StatEO

Classification of earth observation data for land cover statistics in Austria

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Independent statistics for evidence-based decision making

STATISTICS AUSTRIA
The Information Manager

Result

- https://www.statistik.at/atlas/?mapid=topo_eo_landcover

Content

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- Ground Truth
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Objectives

- Classification accuracy of 80 – 90 %
- Discrimination of 10 defined classes
- 10 m resolution
- Year of observation is 2019

Data Sources and pre-processing

- Sentinel 1 Monthly Mean GMR from external data provider
  - March – October
- Sentinel 2 mosaic created with R Package SITS
  - Period of 14 days from 1 March – 31 October
  - NDVI, NDWI calculated
- Cloud area masked out - no imputation was done
- DEM

1	Sentinel 2 Bands
2	NDVI
3	NDWI
4	Sentinel 1 GMR VV/VH
5	DEM

Ground Truth

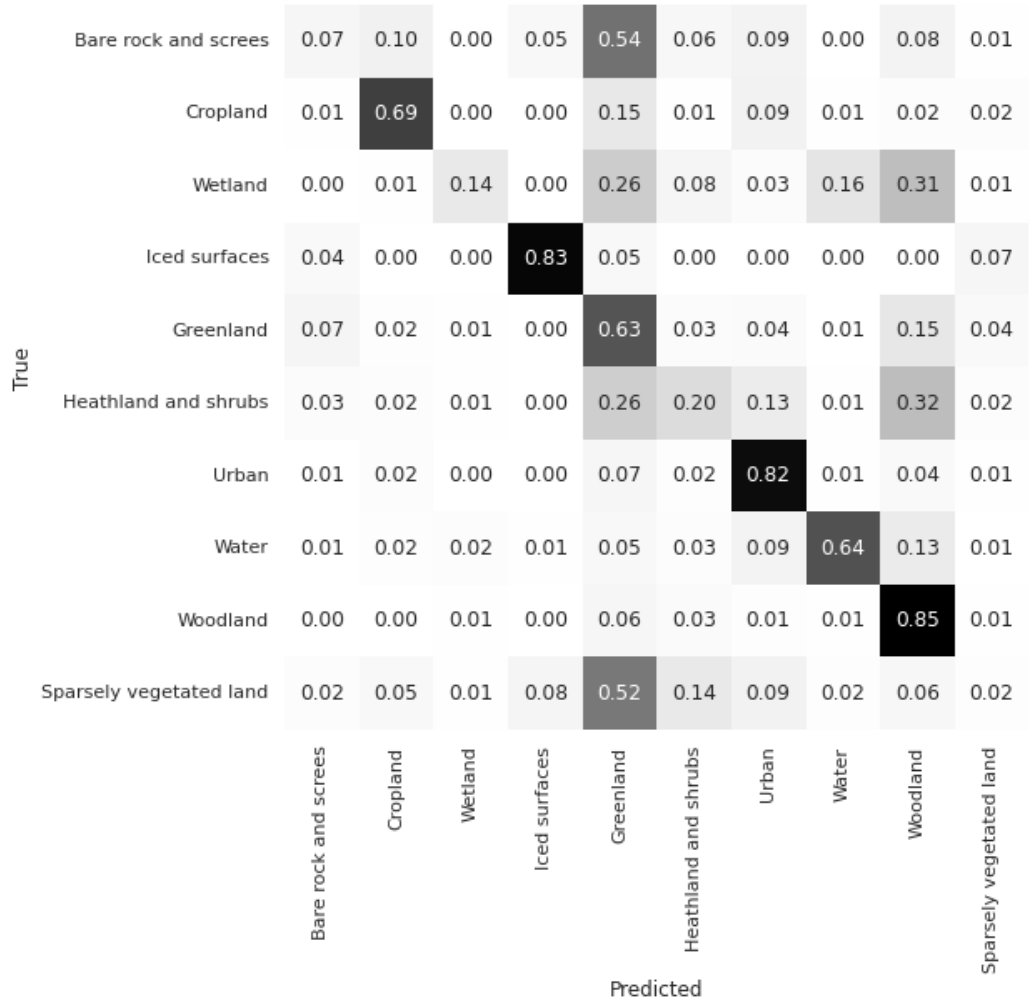
- Used Data: InVeKoS, Corine landcover
- Eight municipalities where defined, which represent different types of land cover
- Stratified distribution of sampling points

Accuracy

- Hyperparameter Tuning
  - Grid Search
  - nested Cross validation

$$Balanced\ Accuracy = \frac{sensitivity\ +\ specificity}{2}$$

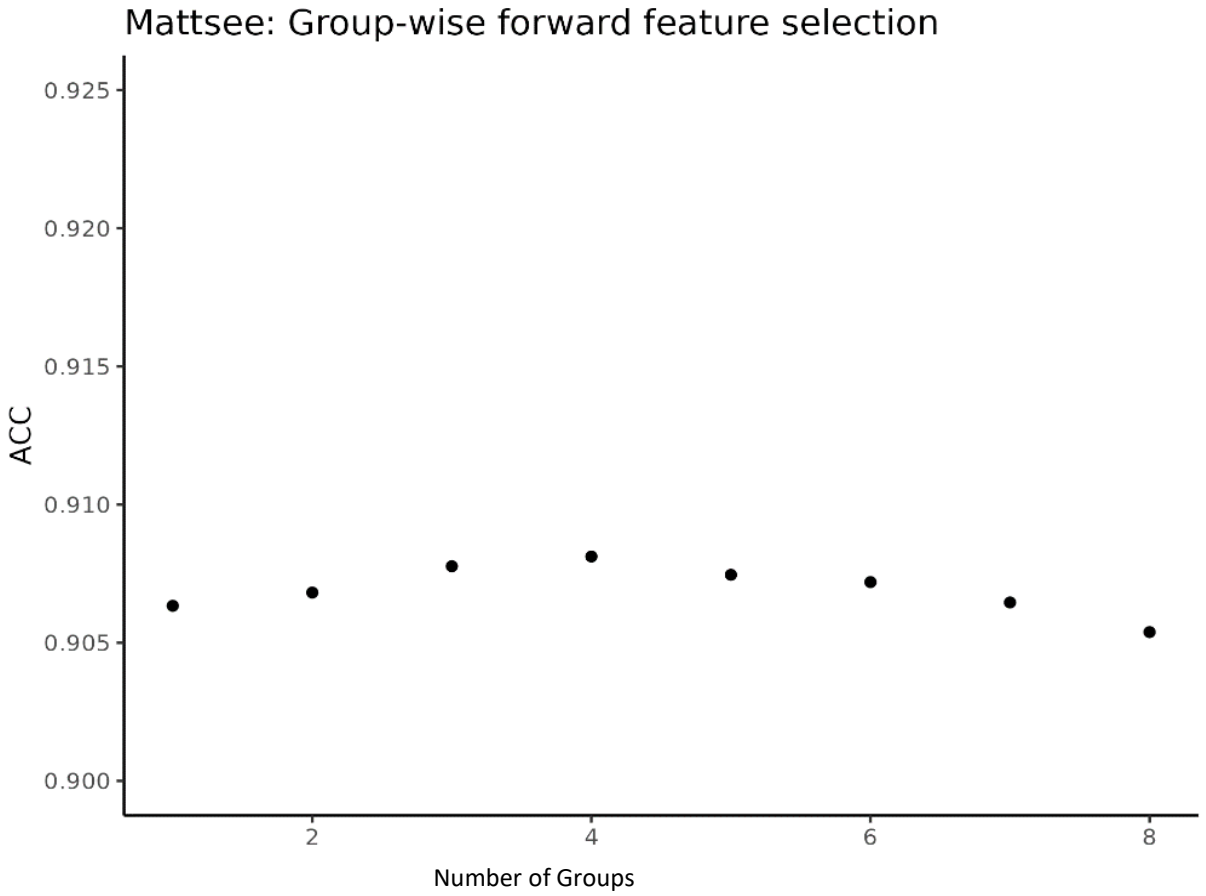
Data sources	Balanced Accuracy
S1, S2, DEM	0.795
S1, S2	0.786
S2, DEM	0.787



S1, S2, DEM

Variable Importance

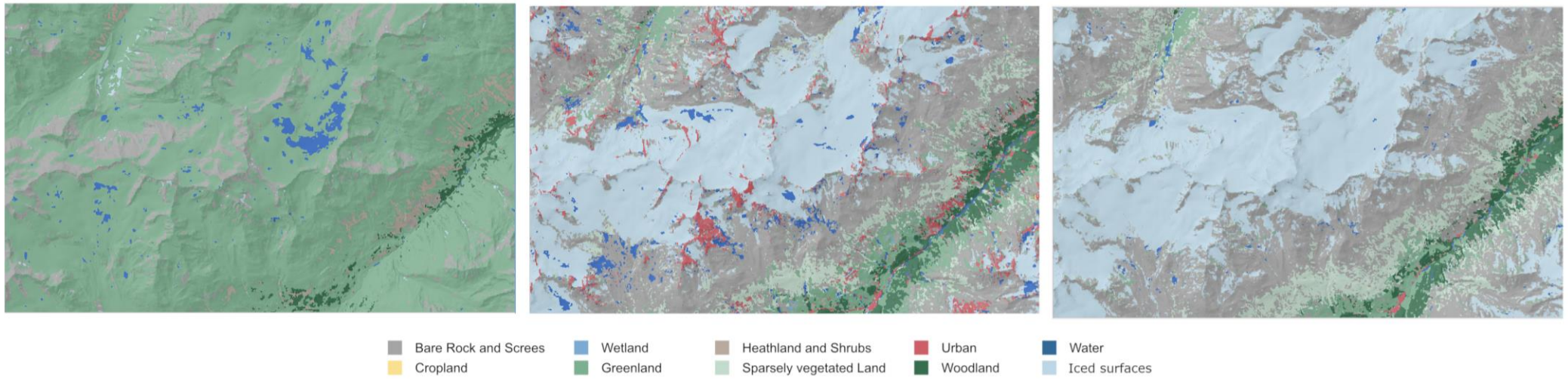
Group-wise forward feature selection



Group	Data
1	Sentinel 2 Bands
2	NDVI
3	NDWI
4	Tasseled Cap Greenness
5	Tasseled Cap Wettness
6	Tasseled Cap Brightniss
7	FCOVER, LAI, FVC
8	Sentinel 1 MMGMR VV/VH

Orynbaikyzy et. al . 2020

Comparison in High Alps



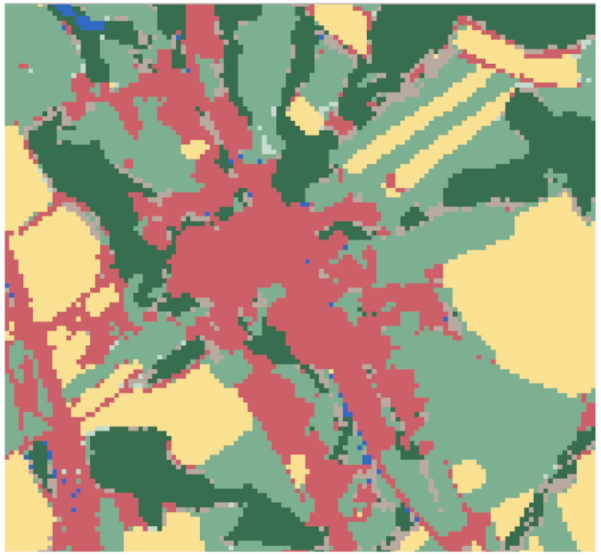
S2, DEM

S2, S1

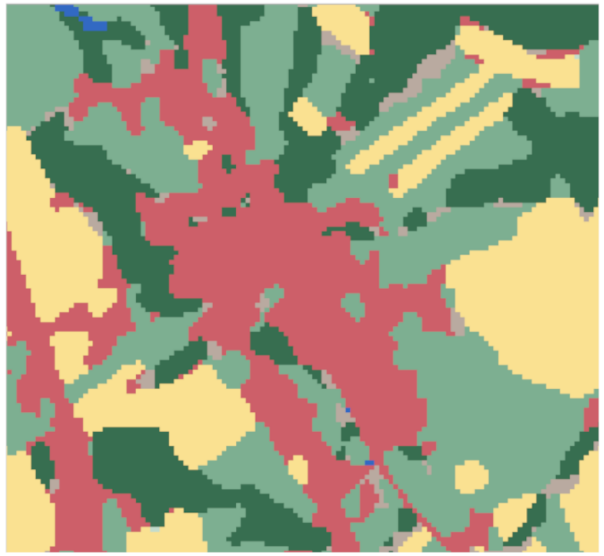
S2, S1, DEM

Post-classification

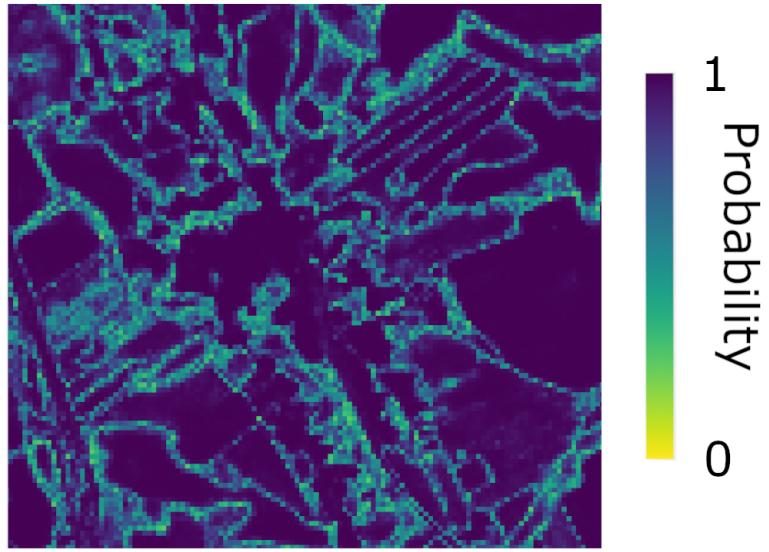
Bilateral smoothing filter



Original



Smoothed



Probability of class with higherst probability

Observations

- S1 is very beneficial for High Alps areas
- DEM for discrimination of Urban and Bare rock

- Water/Glacier areas in mountains are problematic because of there seasonal character
- Bad accuracy for wetlands, bare rock and screes, sparsely vegetated land and Heathland and shrubs

Possible Improvements

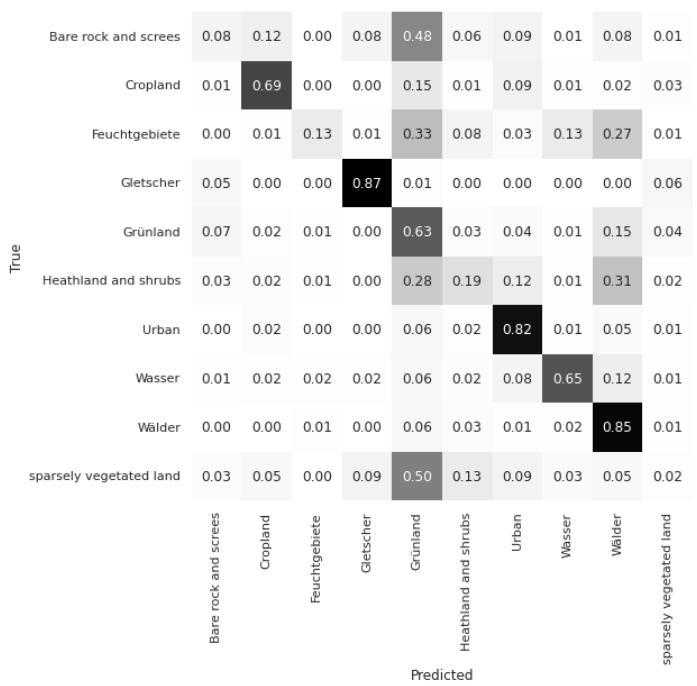
- Deep learning (1D CNN, LSTM…)
  - The mentioned NN process the time series data as a true time series and not as independent features like the most ML methods
- Minimize errors in ground truth dataset
- Speed up processing
- Imputing cloud covered areas
- Include knowledge-based data sources
- More sophisticated post-processing and reclassification
- Compare pixel based vs object based approach
- Finer granularity of classification

Outlook

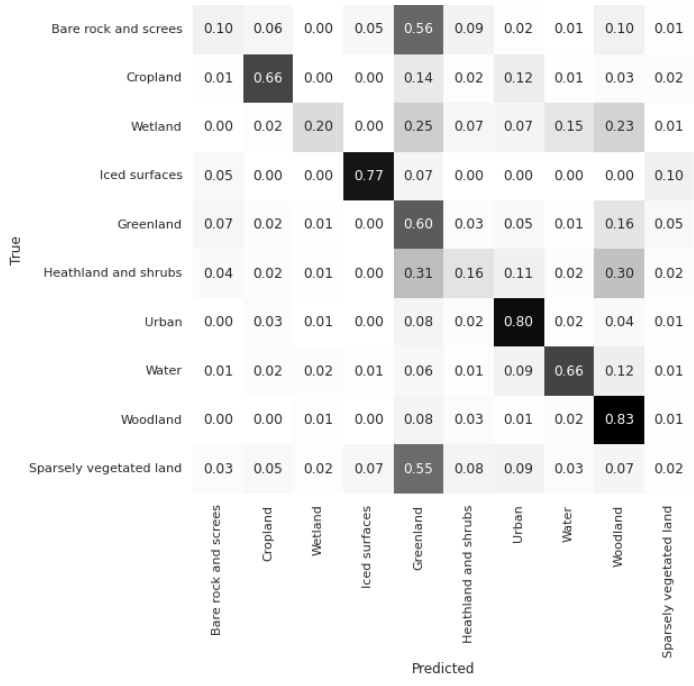
- Redo the classification for the years 2020, 2021, 2022
  - inspect the temporal stability of the classification
- Calculate statistics according to the needs of stakeholders (Mountain Green Cover,…)

Conclusion

- We where able to produce a land cover map with acceptable accuracy
- In mountainous areas S2, S1, DEM should be used, otherwise S2 is sufficient
- Certain classes with minor areas were expectedly inaccurate
- A workflow which happens entirely in the cloud could not be implemented
- We only used data that can be freely accessed


Bare rock and screes 0.08 0.12 0.00 0.08 0.48 0.06 0.09 0.01 0.08 0.01
Cropland 0.01 0.69 0.00 0.00 0.15 0.01 0.09 0.01 0.02 0.03
Feuchtgebiete 0.00 0.01 0.13 0.01 0.33 0.08 0.03 0.13 0.27 0.01
Gletscher 0.05 0.00 0.00 0.87 0.01 0.00 0.00 0.00 0.00 0.06
Grünland 0.07 0.02 0.01 0.00 0.63 0.03 0.04 0.01 0.15 0.04
Heathland and shrubs 0.03 0.02 0.01 0.00 0.28 0.19 0.12 0.01 0.31 0.02
Urban 0.00 0.02 0.00 0.00 0.06 0.02 0.82 0.01 0.05 0.01
Wasser 0.01 0.02 0.02 0.02 0.06 0.02 0.08 0.65 0.12 0.01
Wälder 0.00 0.00 0.01 0.00 0.06 0.03 0.01 0.02 0.85 0.01
sparsely vegetated land 0.03 0.05 0.00 0.09 0.50 0.13 0.09 0.03 0.05 0.02
True
Bare rock and screes
Cropland
Feuchtgebiete
Gletscher
Grünland
Heathland and shrubs
Urban
Wasser
Wälder
sparsely vegetated land
Predicted

S2, S1


Bare rock and screes 0.10 0.06 0.00 0.05 0.56 0.09 0.02 0.01 0.10 0.01
Cropland 0.01 0.66 0.00 0.00 0.14 0.02 0.12 0.01 0.03 0.02
Wetland 0.00 0.02 0.20 0.00 0.25 0.07 0.07 0.15 0.23 0.01
Iced surfaces 0.05 0.00 0.00 0.77 0.07 0.00 0.00 0.00 0.00 0.10
Greenland 0.07 0.02 0.01 0.00 0.60 0.03 0.05 0.01 0.16 0.05
Heathland and shrubs 0.04 0.02 0.01 0.00 0.31 0.16 0.11 0.02 0.30 0.02
Urban 0.00 0.03 0.01 0.00 0.08 0.02 0.80 0.02 0.04 0.01
Water 0.01 0.02 0.02 0.01 0.06 0.01 0.09 0.66 0.12 0.01
Woodland 0.00 0.00 0.01 0.00 0.08 0.03 0.01 0.02 0.83 0.01
Sparsely vegetated land 0.03 0.05 0.02 0.07 0.55 0.08 0.09 0.03 0.07 0.02
True
Bare rock and screes
Cropland
Wetland
Iced surfaces
Greenland
Heathland and shrubs
Urban
Water
Woodland
Sparsely vegetated land
Predicted

S2, DEM