



Bee Observer

Diren Senger, Alexander Goncharskiy, Alexandros Melemenidis



Diren Senger
UNIVERSITY OF BREMEN

Alexander Goncharskiy
COMMERZBANK AG

Alexandros Melemenidis
EUROPEAN CENTRAL BANK

Introduction - Bee Observer



Bee Observer



CORRELAID

RHEIN-MAIN



Bundesministerium
für Bildung
und Forschung

 Universität Bremen

Introduction - The honey bee

The European Honeybee (*apis mellifera*)



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Superorganism
Honey bee colony



Environmental influences

Parasites

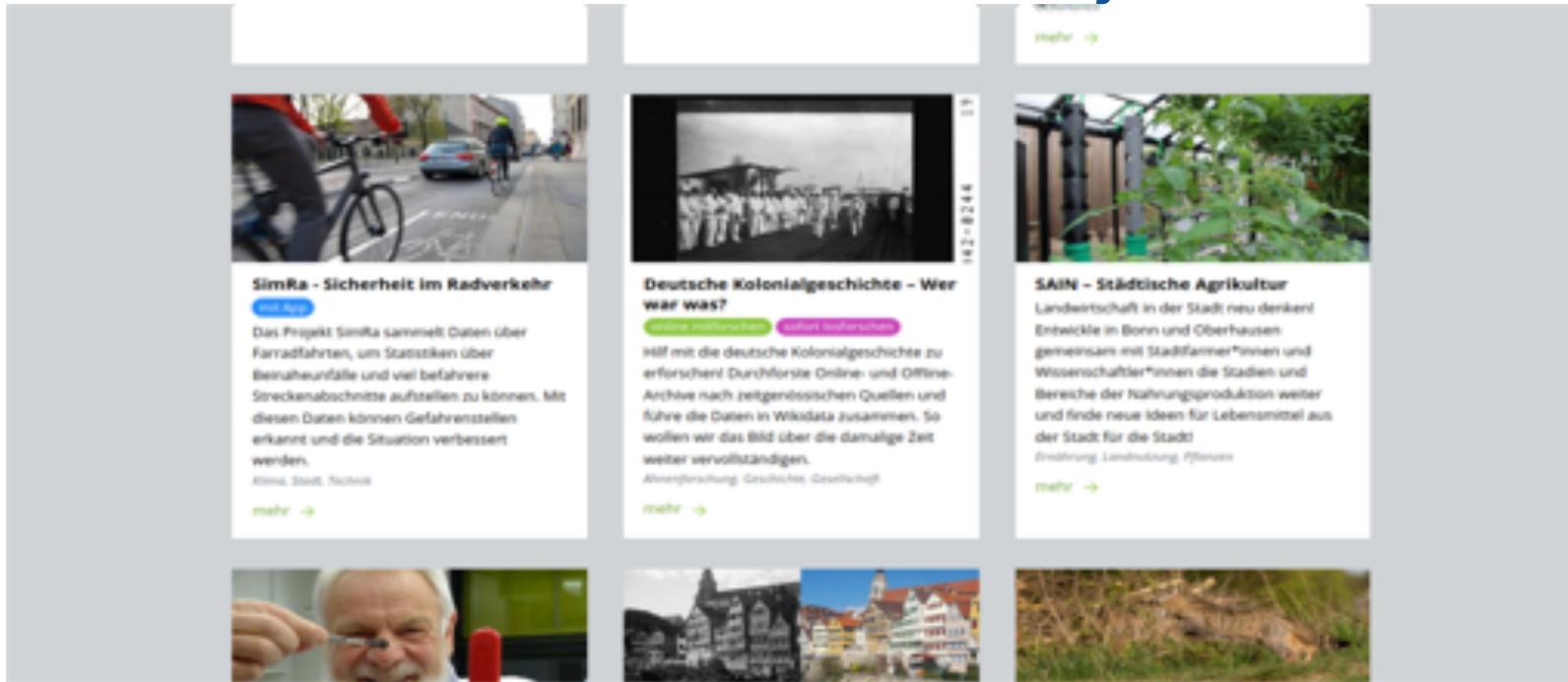
Living conditions

Citizen Science – Lead Your Project

Science by nonprofessionals,
citizens as data collectors or
thinkers



Citizen Science – Find Your Project



SimRa - Sicherheit im Radverkehr
Das Projekt SimRa sammelt Daten über Fahrradfahrten, um Statistiken über Beinaheunfälle und viel befahrene Streckenabschnitte aufzustellen zu können. Mit diesen Daten können Gefahrenstellen erkannt und die Situation verbessert werden.
Klima, Stadt, Technik
[mehr →](#)

Deutsche Kolonialgeschichte – Wer war was?
Hilf mit die deutsche Kolonialgeschichte zu erforschen! Durchforste Online- und Offline-Archive nach zeitgenössischen Quellen und führe die Daten in Wikidata zusammen. So wollen wir das Bild über die damalige Zeit weiter vervollständigen.
Altenforschung, Geschichte, Gesellschaft
[mehr →](#)

SAIN – Städtische Agrikultur
Landwirtschaft in der Stadt neu denken! Entwickle in Bonn und Oberhausen gemeinsam mit Stadt Farmer*innen und Wissenschaftler*innen die Städte und Bereiche der Nahrungsproduktion weiter und finde neue Ideen für Lebensmittel aus der Stadt für die Stadt!
Ernährung, Landnutzung, Pflanzen
[mehr →](#)

<https://www.buergerschaffenwissen.de/projekte>

Citizen Science – Challenges and Chances

Find more relevant research questions

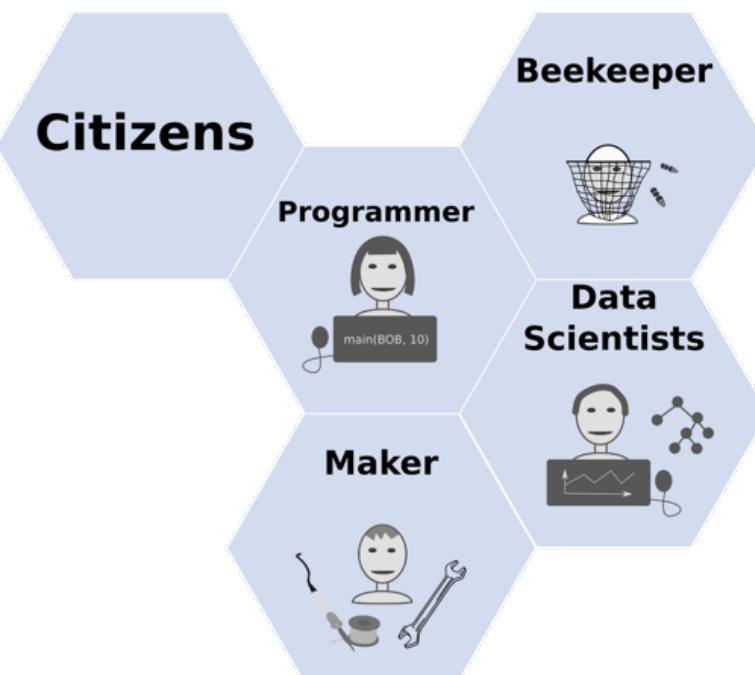
Make best use of available knowledge
and experience

Collect more data from different
locations

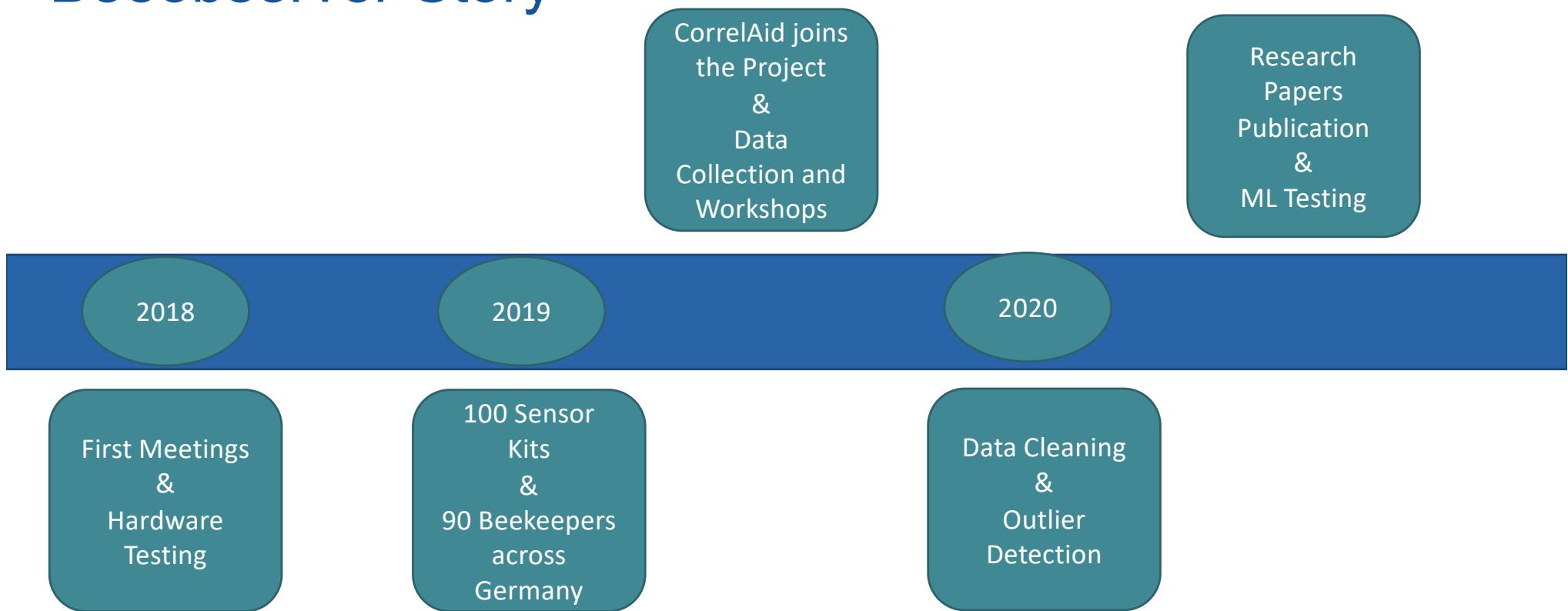
- ✗ Mostly no experimental setup
- ✗ How to pay citizens for their work?



Citizen Science – Beeobserver



Beeobserver Story



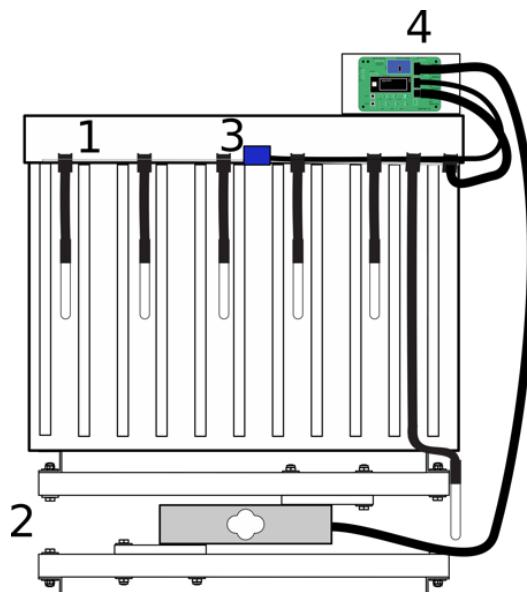
Bee Observer - Sensor Data

Data collection since February 2019

Sensor-kits:

1. six thermometers (5 in, 1 out)
2. load-cell (scale)
3. humidity sensor
4. processing unit

Data stored in *influxdb*



Source: Senger et al. (2020)

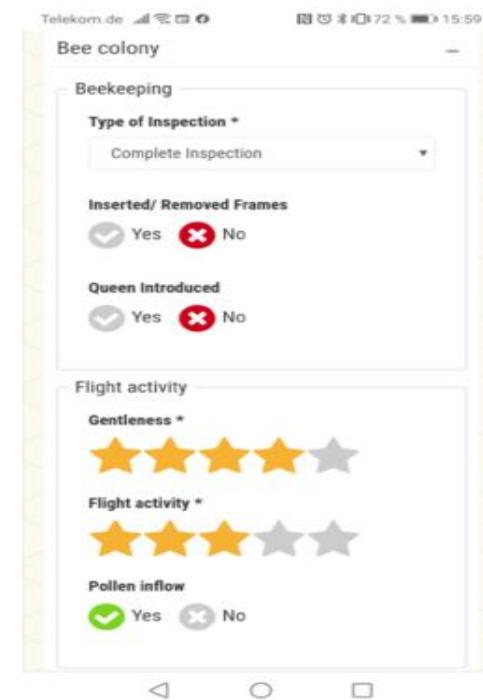
Bee Observer - Inspections App

Sensor data is complemented by
Beekeeper observations

- mix of Boolean, scores, free text, categorical and numeric data
- most values voluntary

Apiary metadata

- type of hive, race of queen
- geolocation (voluntary)



The screenshot shows a mobile application interface for beekeeping. At the top, there are status icons for signal strength, battery level (72%), and time (15:59). The main screen is titled 'Bee colony' and contains sections for 'Beekeeping' and 'Flight activity'.

Beekeeping:

- Type of Inspection ***: A dropdown menu is set to 'Complete Inspection'.
- Inserted/ Removed Frames**: A checkbox is checked (Yes).
- Queen Introduced**: A checkbox is checked (Yes).

Flight activity:

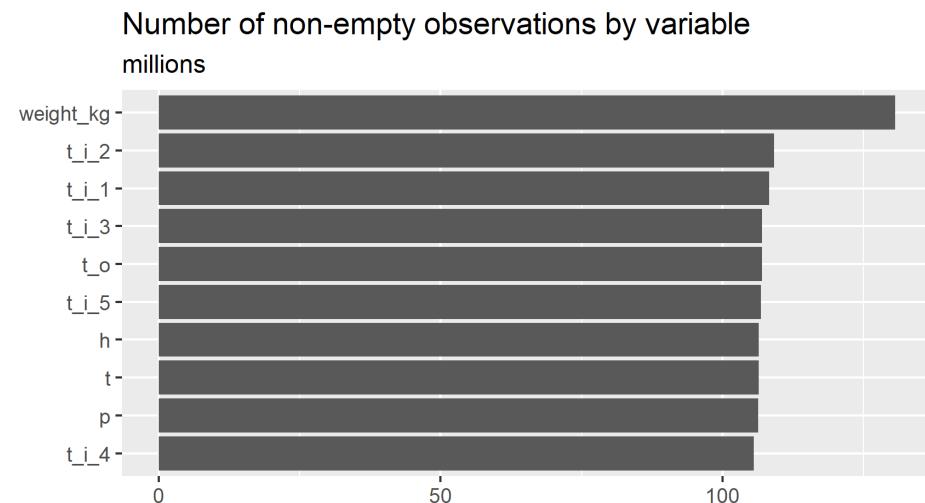
- Gentleness ***: A rating scale with 5 yellow stars and 1 gray star.
- Flight activity ***: A rating scale with 4 yellow stars and 2 gray stars.
- Pollen inflow**: A checkbox is checked (Yes).

Data Profiling - Sensor Data

hundreds of millions of observations from 129 beehives

BUT

- variation across variables
- regular gaps
- some sensor kits do not have all sensors
- values outside the technical sensor range



Note: Data until 30 September 2020.

Data Profiling

The main issues in terms of data quality are:

- no data at all (interruption of electricity or WiFi)
- incomplete observations (single components fail)

Data availability over time

sensor kit dmmsqtndFSd8TgNk



Heatmap of data availability for an example beehive

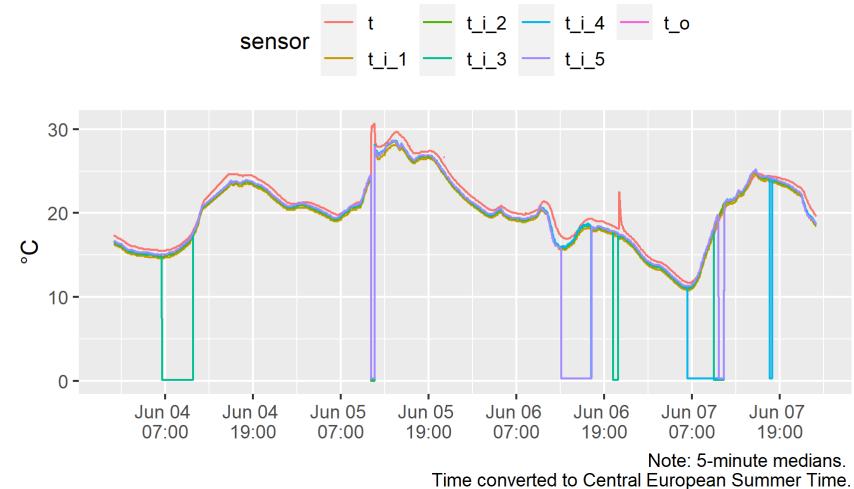
Data profiling - Data Correctness

The other problem (less frequent) is obviously incorrect data:

- values outside the technical sensor range
- values within the range, but displaying implausible fluctuation (and/or lack thereof)

Some cleaning needed!

persistent implausible temperature readings
sensor kit E421ET8aqCTmPBz2

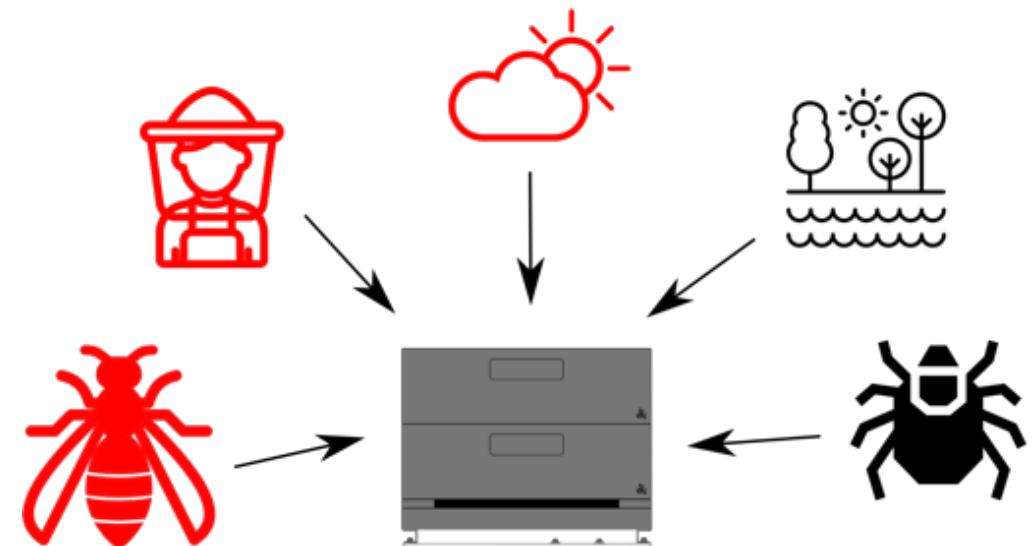


Example for apparent issues with thermometers

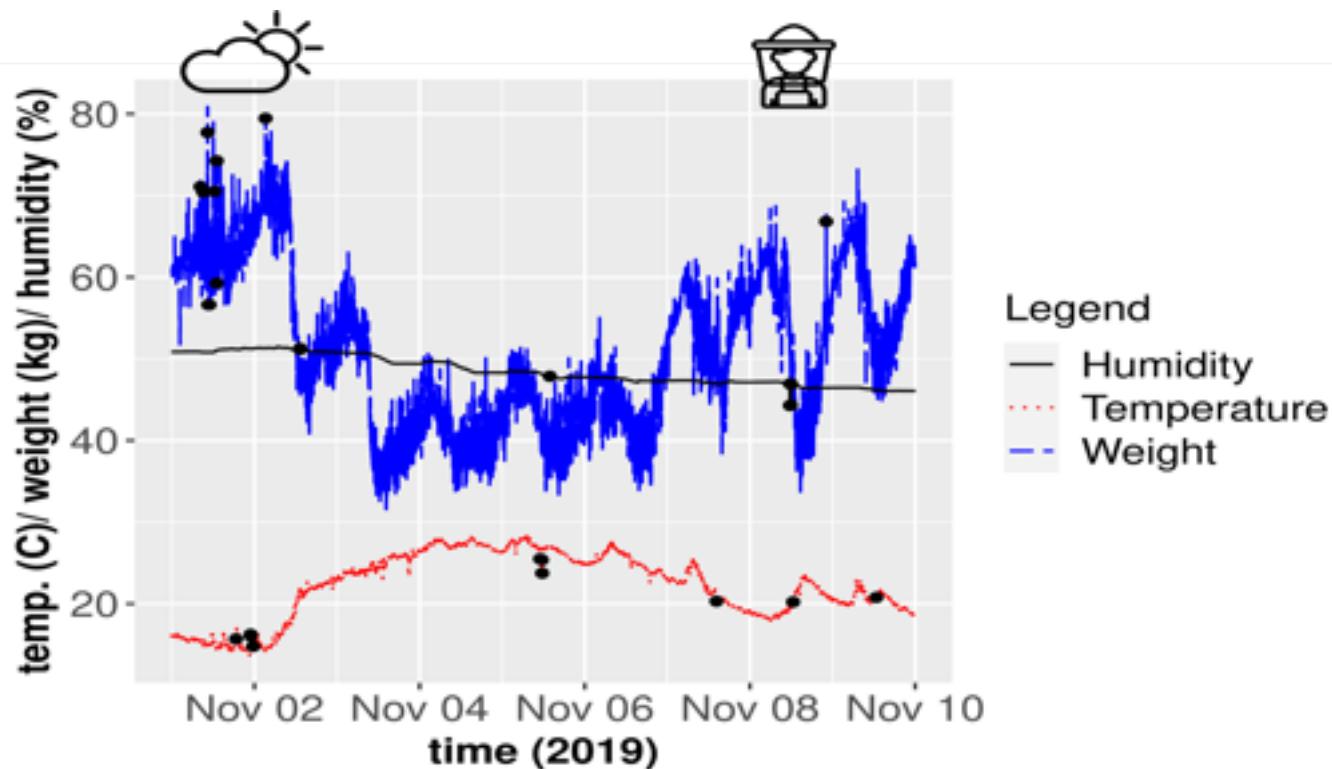
Local Outlier Detection

Data Modelling & Sensor Measurements Predictions

Difference between Prediction and the Actual Value



Local Outlier Detection



Analytical Use Case for Supervised Learning - Swarm Detection

When colonies swarm, the beekeeper has around one day to react. Otherwise the swarmed part of the colony may die or at least be lost to the beekeeper. Also the “old” part of the colony may be weakened.

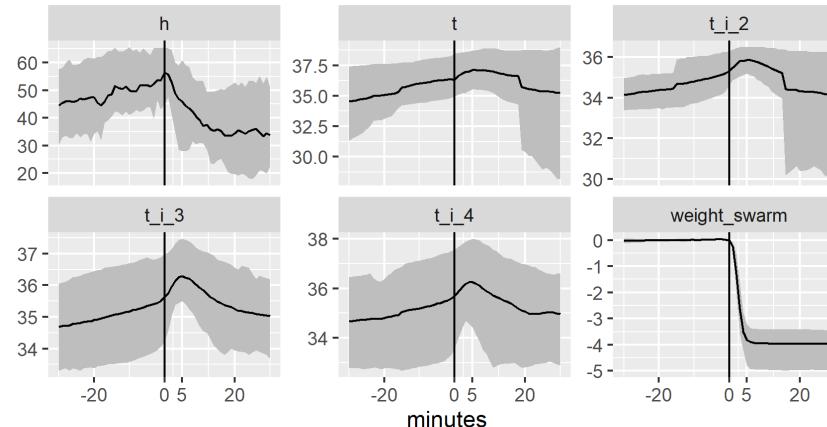
Swarms can be characterised by typical developments!



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What happens during a swarm?

Developments during a swarm event
line: mean developments - area: range over eight hives



Notes: The vertical line denotes the start of the colony leaving the hive.
The weight variable was standardised to zero at the beginning of the event.

Developments in key variables during a swarm

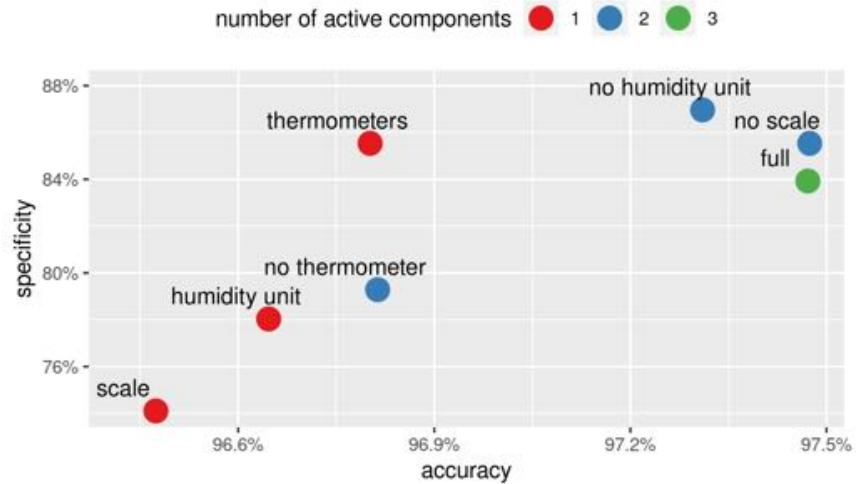
How do we model?

Non-linear model based on key variables, their growth rates and lags, time of day.

- small sample with missing data -> dimension reduction to maximum thermometer value, but also multiple models on subsets of variables
- unbalanced sample (few observed swarms): up-sampling training set with SMOTE

Random Forest works quite well

Model performance by number of used sensors
based on 10-fold cross-validation on the training set



Performance metrics of RF models using subsets of sensor components

Q&A



Introduction - Precision beekeeping

The colony is a complex super-organism

- complex organisation
- division of labour
- developments are hard to observe: inspections are stressful, in winter not possible at all

Precision beekeeping

- install **sensors within beehive** for continuous monitoring
- weight, temperature, humidity, gas concentration, video, audio
- first works using simple algorithmic rules
- later first steps using ML approaches
- most based on small samples

Introduction - The honey bee

The European Honeybee (*apis mellifera*)

- important for pollination
- producer of honey
- increasing number of colonies in DE
- but increasing cases of colony losses over the winter



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Outline

- Topical context - Bees and beekeeping
- Bee Observer as a Citizen Science project
- The data
- ML use cases