

A wide-angle photograph of a vast, golden wheat field under a clear blue sky. The sun is low on the horizon, casting long shadows and creating a warm, golden glow across the landscape. In the distance, there are rolling hills and a line of trees. The foreground is filled with the textured, golden stalks of wheat.

**Dude, where are my
crops?**

Outline

1. Introduction & Business case
2. Data
3. Workflow
4. Results
5. Conclusion



Our Team:

Golden Crop Ltd.



Anitha Grace U.
B. Sc. Water and
Environmental Engineering



Felix Behrendt
M. Sc. Geoinformatics
Teacher



Max Langer
M. Sc. Biology



Kirmeier



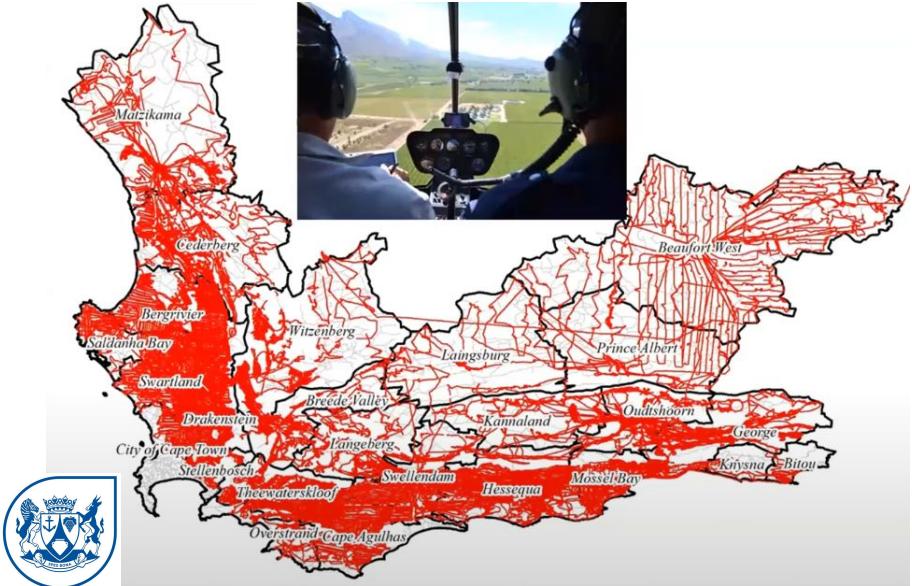
Timo Fischer
Dr. rer nat. Neurophysiology



Current Situation

- agriculture census reports are created with the aid of helicopters or on ground
- this is costly (1. Mio \$)
- and time-consuming (16 weeks)
- fields are overlooked

Helicopter flight path for the census



© Western Cape Government



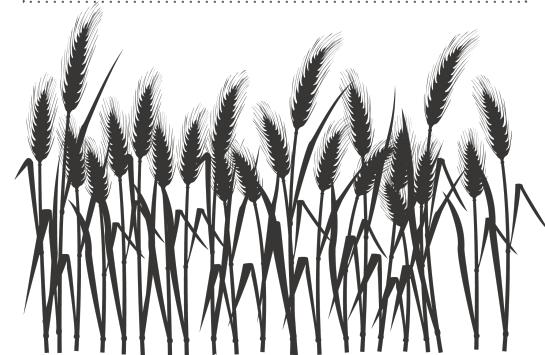
Why is an accurate census important!



Over 86000 fields with varying sizes in the area

- thus affecting planning & market price
- spatial planning and development

Example: average field size of 3.1 ha
missing a single field means missing ca. 11.5 t
of wheat in the census

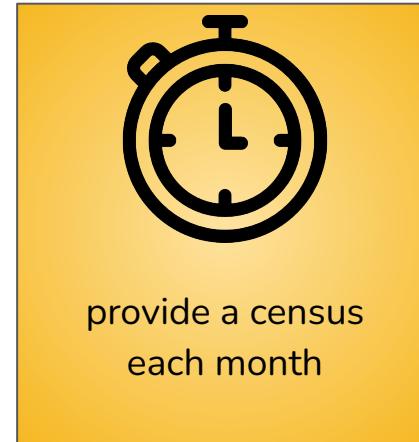
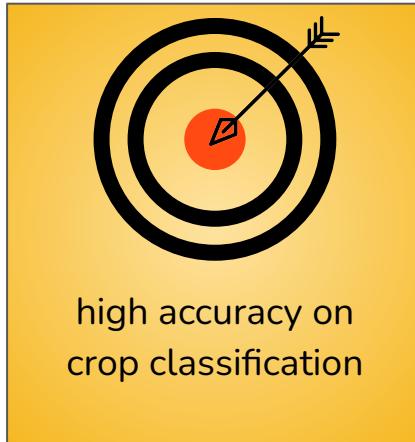


The Golden Crop Solution

Objective:

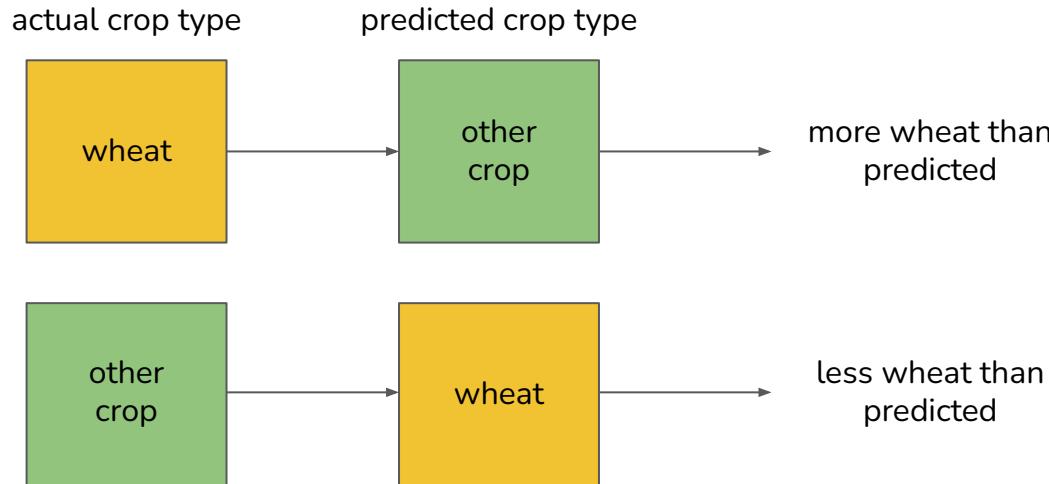
Classify crop type in fields in the Western Cape of South Africa based on satellite data

Goals for the model:



The Golden Crop Solution

Evaluation metric: F1 - score

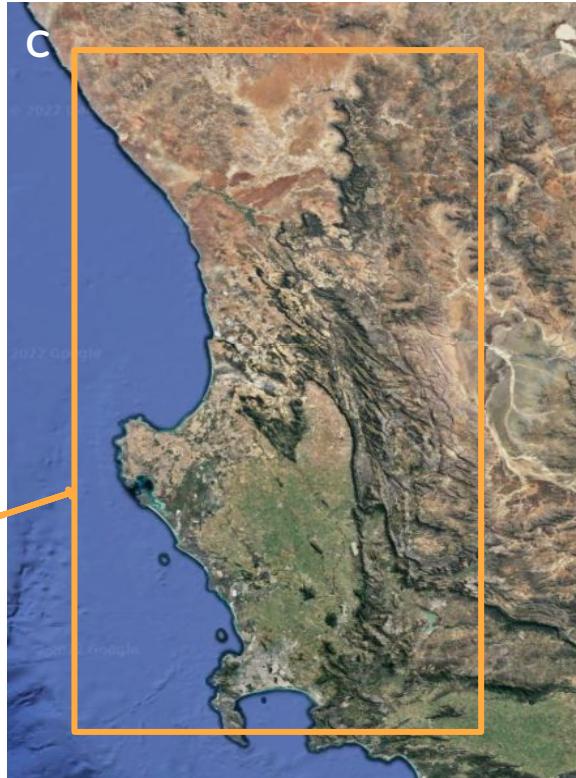


→ both outcomes are equally problematic for the census

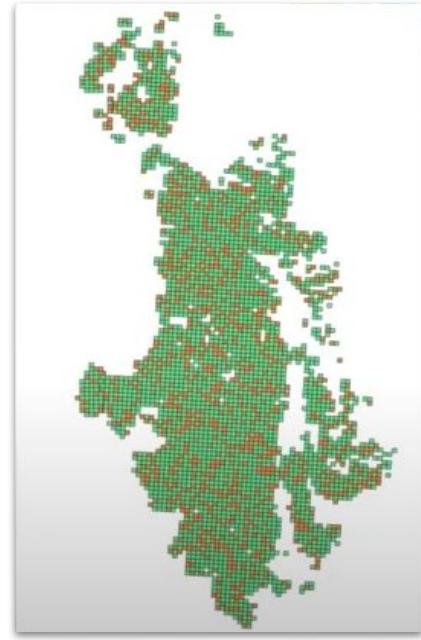
→ with the F1 score we try to minimize both



Area of Interest



Tile Distribution



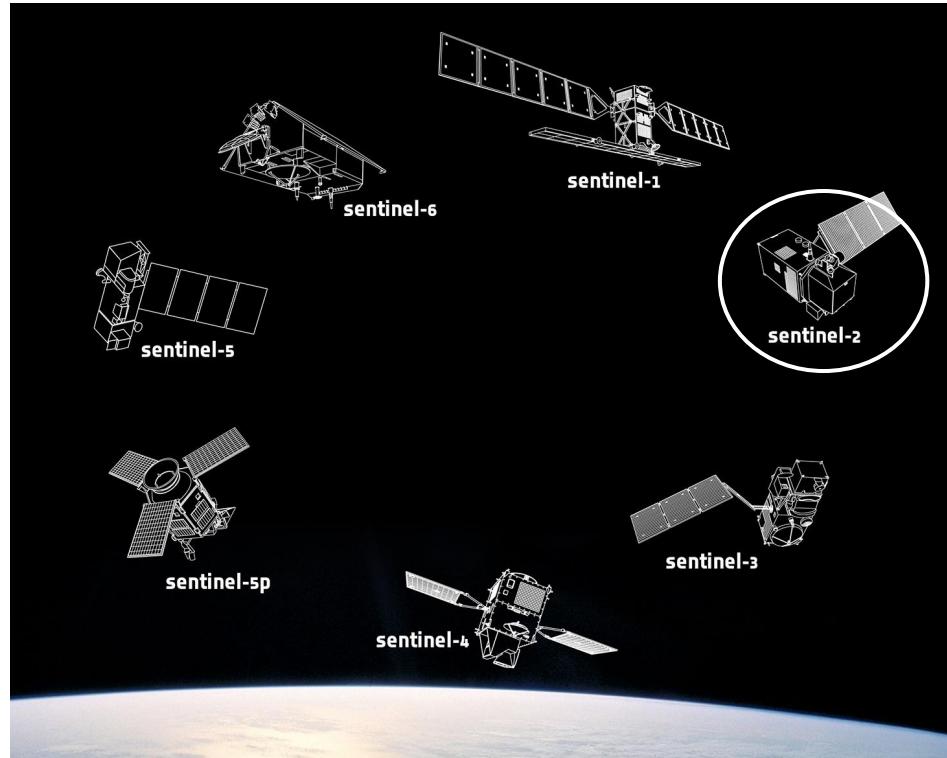
 **Radiant Earth Foundation**
EARTH IMAGERY FOR IMPACT
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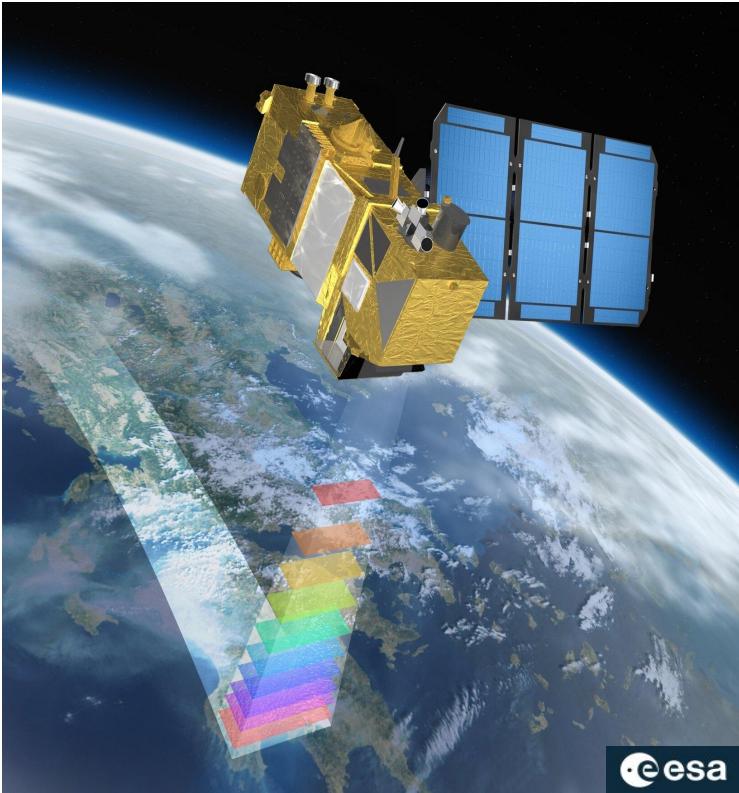
Overview of the Sentinel project (ESA)

The Sentinel missions mark a new era in Earth observation

- focusing on delivering a wealth of operational data for decades to come.
- Our dataset belongs to earth observation of Sentinel, in particular, Sentinel-2B

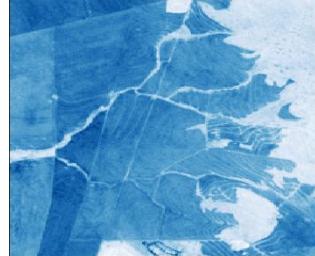


Overview of the Sentinel project (ESA)

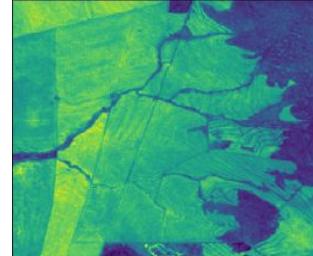


| Sentinel-2 Bands | Central Wavelength (μm) |
|-----------------------------|--------------------------------------|
| Band 1—Coastal aerosol | 0.443 |
| Band 2—Blue | 0.490 |
| Band 3—Green | 0.560 |
| Band 4—Red | 0.665 |
| Band 5—Vegetation Red Edge | 0.705 |
| Band 6—Vegetation Red Edge | 0.740 |
| Band 7—Vegetation Red Edge | 0.783 |
| Band 8—NIR | 0.842 |
| Band 8A—Vegetation Red Edge | 0.865 |
| Band 9—Water Vapour | 0.945 |
| Band 10—SWIR—Cirrus | 1.375 |
| Band 11—SWIR | 1.610 |
| Band 12—SWIR | 2.190 |

B02



B11



Crop fields



Dataset

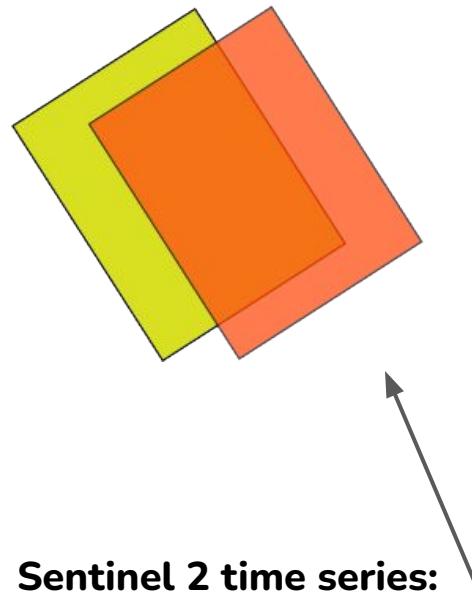
- area: West Cape of South Africa
- size: 48 GB
- creator: Radiant Earth Foundation
- time: growing Season 2017
[Mai - November]
- time interval: 3 - 10 days



Radiant Earth
Foundation

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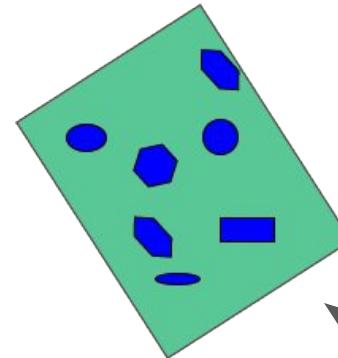
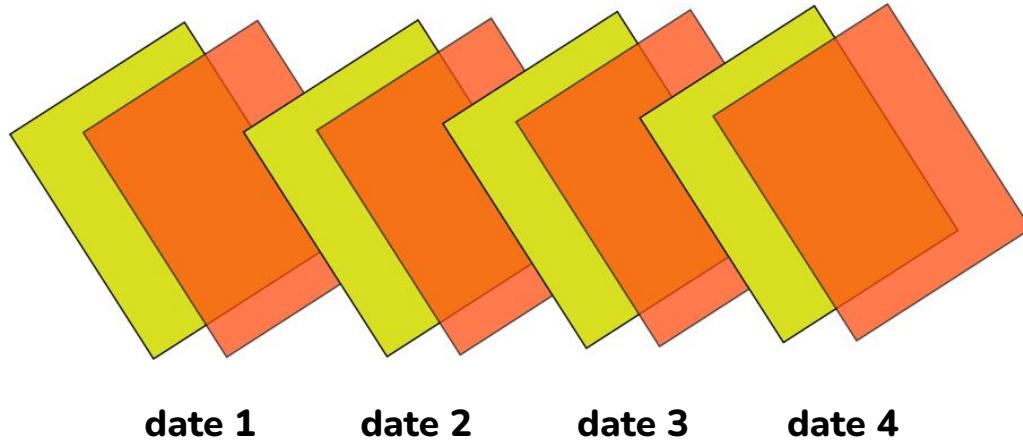


Sentinel 2 time series:

- each color is a different band
- each pair is one time



Dataset



**field boundaries
and crop types**

Summary:

- 6 bands + cloud mask
- 76 timestamps
- area of 17231 km²

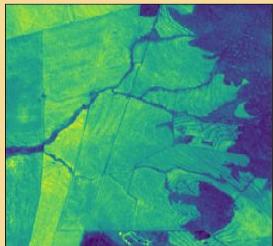


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Workflow

Acquiring Spatial-Temporal Data

Metadata
+



Tile: 1250

Band: 11

Date: 1. April

Preprocessing

data conversion



cloud - masking



spatial aggregation



Feature Engineering

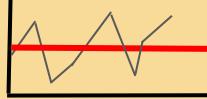
spectral metrics

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

texture metrics

$$GLCM = \begin{pmatrix} 2 & 2 & 5 \\ 3 & 4 & 9 \end{pmatrix}$$

*temporal
aggregation*



Modeling

KNN

XGBoost

RandomForest

ANN

Extreme
Random Forest

Product



Crop Types



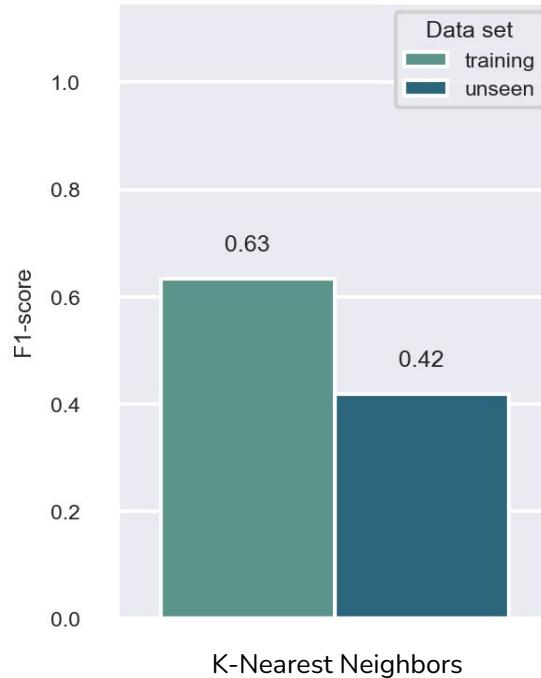
Error

Analyses

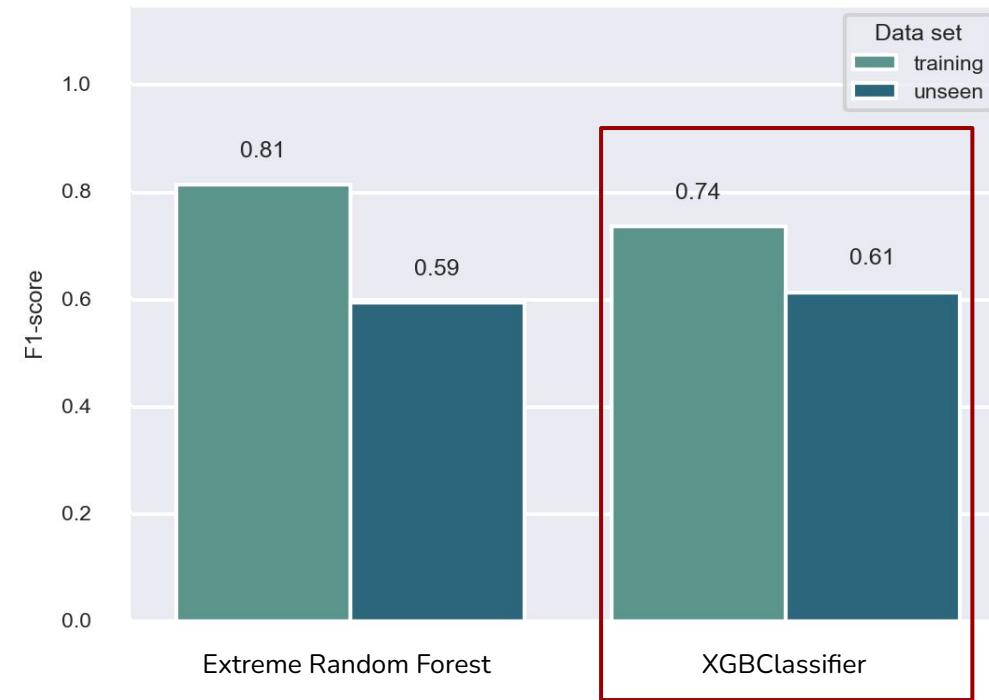


Performance of the models

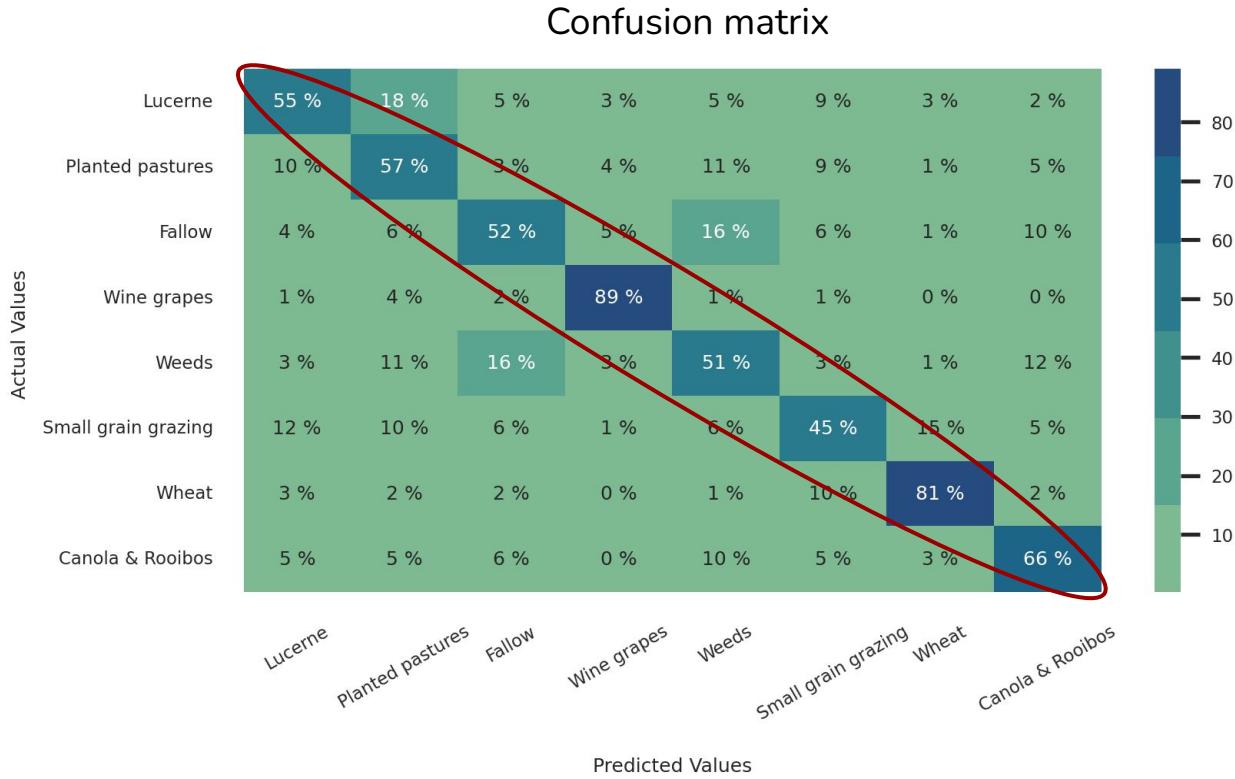
Scores of the baseline model



Scores of the models

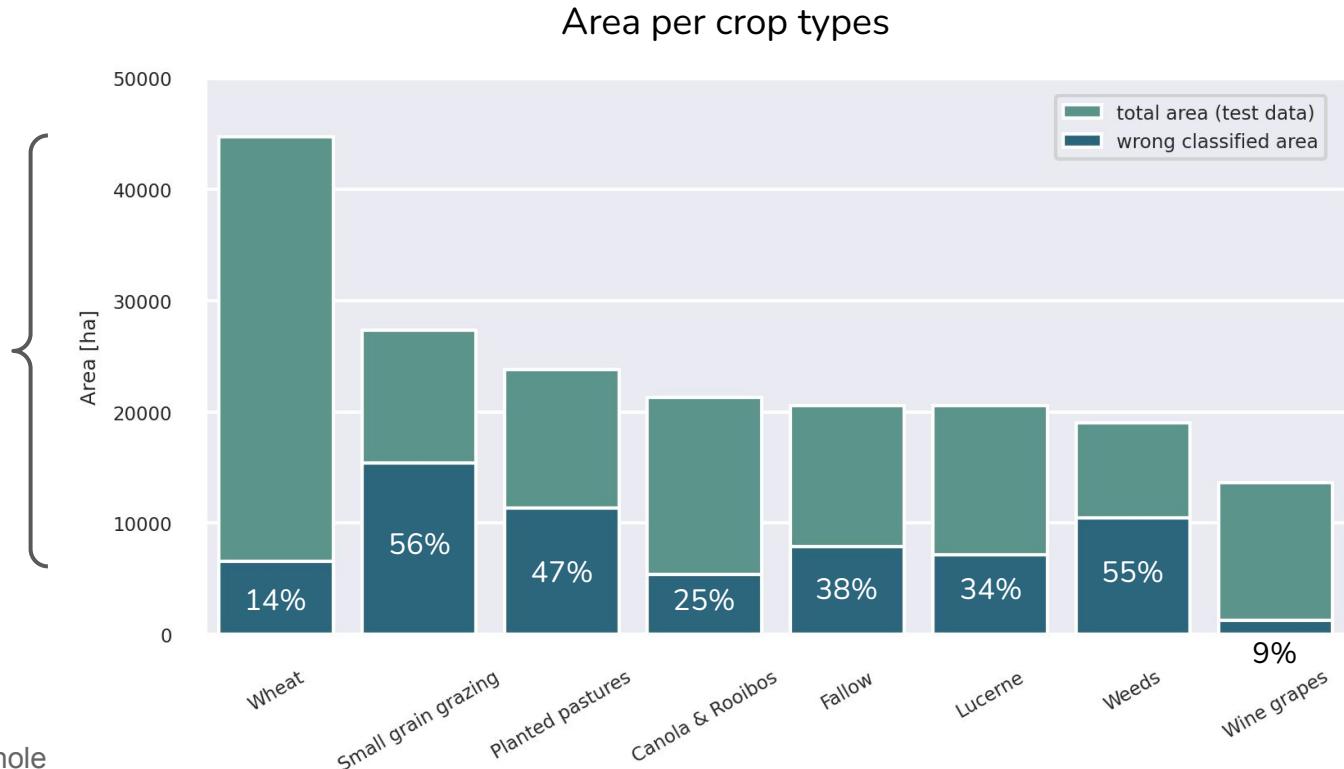


XGBClassifier - Error analysis



XGBClassifier - Error analysis: area of each label

saved survey costs
for wheat: 70.000 \$*



*this represents only $\frac{1}{3}$ of the whole



Conclusion

- Decision Tree Ensemble Models perform well with the task
- Crop identification
 - wine grapes and wheat can be classified with a high accuracy
 - the other crop types are often misclassified



Photo by Matteo Raimondi on Unsplash



Conclusion



high accuracy estimation
for two of eight crop types



reducing the cost
by 270.000 \$

reducing time to 3 h
for the entire area



no monthly census update



Outlook

- **possible improvements**
 - adjusting the model (better generalization)
 - a dashboard predicts crop type of any given data
 - dockerization of the project
- **our model could be used for other regions as well**
 - using Sentinel-2 data
 - probably also on other crop types



Photo by Matteo Raimondi on Unsplash



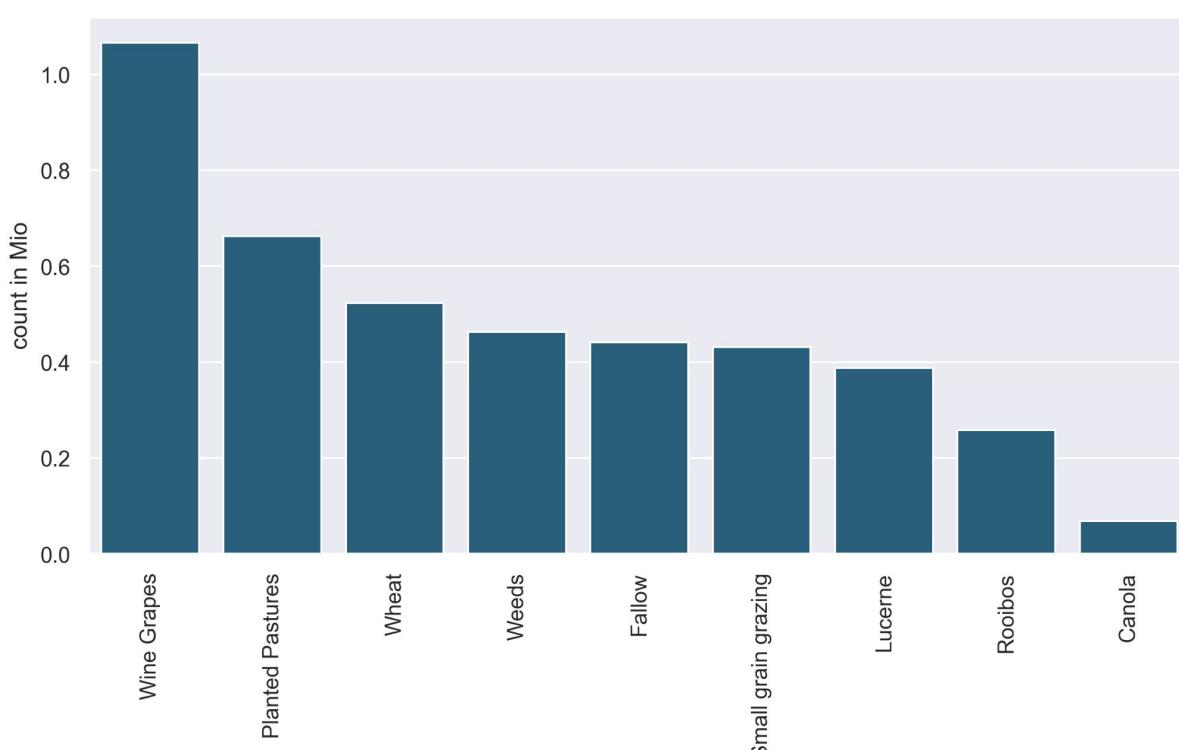
The End

Thank you for your attention



Further information

Distribution of the classes

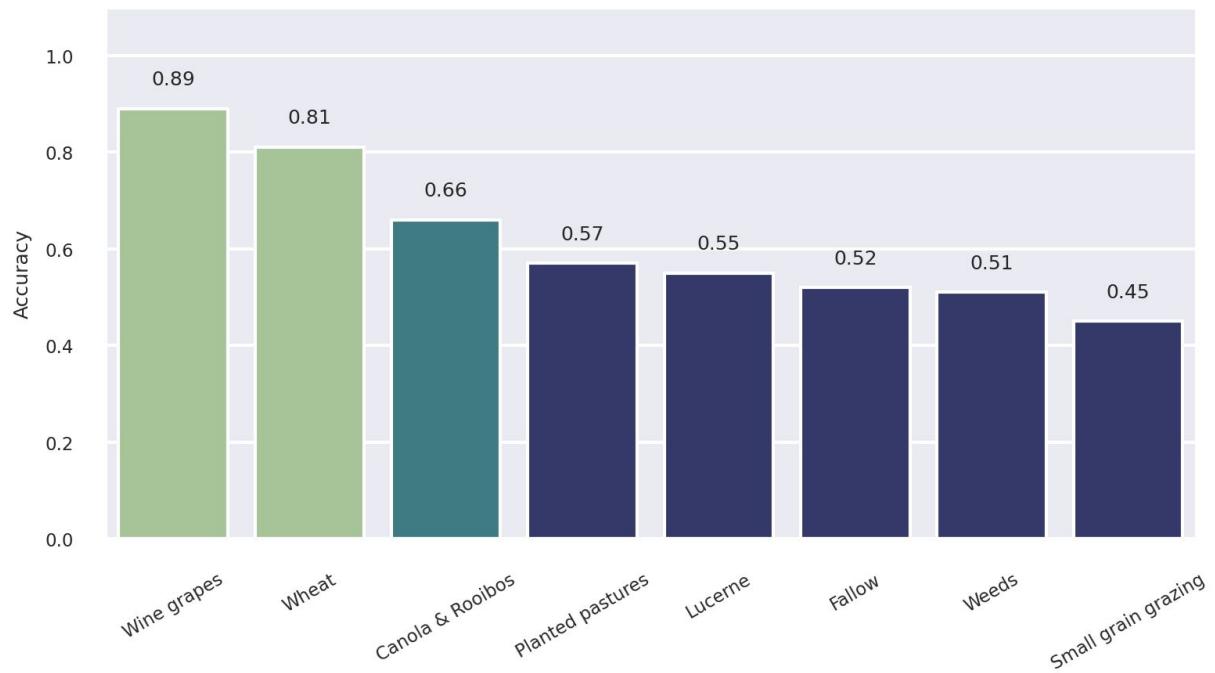


| Type | Usage |
|---------------------|-----------------------------------|
| Lucerne / Medics | increase soil, food for livestock |
| Planted pastures | livestock and food |
| Fallow | regeneration soil |
| Wine Grapes | wine production |
| Weeds | unused fields |
| Small grain grazing | grazing, silage or hay production |
| Wheat | food |
| Canola | oil |
| Rooibos | tea |



XGBClассifier - Error analysis: accuracy of each label

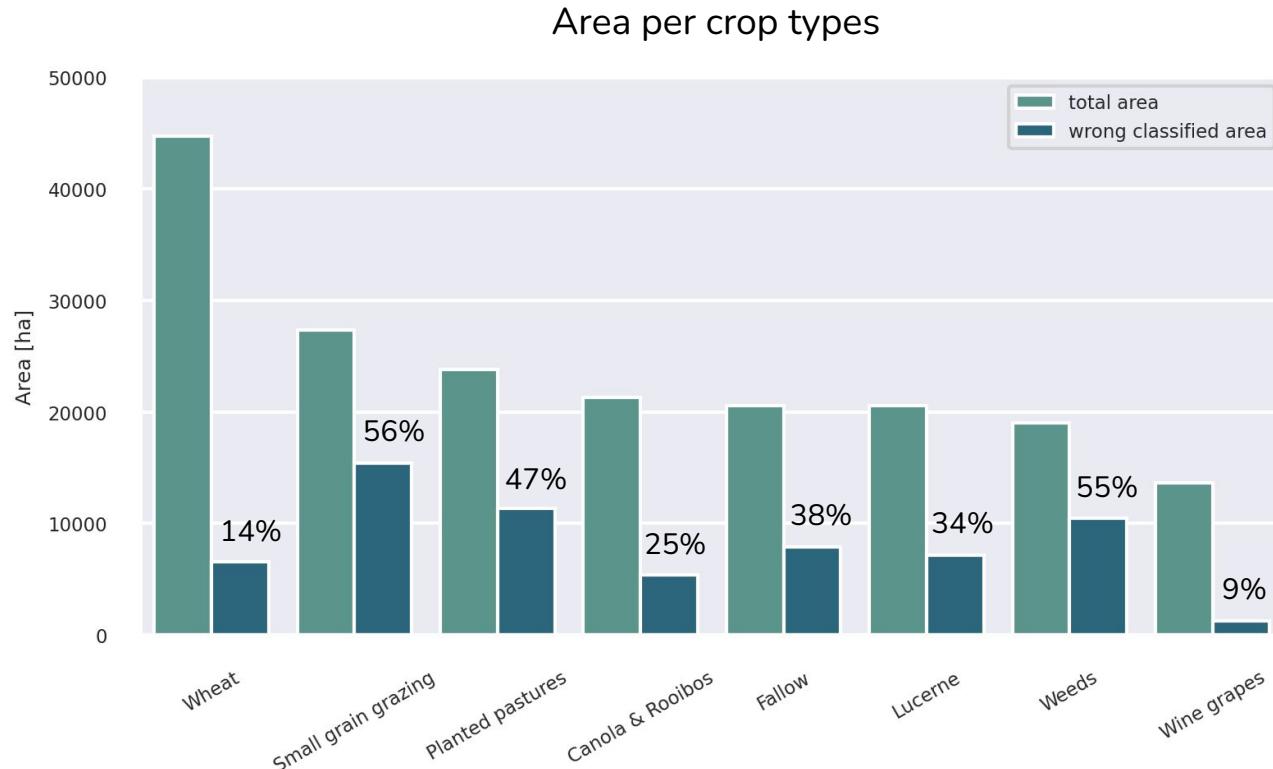
Accuracy on the different crop types



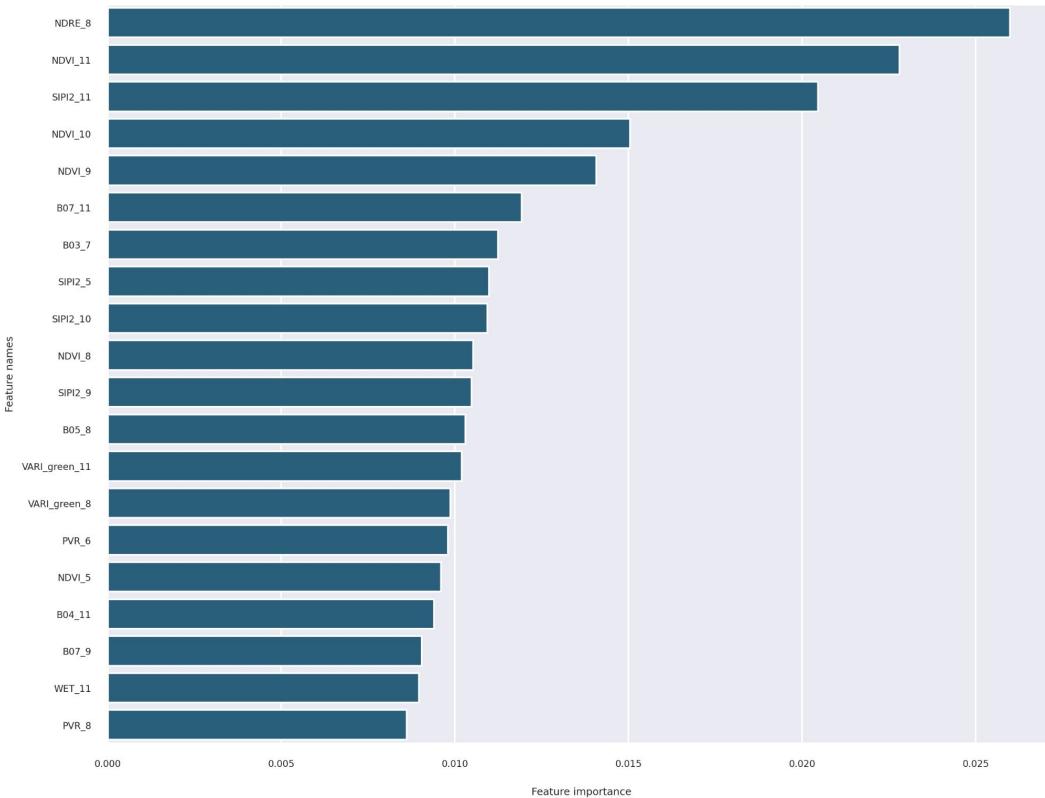
| Crop type | most often confused with | confusion chance [%] |
|---------------------|--------------------------|----------------------|
| Wine grapes | Planted pastures | 4.84 |
| Wheat | Small grain grazing | 12.3 |
| Canola & Rooibos | Weeds | 15.05 |
| Planted pastures | Weeds | 20.19 |
| Lucerne | Planted pastures | 31.61 |
| Fallow | Weeds | 31.25 |
| Weeds | Fallow | 30.74 |
| Small grain grazing | Wheat | 32.66 |



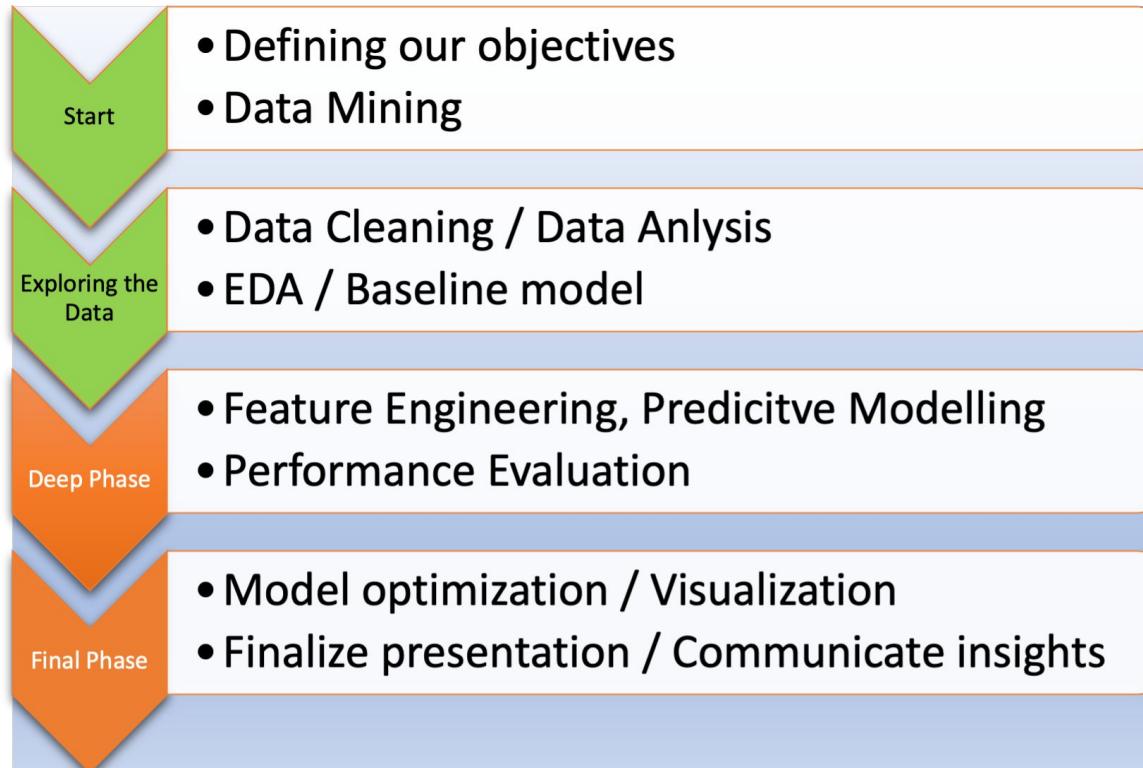
XGBClassifier - Error analysis: accuracy of each label



Error analysis: feature importance



Outlook



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