Remote Sensing Technology
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BreizhCrops: A Satellite Time Series Dataset for Crop Type Identification

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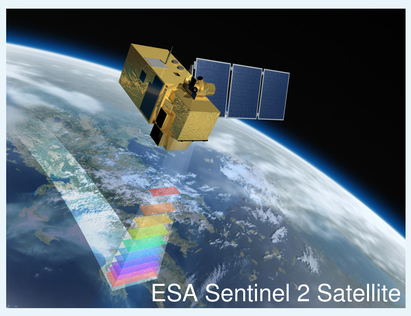
Objective

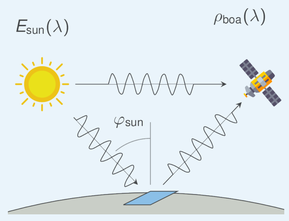
Satellite Data

$$\boldsymbol{X} = (\boldsymbol{x}_0, \boldsymbol{x}_1, \ldots, \boldsymbol{x}_T)$$



surface reflectance

$$\rho_\lambda = \frac{\pi L_\lambda d^2}{E_{\text{sun}} \cos(\varphi_{\text{sun}})}$$

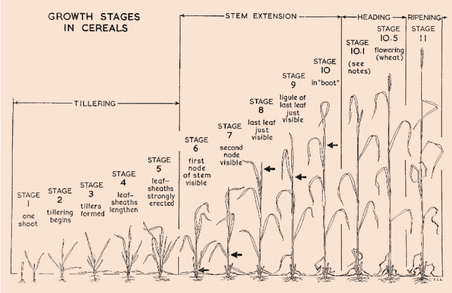


in 13 spectral bands

$$\boldsymbol{x}_t = (\rho_{\text{red}}, \rho_{\text{green}}, \rho_{\text{nir}}, \ldots)^T$$

Classification Model

$$\boldsymbol{y} = f(\boldsymbol{X})$$



cereal vegetation model by Large (1954)

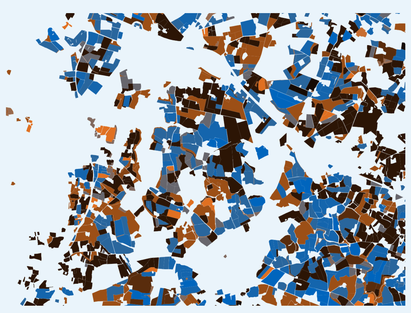
learning a **vegetation** model f

crop yield? crop health? production?

#foodsecurity

Crop Type Labels

$$\boldsymbol{y} = (y_{\text{corn}}, y_{\text{barley}}, \ldots) \in \mathbb{R}^{13}$$



IGN crop type labels

- European Common Agricultural Policy (CAP)
- collected yearly in entire Europe
- slowly made publicly available
- today, gathered on a national basis
- in future harmonized within Europe's INSPIRE directive

Results

We show the feasibility of classifying this dataset with **LSTM** (Hochreiter & Schmidhuber, 1997) and **Tranformer** (Vaswani et al., 2017) baselines.

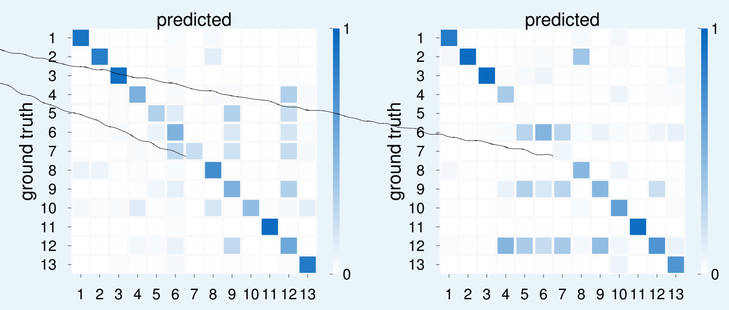
Comparison of baseline models

method	accuracy	κ	f_1	prec.	rec.
Transformer	**.69**	**.63**	.57	.60	.56
LSTM	.68	.62	**.59**	**.63**	**.58**

Class-wise results of the LSTM model

#	crop type	prec.	rec.	f_1	#samples
1	barley	.90	.86	.88	4982
2	wheat	.83	.95	.89	13850
3	corn	.93	**.96**	.94	25059
4	fodder	.51	.34	.41	3449
5	fallow	.30	.02	.04	3863
6	misc.	.50	.49	.49	12499
7	orchards	.21	.07	.10	391
8	cereals	.74	.47	.57	4645
9	perm. meadows	.51	.47	.49	20966
10	protein crops	.42	.61	.50	498
11	rapeseed	**.96**	.94	**.95**	2664
12	temp. meadows	.56	.68	.62	29977
13	vegetables	.86	.69	. 76	3114
		.63	**.58**	**.59**	125957

Challenge: Classes with similar vegetation characteristics

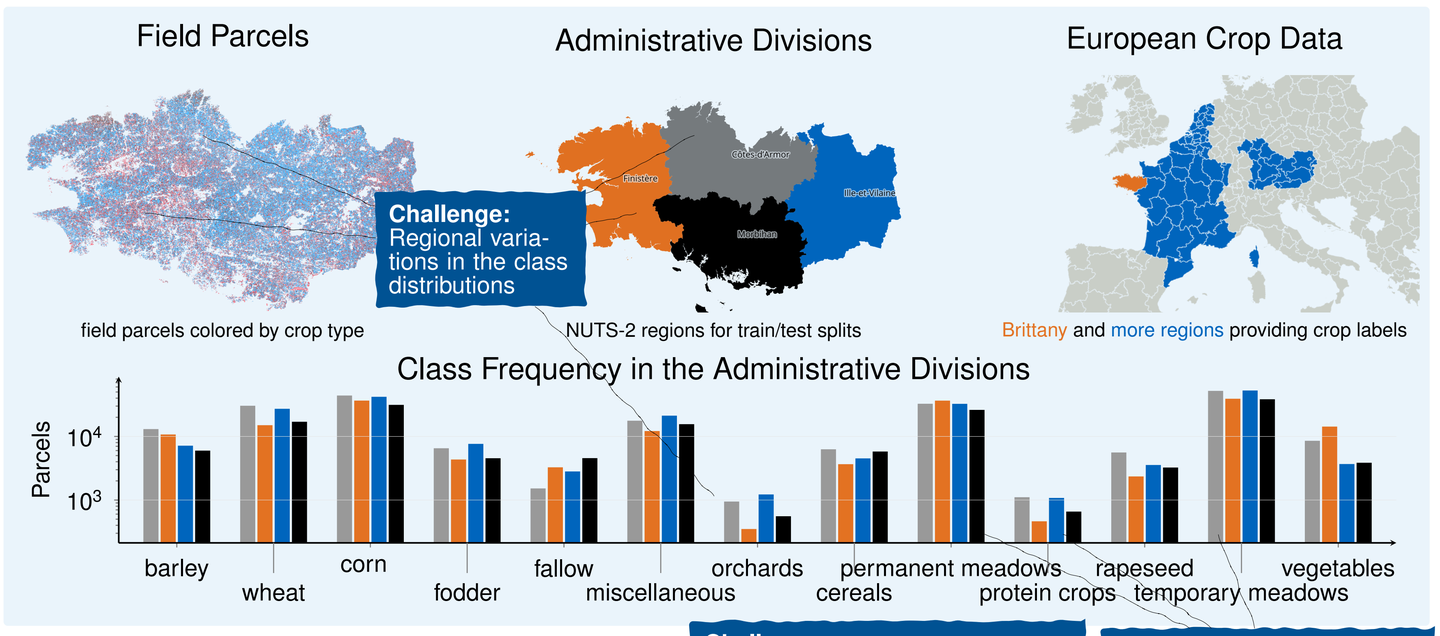


Data

Data gathered in Brittany, France (*Breizh*) in 2017 covering 27,206 km².

Labels

580k field parcels with 13 crop categories

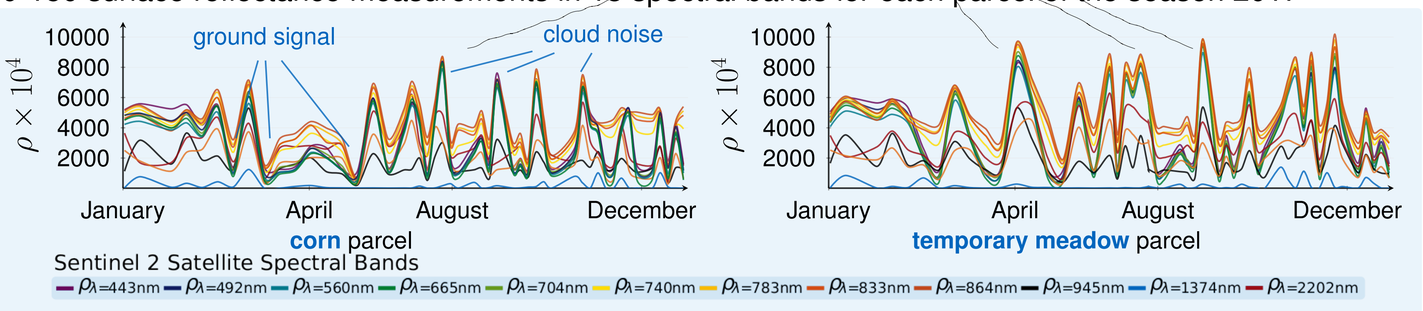


Satellite Reflectance Time Series

Challenge: positive bias caused by clouds

Challenge: Highly imbalanced classes

70-150 surface reflectance measurements in 13 spectral bands for each parcel of the season 2017



Outlook and Next Steps

- test **generalization** over **changing environmental conditions**. Problem of domain adaptation?
- **pre-train** a vegetation model on crop type labels and **fine-tune** related tasks with less labels (e.g., crop yield regression)
- include additional modalities (e.g., radar observations, precipitation, temperature, elevation)

References

Hochreiter, S. and Schmidhuber, J. Long short-term memory. *Neural computation*, 9(8):1735–1780, 1997.

Large, E. C. Growth stages in cereals illustration of the feekes scale. *Plant Pathology*, 3(4):128–129, 1954. ISSN 1365-3059. doi: 10.1111/j.1365-3059.1954.tb00716.x.

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, L., and Polosukhin, I. Attention is all you need. 2017.

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Time Series Workshop

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