



Pl@ntNet European crops: ingesting LUCAS cover photos to improve crop recognition and collect in-situ data

M. van der Velde, H. Goeau, P. Bonnet, R. d'Andrimont, M. Yordanov, A. Affouard,
M. Claverie, B. Czucz, N. Elvekjaer, L. Martinez-Sanchez, X. Rotllan-Puig, A. Sima,
A. Verhegghen, and A. Joly

European Commission, Joint Research Centre, D.5 Food Security Unit, Ispra, Italy

INRIA Sophia-Antipolis – ZENITH team, LIRMM, Montpellier, France

CIRAD, CNRS, INRAE, IRD, Montpellier, France

A citizen observatory of plant biodiversity that makes use of machine learning to help people identify plants using their smartphone



BIODIV. DATA



MACHINE LEARNING



NATURE
OBSERVERS

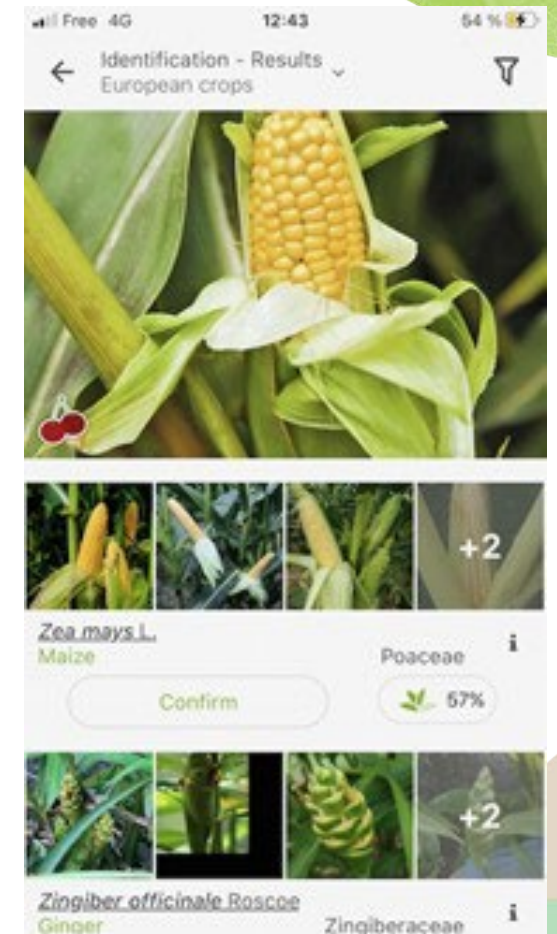


Joly, A., Bonnet, P., Goëau, H., Barbe, J., Selmi, S., Champ, J., ... & Barthélémy, D. (2016). **A look inside the Pl@ntNet experience.** *Multimedia Systems*, 22(6), 751-766.



A Pl@ntNet app dedicated to crops?

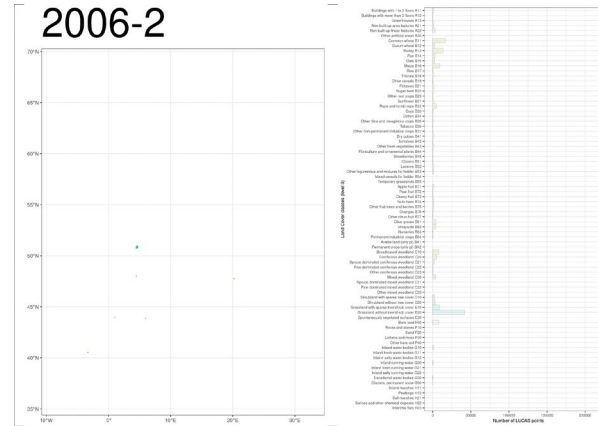
- Enrich it with observations and photos taken during EU LUCAS surveys
- Further develop deep learning algorithms for crops
- Deploy app and collect in-situ data on crops across the world and other use cases
- Use by citizens, farmers, inspectors, ...
- **Pl@ntNet Crops: 217**
species and **>650k** images
and **>600k** observations



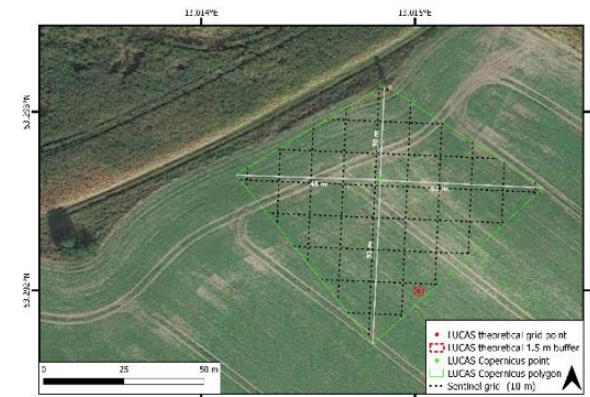
#Open In-situ Data

- LUCAS 2018 Grassland – 3000 points with botanic survey data
- LUCAS Harmonised DB ✓
- LUCAS 2018 Copernicus ✓

- LUCAS Cover – **874,646 close up photos taken during LUCAS!!**



LUCAS Harmonized



LUCAS Copernicus 2018

1) Inventory of what data we have: Databases

What	Description
Annex2_DIV2_1_Database_v2	Final grassland Database from Eurostat. Very good for comparison between surveyor and expert (3729x513)
DIV5_lot9_surveydata_base_LUCAS2018_v3	Expert botanist field form responses for 820 points (730 + alternative points). Includes the data from the full vegetation relevés and lists of photos taken by experts (2676x730)
LUCAS2018_DMT_EXP_v5.5	'Modified database used to create 'LUCAS grassland data analysis Final report'. The only database with the right coordinates for the initial LUCAS grassland points selected for the survey. Difficult to distinguish what is surveyor and expert data. From Blanca (3738x325)

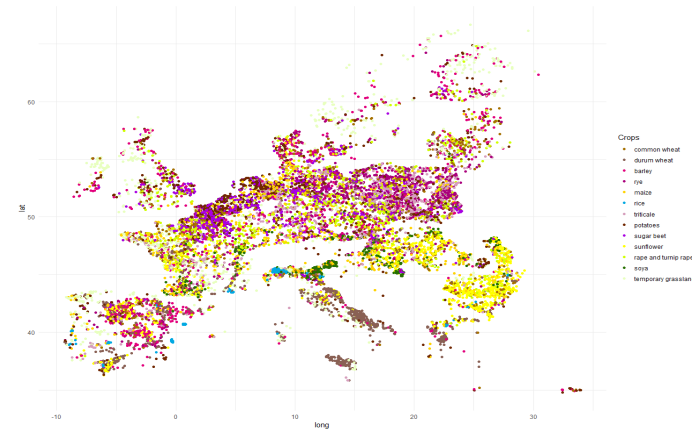
POINT_NUMBER_EXPERTISE	POINT_COORDINATES	POINT_ID	NUMBER_OF_POINTS	NUMBER_OF_POINTS
517	31963452	31963452	5	1
520	33802190	33802190	9	0
1803	46662086	46662086	9	2
3089	54562622	54562622	7	4
3487	56802152	56802152	9	4
621	33921738	33921738	0	0
1186	28182294	28182294	4	3
1174	42161622	42161622	8	3
2206	49602728	49602728	5	3
2207	52002942	52002942	10	8
860	34802648	34802648	8	6
1237	38842482	38842482	11	8
1579	44323170	44323170	7	0

LUCAS Grassland 2018

JRC 2021 Excellence Awards Knowledge Management 4.0!

LUCAS cover photos (874,646)

- LUCAS cover photos of crops (242,476)
- “the picture should be taken at a close distance, so that the structure of leaves can be clearly seen, as well as flowers or fruits”
- Not publicly available yet: ESTAT 2022 – anonymization by EFTAS (data-paper in the pipe)
- In-house use with Mobilenet on **mature crops** and out-house collaboration with PI@ntNet



Common wheat (B11)



Durum wheat (B12)



Barley (B13)



Rye (B14)



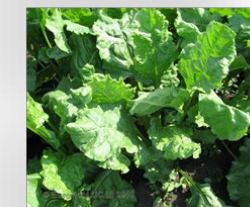
Oats (B15)



Maize (B16)



Potato (B21)



Sugar beet (B22)



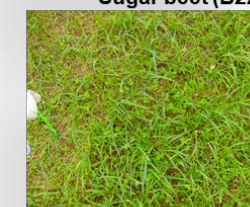
Sunflower (B31)



Rapeseed (B32)

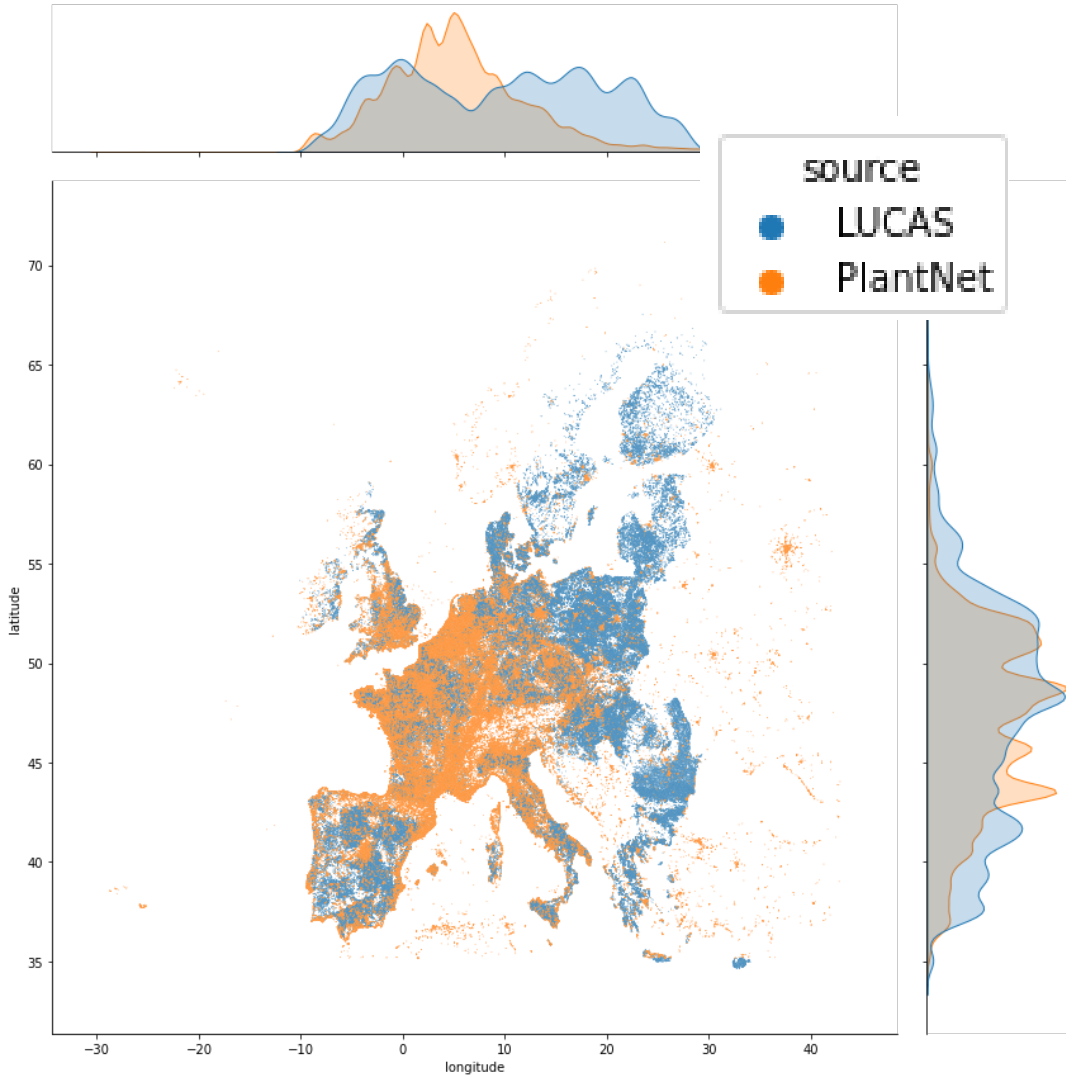


Soy (B33)

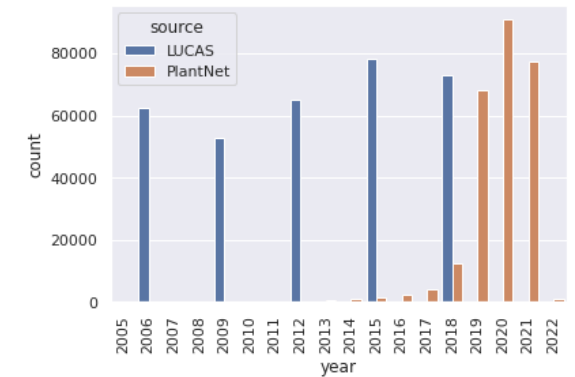
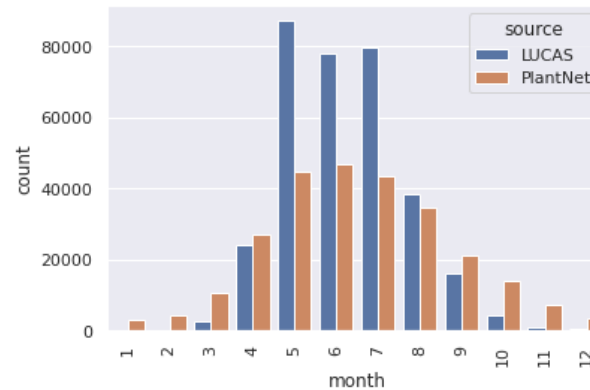


Grassland (B55)

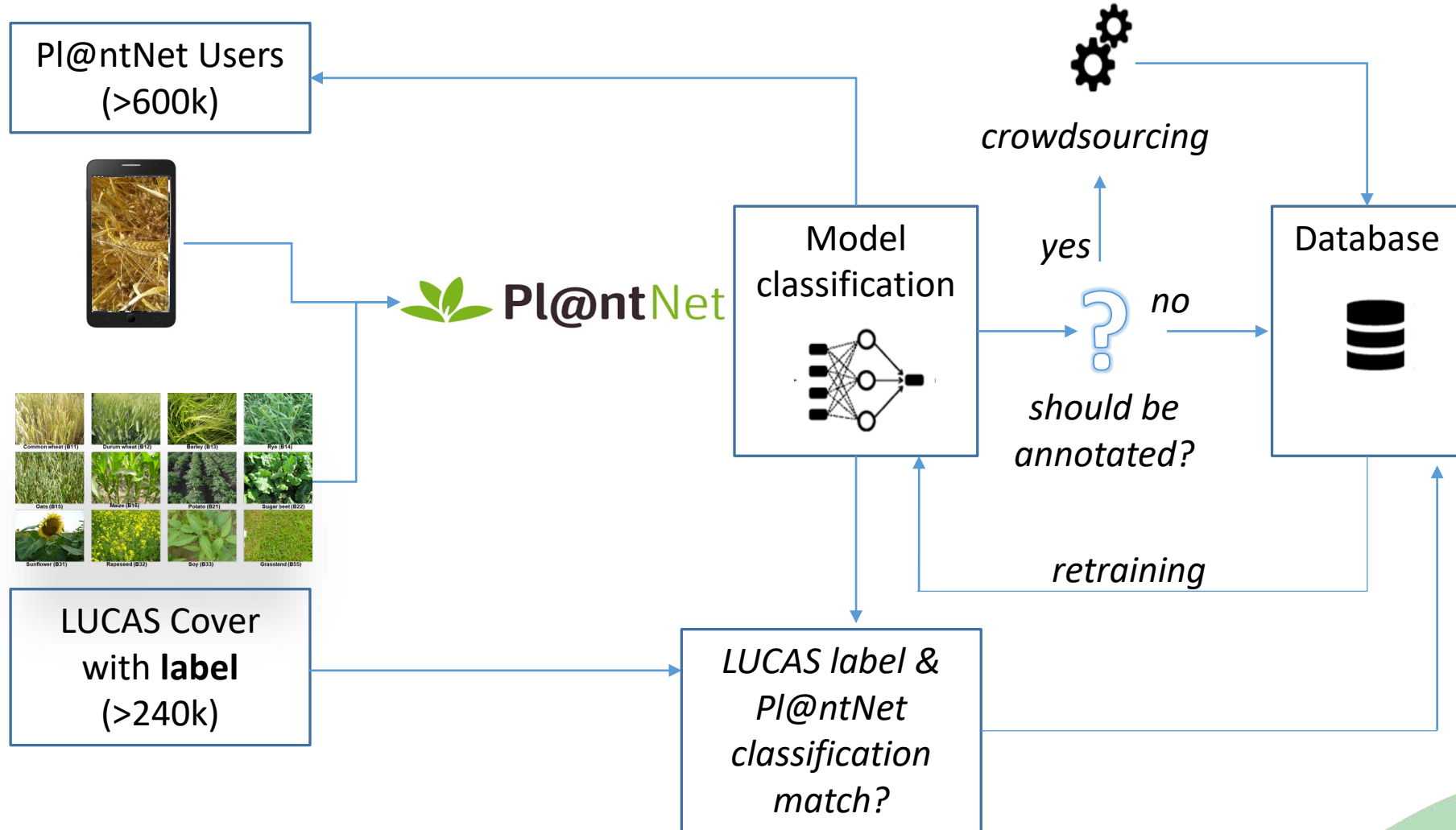
Spatio-temporal complementarity



- LUCAS representative across Europe
- PI@ntNet bias around populated areas
- LUCAS sampling during summer
- Volumes of data collected with PI@ntNet rapidly growing



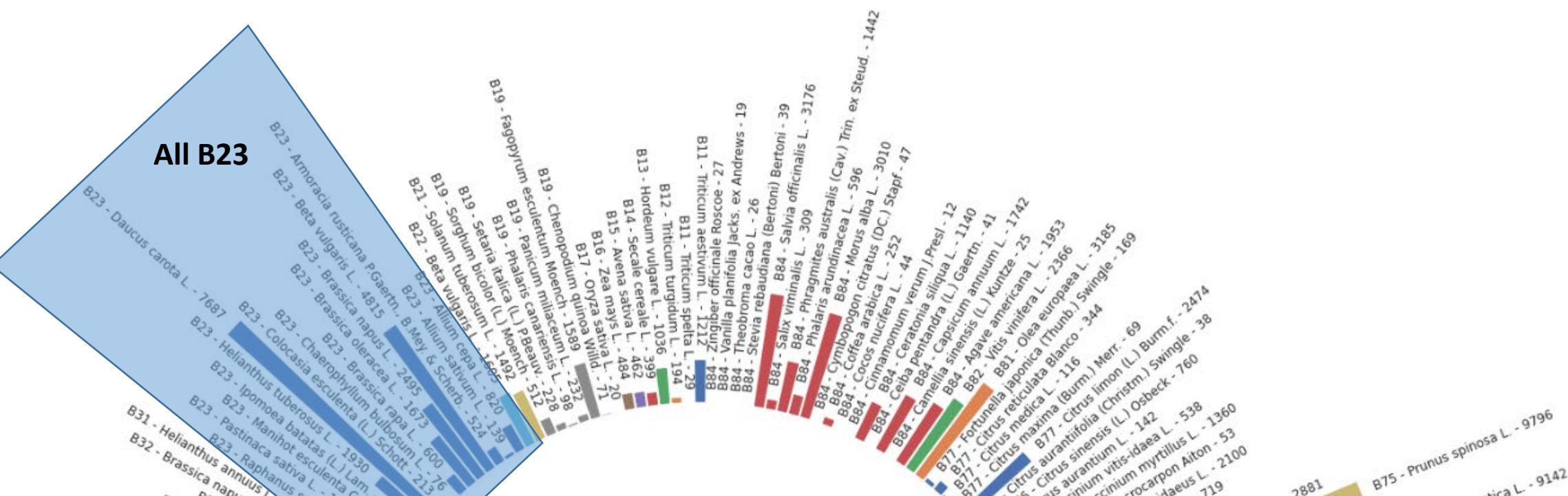
Ingesting LUCAS cover in Pl@ntNet





In practice... the legend challenge

- Pl@ntNet at species level – LUCAS not: matching needed
- **217 species** mapped to **36 LUCAS legend level 3 classes**
- Implications for the accuracy assessment!



In practice...

PI@ntNet photos

vs

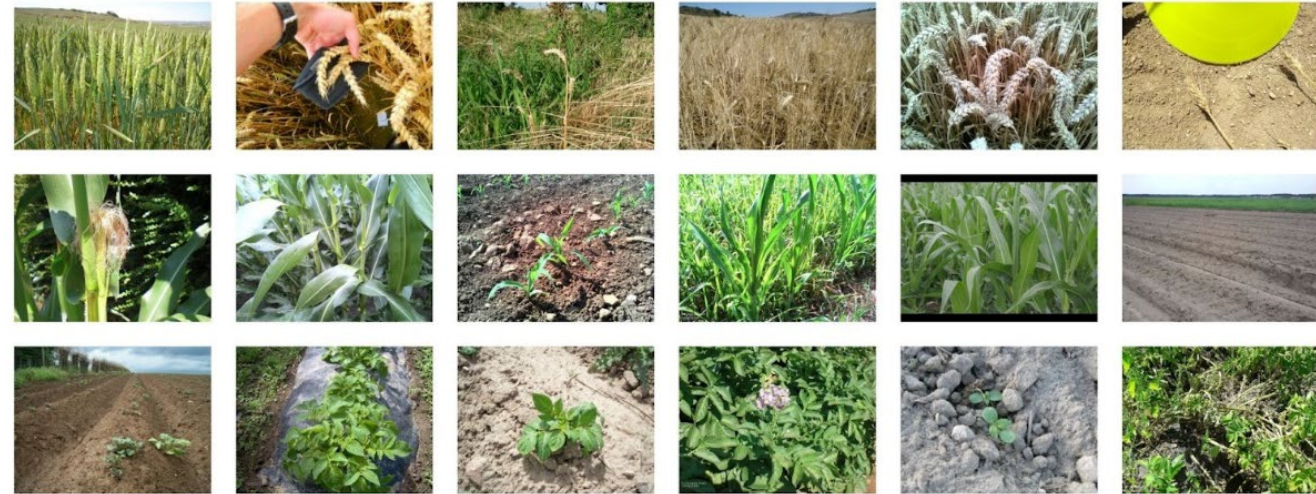
LUCAS cover photos



**Common
wheat**

Maize

Potatoes



- LUCAS and PI@ntNet protocol differ! PI@ntNet more coherent, close up, LUCAS marker blocks view, ...
- PI@ntNet protocol at plant organ level (flower, fruit, leaf)



Classification results

Model **first** classifies *view* and **second** classified *species*

View

	Total	Flower	Fruit	Leaf	Bark	Habit	Other
Pl@ntNet User (n)	605.242	231.669	62.541	260.005	17.099	26.666	7.262
Pl@ntNet User (%)		38	10	43	3	4	1
LUCAS Cover total (n)	242.476	24.401	25.333	67.488	1.692	98.234	25.328
LUCAS Cover total (%)		10	10	28	1	41	10

Species

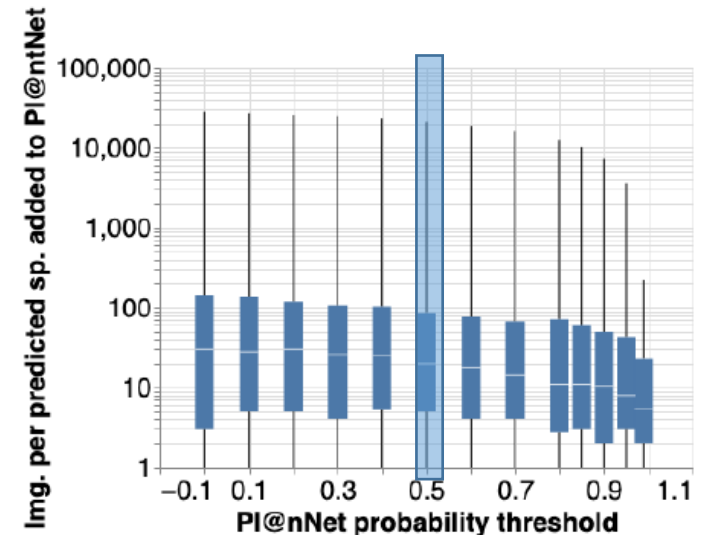
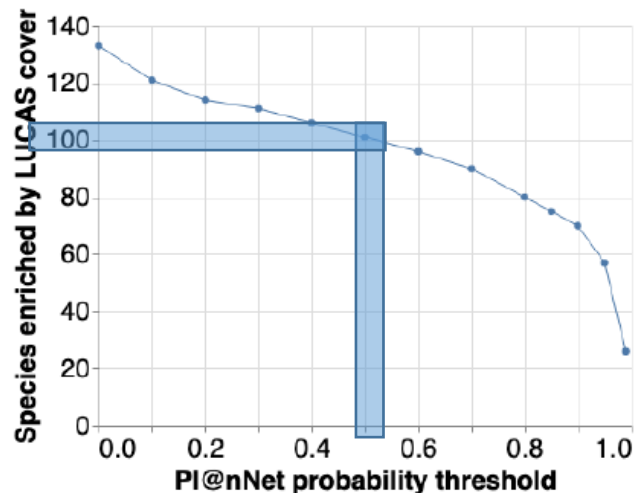
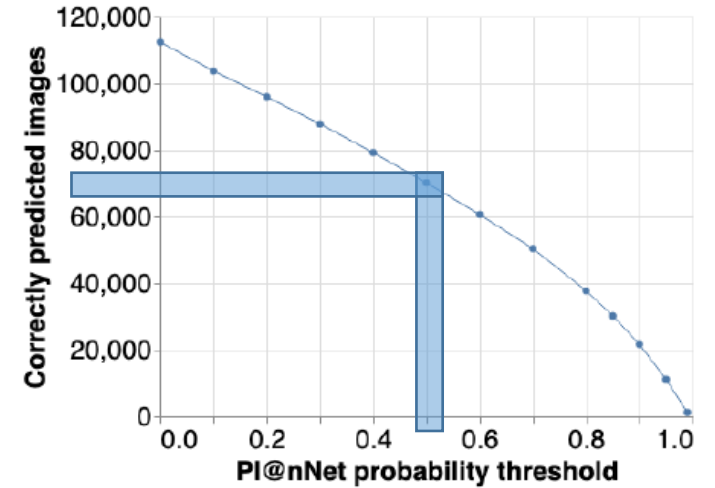
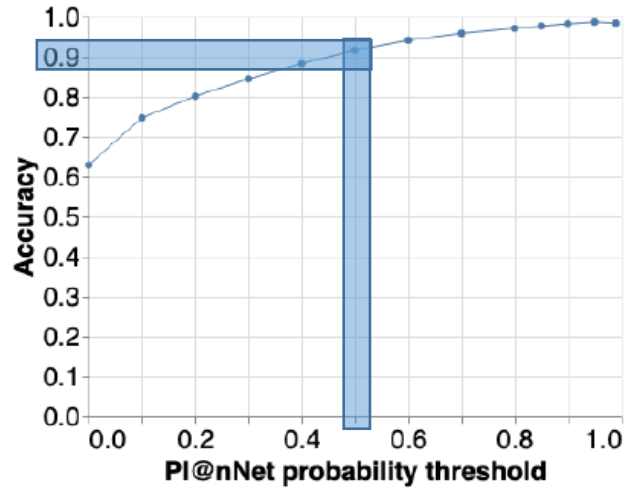
Mean Average Precision	Top-1 accuracy	Top-5 accuracy
0.927	0.891	0.972



PI@ntNet classification vs LUCAS label

LUCAS into PI@ntNet

- From **240k** to **112k** as habitat view, marker, species not in list
- Prob. threshold of **0.51**:
75.598 photos included
- **100** species with accuracy of **0.9** enriched (simplified label)



Web interface and phenology



Explore data collected for each species

Locations

Photos

Classifications

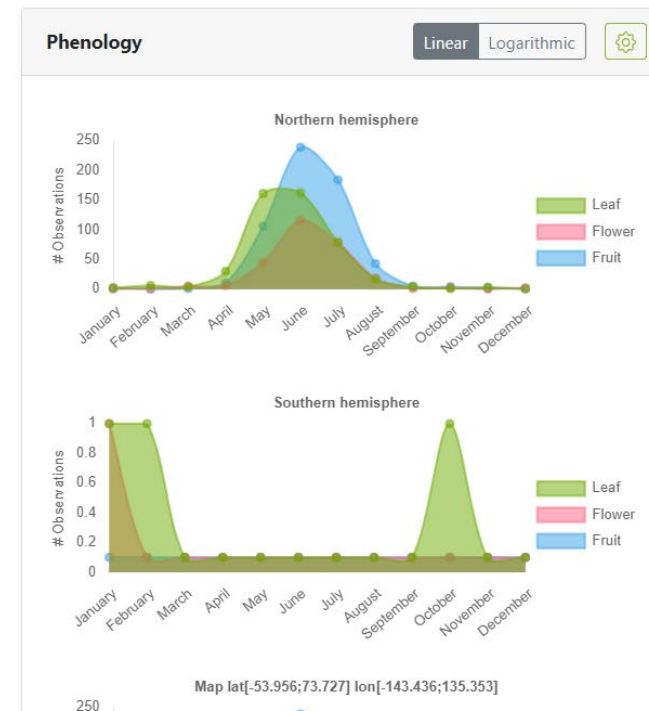
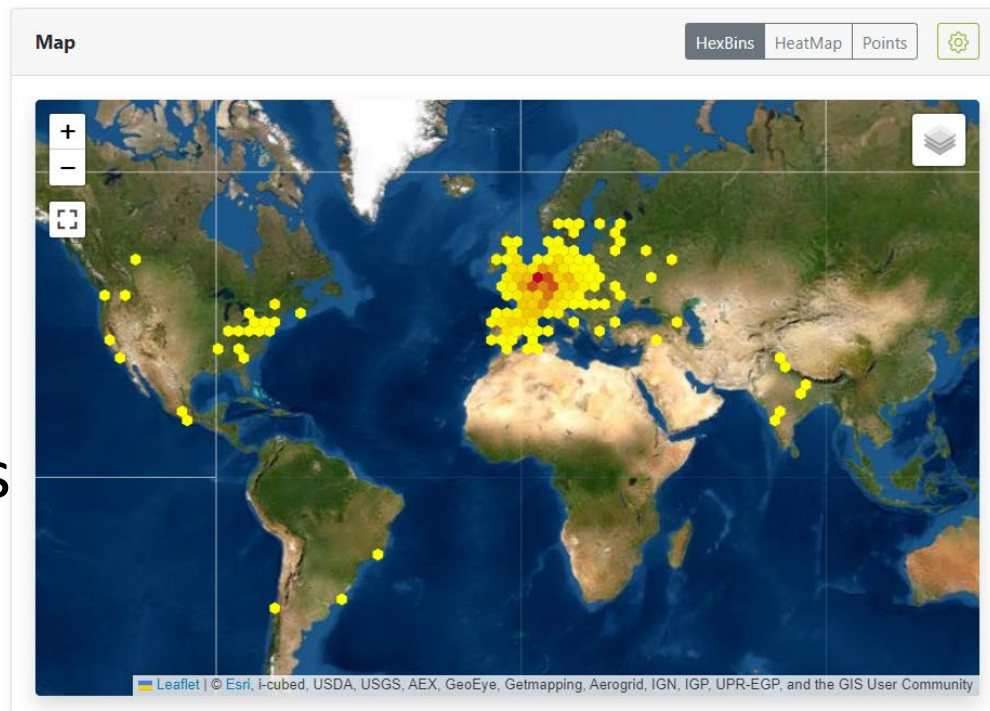
Phenology

Input for SDMs

Triticum aestivum L.

2,141 1,833 observations

Wheat, Bread Wheat, Common wheat, Soft wheat, Canadian hard winter wheat, Cultivated Wheat, గోధుమ



Triticum aestivum L.

European crops

Family
Poaceae

Genus
Triticum

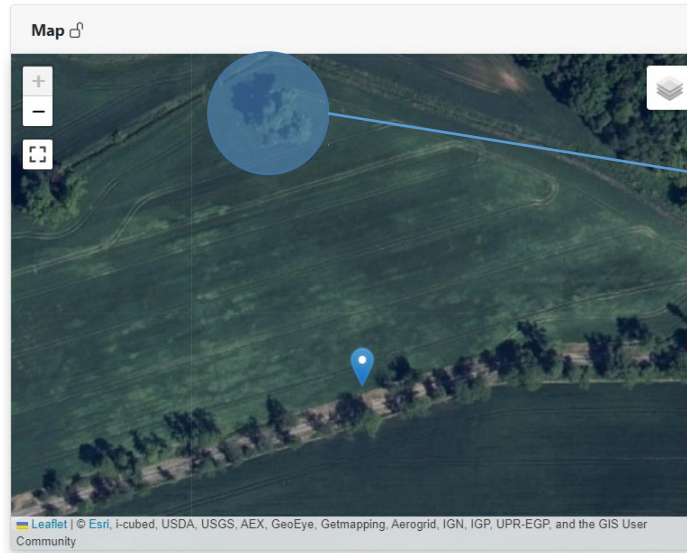
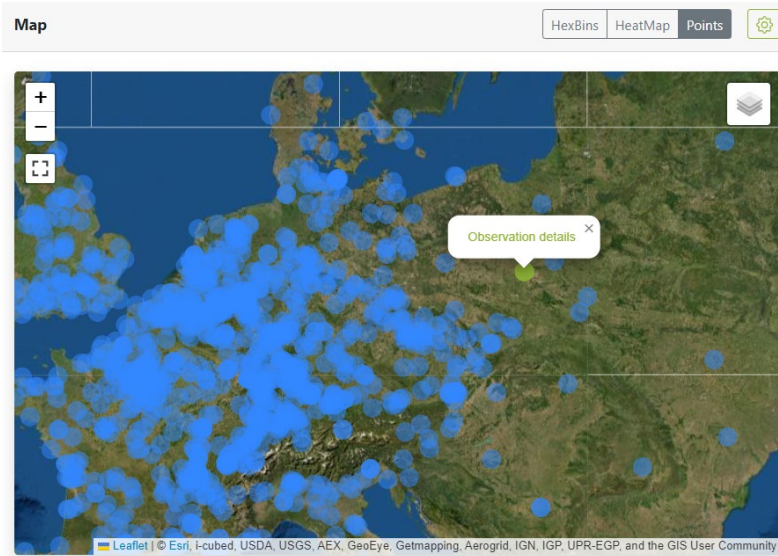
Species
Triticum aestivum L.

Common name(s)
Wheat
Bread Wheat
Common wheat
Soft wheat
Canadian hard winter wheat
Cultivated Wheat
గోధుమ

[View all / Edit](#)

Uses
MEDICINE
folklore

In-situ application case



A photograph of a field with a blue circle highlighting a specific area. Below the photo is a voting interface with icons for different crops and a "Vote for the quality" section.

Vote for an organ

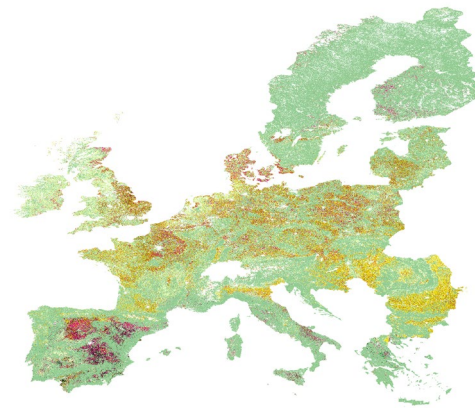
Vote for the quality

Use as ground truth?

Precision of location

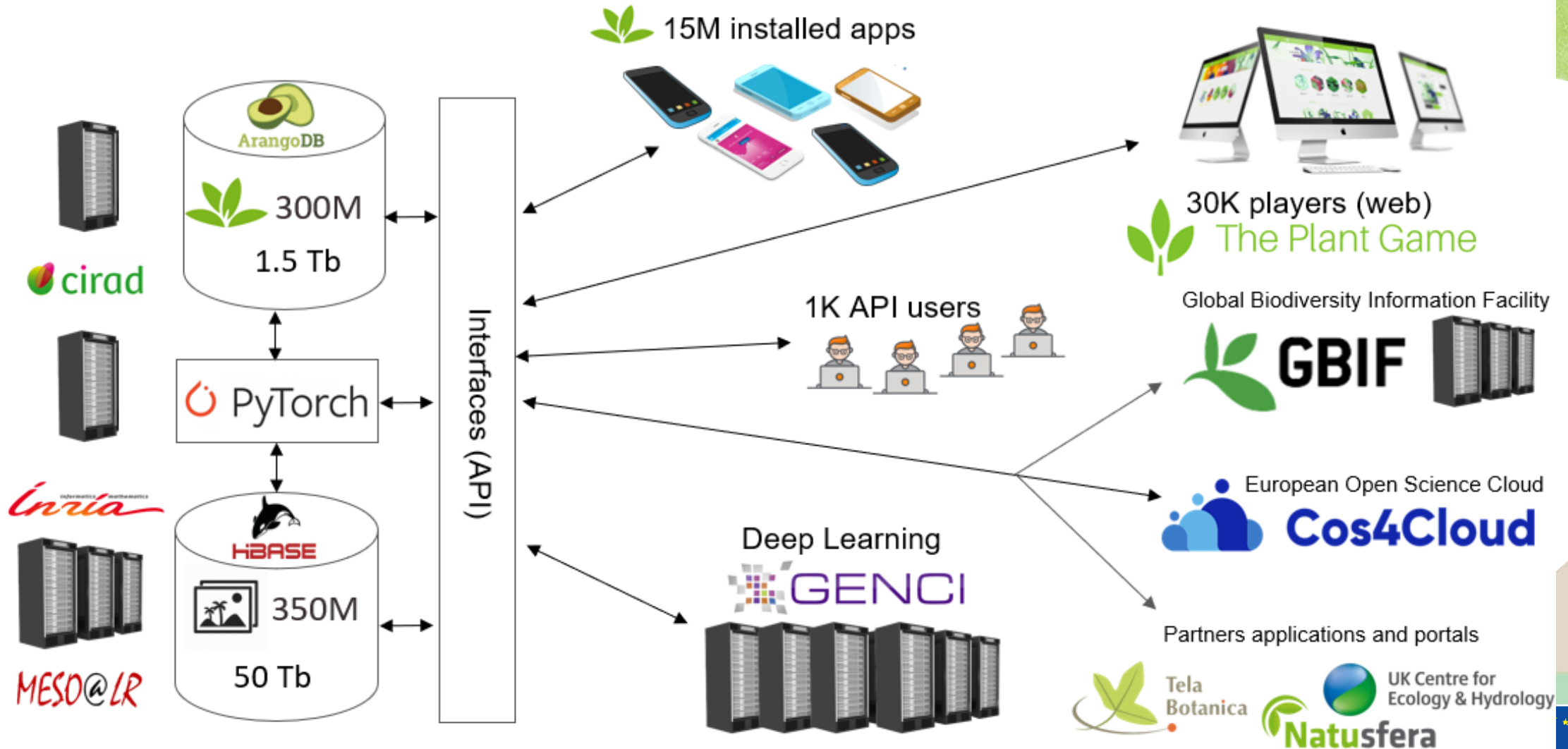
Visual positioning

- 211 Common wheat
- 212 Durum wheat
- 213 Barley
- 214 Rye
- 215 Oats
- 216 Maize
- 217 Rice
- 218 Triticale
- 219 Other cereals
- 221 Potatoes
- 222 Sugar beet
- 223 Other root crops
- 230 Other non permanent industrial crops
- 231 Sunflower
- 232 Rape and turnip rape
- 233 Soya
- 240 Dry pulses
- 250 Fodder crops (cereals and leguminous)
- 290 Bare arable land
- 300 Woodland and Shrubland (incl. permanent crops)
- 500 Grasslands



EU crop map 2018 (d'Andrimont, Verhegghen, et al. 2021)

Pl@ntNet Infrastructure



Outlook and Summary

- Legends are now matched – LUCAS surveyors could use the app to speed up classification
- Development of deep learning models – Pl@ntNet available for use – derived models to be shared
- CAP applications – use for evidence of practices (cover crops, N-fixing, ...)!
- Educational agri-food-environment domain applications – where does our food come from?
- Crop and biodiversity monitoring – co-occurrence of crop and flower species?

