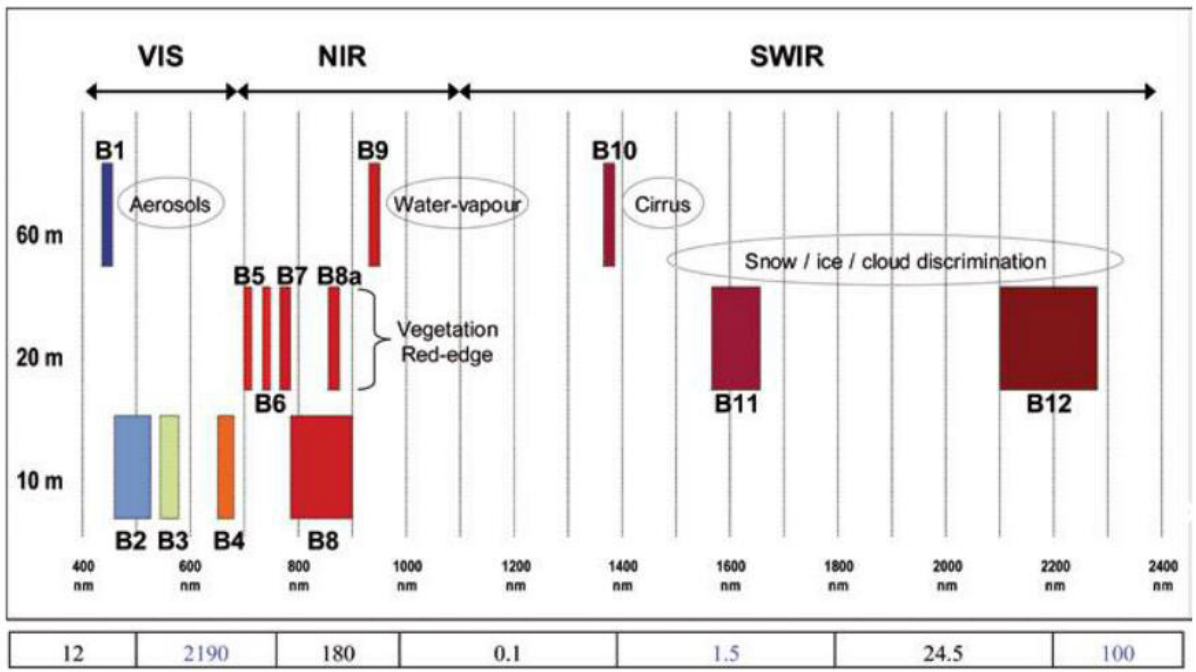
- mission developed and operated by ESA (several Sentinel missions, S-2 ideal for agriculture, forestry, and other land management applications)
- provides high-resolution images
- free, full, and open data policy of the European Commission and ESA



Sentinel-2 specification

- two satellites phased by 180°, satellites revisit the Equator every ~ 5 days
- 13 bands between 443 – 2190 nm (+ indices, e. g. NDVI vegetation)
- different levels of image preprocessing (orthorectification, cloud masks), images are tiled to cover 100 x 100 km^2

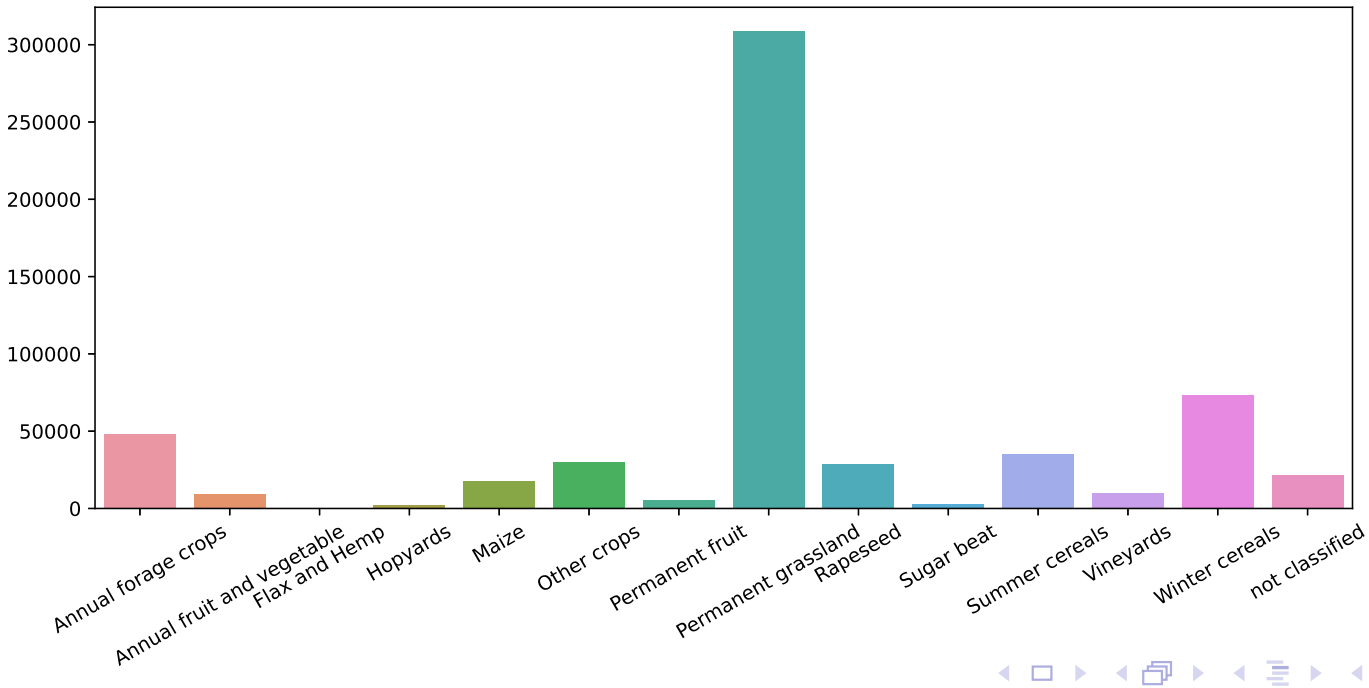
Figure: Thirteen spectral bands of Sentinel-2 satellite.



Agricultural data

- data provided by State Agricultural Intervention Fund (Státní zemědělský intervenční fond (SZIF))
- specification of approx. 600,000 agricultural fields in CZ in 2018
- includes geographical coordinates of its bounding box and polygon, unique id and crop (13 unique + not classified) grown on the field

Figure: Counts of crops grown in the Czech Republic in 2018.

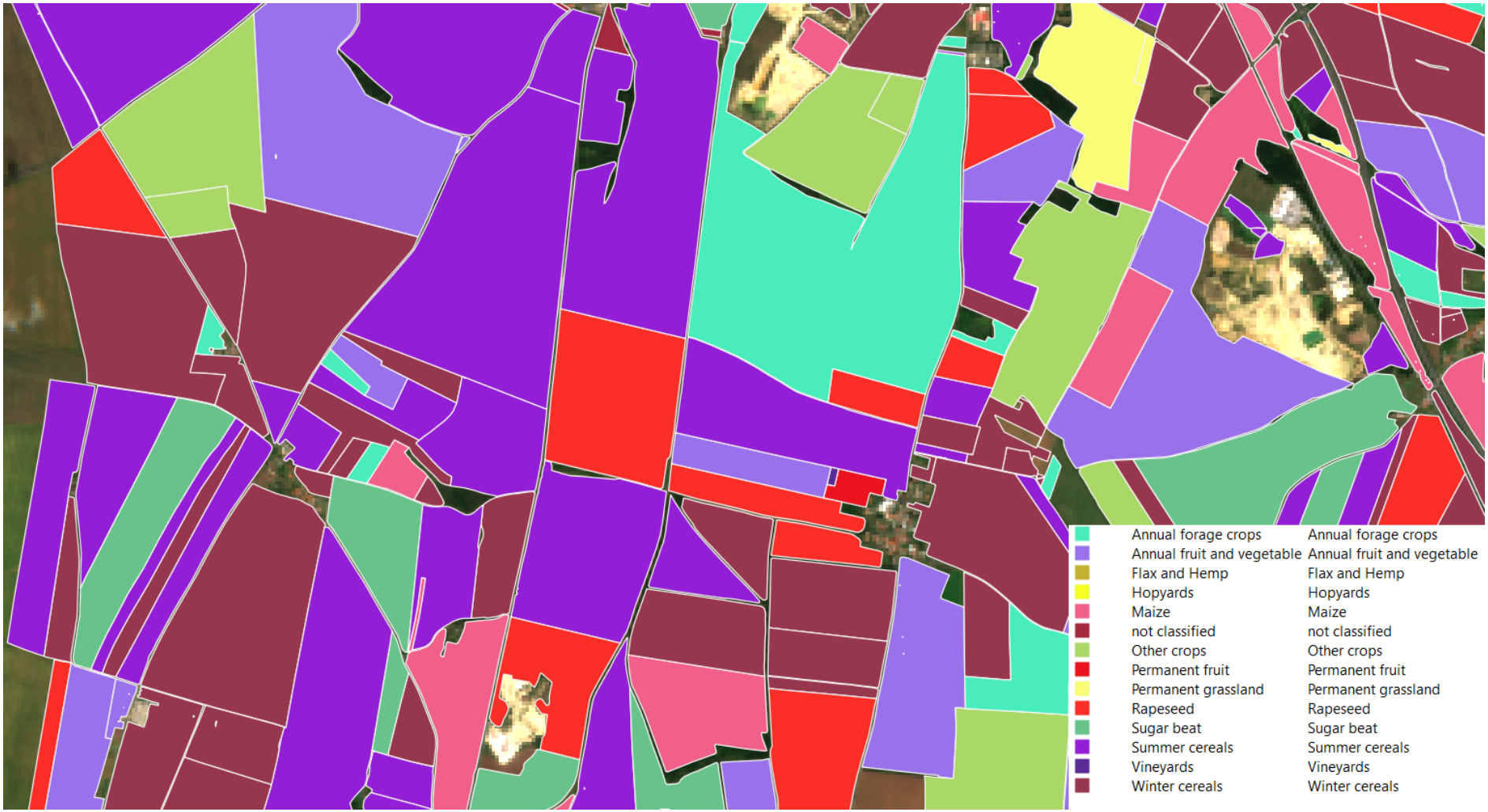


Agricultural data

Figure: Visualization of truecolor RGB Sentinel-2 image.

Agricultural data

Figure: Visualization of truecolor RGB Sentinel-2 image with agricultural fields.



Initial problems

- satellite data: clouds, defective pixels
- agricultural data: incorrect input (at least 95 % *should* be correct), crop in different growth phase
- multi-temporal vs. mono-temporal approach

Image preprocessing:

- normalization,
- ensuring same image dimensonality (resizing: ignoring spatial information; padding + cropping)
- filtering large images,
- ignoring fields with high cloud cover,
- using generator to avoid RAM overflow
- possible data augmentation

Convolutional neural networks

- consecutive application of convolution and pooling layers
- fully-connected top with outputs equal to number of classes
- existing ResNet50 architecture used (dimensionality reduction from n bands to RGB; cherry-pick, PCA, optimal linear combination, achieved by convolutional layer)
- applied on 40,000 fields in Central Czech Republic

Figure: Confusion matrix of CNN classifier on monotemporal data with 40,000 samples in the dataset.

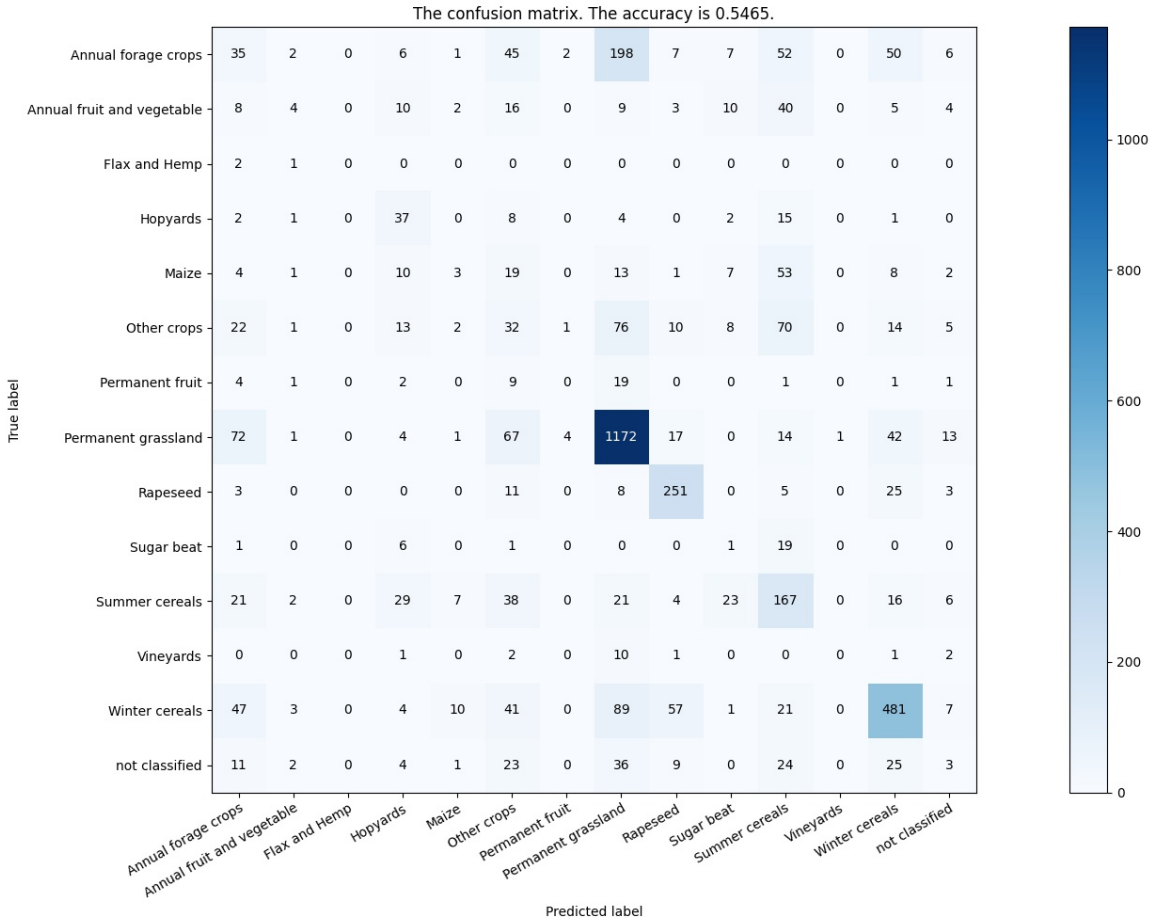
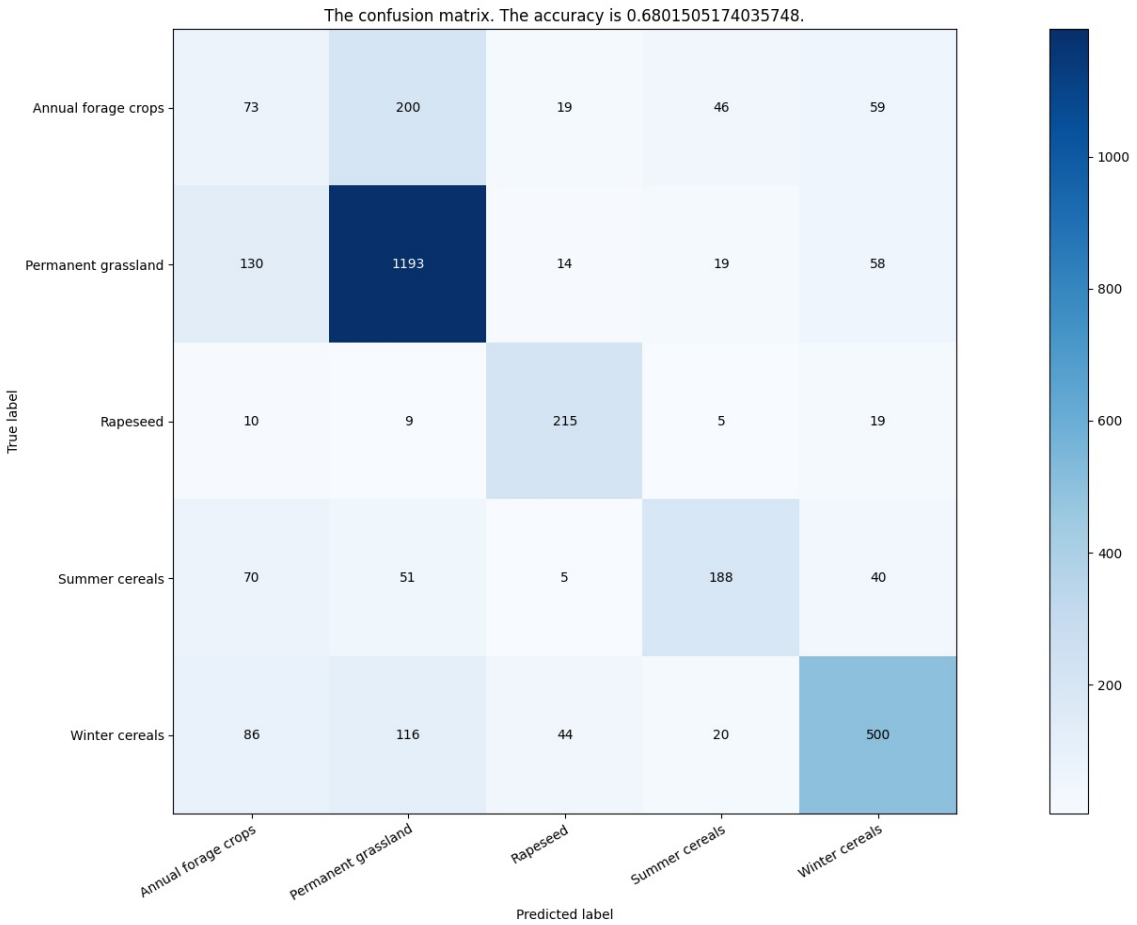


Figure: Confusion matrix of CNN classifier on monotemporal data using narrowed dataset.



Where to go?

Unbalanced dataset:

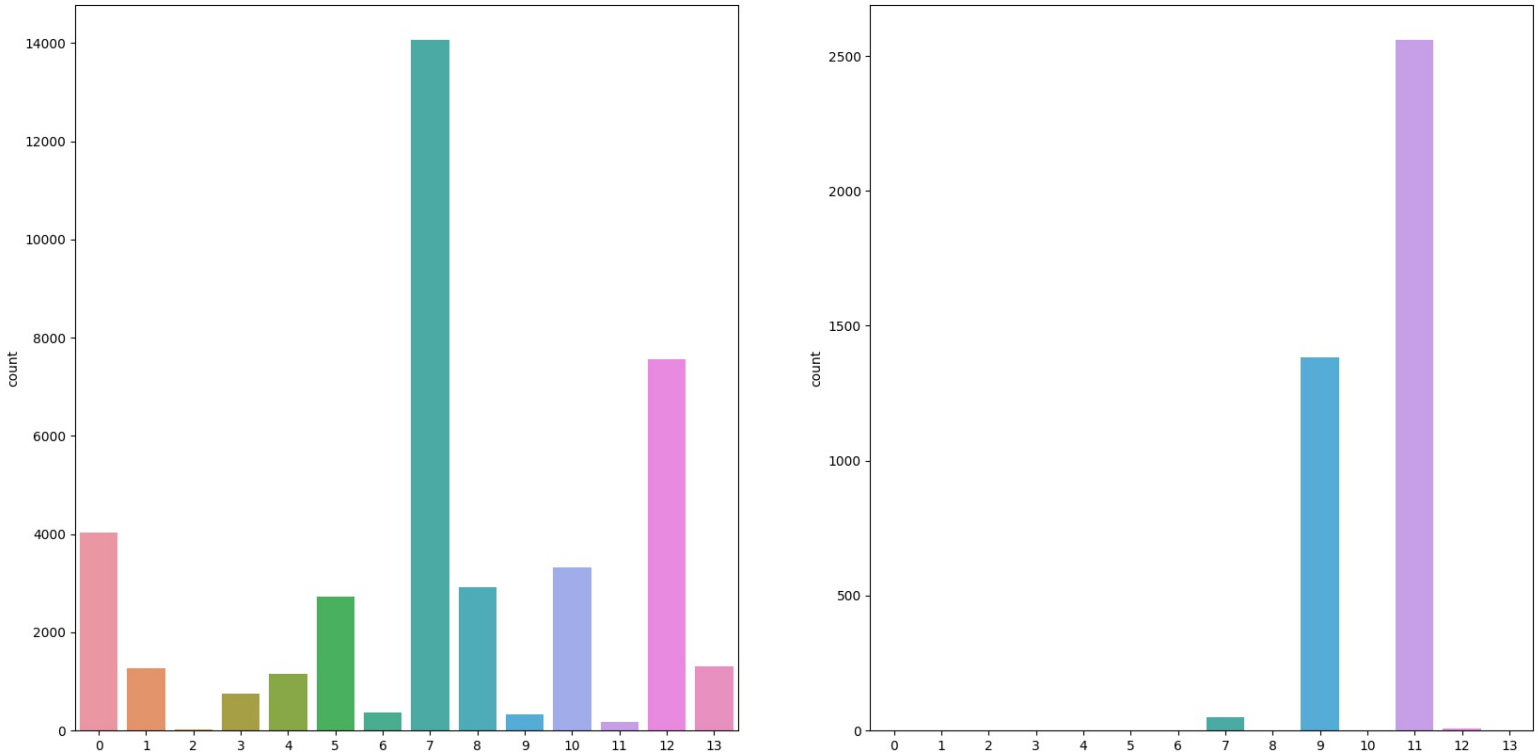
- loss function weighing
- correct statistical sampling to achieve balanced dataset

Multi-temporal issue:

- different classifiers which use only mean and standard deviation of every field
- 3D convolutions
- CNN-LSTM (used e.g. for video analysis); CNN extracts the visual features; LSTM used for time-series

Demonstration of count weighing

Figure: Counts in test labels and predicted test labels.



7: Permanent Grassland 9: Sugar beat 11: Vineyards

Future goals & Conclusion

Future goals:

- deal with unbalanced dataset
- improve the architecture to use multi-temporal data
- tune the hyperparameters

Conclusion:

- we have given a proof-of-concept of analysis of combination of satellite and agricultural data
- for that cause, convolutional neural networks are being used

Thank you for your attention