DATA VISUALIZATION – BEE MONITORING

06.12.2022 Tim Wywiol, Vanisha Singh, Rohit Das

1. Basic Information

Title: The Bee Happy Dashboard

Team members:

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2. Overview

In modern day, unfortunately the population of insects such as bees has reduced significantly due to human-initiated actions such as the utilization of pesticides, habitat destruction, air pollution, and changes stemming from global warming. This issue has many dire implications, such as the growth of up to 70% of fruits vegetables relying on the fertilization from insects such as bees, bumblebees, etc.

The impact of these factors can be severe. Resultantly, it is common for beekeepers to face the issue of many of their beehives dying during the winter period. Traditionally, beekeepers will monitor the health of their beehive using the following methods:

1. Wear protection and prepare equipment
2. Monitor activity levels of bees and observe the number of bees travelling in and out of the hive.
3. Open beehive
4. Look at the bees, look at the brood of bees, looking for food, locate the queen
    a. It is common to lift the bee hive to obtain a general feeling of its weight.
5. Based on this subjective finding, the beekeeper decides to do proactive measurements such as feeding, harvesting, parasite treatment, etc.

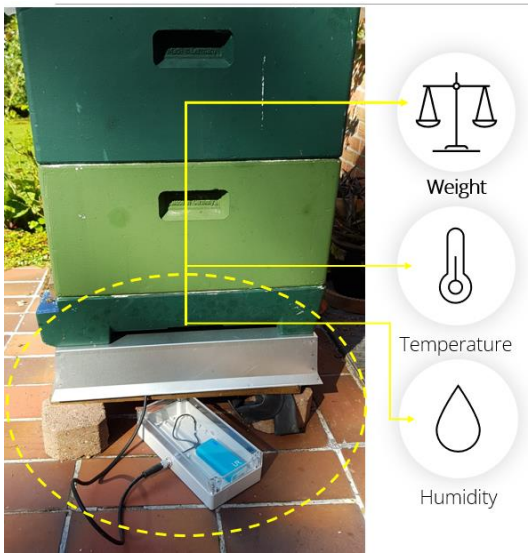
This project will involve the visualization of sensor data from beehives so that it will make it easier and more convenient for beekeepers to monitor their beehives after analyzing data-driven visualizations. Furthermore, the visualization will inform beekeepers if the activity occurring within hives is normal or unusual.

Additionally, this visualization will also allow the user to observe any correlation between shifting weather or seasonal patterns and the activity occurring within the beehives.

3. Data and Data Processing

Datasets:

Main beehive data set: https://thingspeak.com/channels/1622781

Data attribute	Info
Total_weight	[kg] total bee hive weight
Humidity	Humidity inside bee hive
Temperature	The temperature inside bee hive
Timestamp	Measurement time
	

Data set enrichment by:

1. Weather around the beehive:
   - https://cdc.dwd.de/portal/202209231028/mapview
   - Recent data (last 500 days) / every 10 min resolution
   - Optional (https://www.worldweatheronline.com/weather-api/api/docs/historical-weather-api.aspx)

Temperature:

https://opendata.dwd.de/climate_environment/CDC/observations_germany/climate/10_minutes/air_temperature/recent/

Data attribute	Info
STATIONS_ID	Station ID: 1. Grambek:1736 2. Hamburg: 1975 3. Boizenburg 591
MESS_DATUM	Measurement time in UTC
QN	quality level of next columns
PP_10 [hPa]	pressure at station height
TT_10 [°C]	air temperature at 2m height

Rain:

https://opendata.dwd.de/climate_environment/CDC/observations_germany/climate/10_minutes/precipitation/recent/

Data attribute	Info
STATIONS_ID	Station ID: 1. Grambek:1736 2. Hamburg: 1975 3. Boizenburg 591
MESS_DATUM	Measurement time in UTC
QN	quality level of next columns
RWS_DAU_10 [min]	duration of precipitation within the last 10 minuntes
RWS_10 [mm]	precipitation heigth of the last 10 minutes
RWS_IND_10	Index 0 no precipitation 1 precipitation has fallen 3 precipitations have fallen and heating of instrument was on

Solar:

Data attribute	Info
STATIONS_ID	Station ID: 1. Grambek:1736

	2. Hamburg: 1975 3. Boizenburg 591
MESS_DATUM	Measurement time in UTC
QN	quality level of next columns
DS_10 [J/cm^2]	10min-sum of diffuse solar radiation
GS_10	10min-sum of solar incoming radiation
SD_10 [h]	10min-sum of sunshine duration

Wind:

Data attribute	Info
STATIONS_ID	Station ID: 1. Grambek:1736 2. Hamburg: 1975 3. Boizenburg 591
MESS_DATUM	Measurement time in UTC
QN	quality level of next columns
FF_10	mean of wind speed during the last 10 minutes m/s
DD_10	mean of wind direction during the last 10 minutes [degree]
SD_10 [h]	10min-sum of sunshine duration

2. Air pollutionion: https://aqicn.org/api/

2020-2022 | Daily resolution

Data attribute	Info
Date	Daily basis
temperature	
Wind-speed	
Pm2.5	air pollutant species
PM10	air pollutant species
Dew	Ozone

Pressure	Air pressure
Country	Hamburg

3. Air Quality API for the next 8 days
    a. curl -i http://api.waqi.info/feed/shanghai/?token=demo

4. (optional) Blooming season: https://www.lwg.bayern.de/mam/cms06/gartenbau/dateien/bf_gesamt_bienengehoelze_in.pdf

5. (optional) Winterraps (Phenology): https://opendata.dwd.de/climate_environment/CDC/observations_germany/phenology/annual_reporters/crops/recent/PH_Jahresmelder_Landwirtschaft_Kulturpflanze_Winterraps_akt.txt

Preprocessing:

This project will involve the visualization of the beehive dataset which contains data on humidity, temperature and the weight of the beehive respectively from 2020 to 2022. This data is updated every 10 minutes. Additionally, this project will also be using a weather dataset that contains information regarding the outside temperature during the same time period. This project will involve observing if there is any correlation between weather patterns and beehive activity. Furthermore, the project will also use datasets containing information on air pollution in Hamburg (and the blooming seasons of the rapeseed flower). This is to observe if there is any relation between these variables and the general health of the beehive.

- Outliers' correction, filling missing values by interpolation
- Enrichment of bee data set with additional data such as water, blooming season, and air pollution

4. Usage scenarios & tasks

The following outlines key tasks and support that the Bee Happy Dashboard will be able to provide:

- Data-driven support for decision making such as finding the optimal timepoint of harvesting, feeding, parasite treatment, etc. for beekeeping. This is helpful as there is a lack of information on these topics during the traditional beekeeping process.

    - Save time during the beekeeping process by utilizing data visualization on the Bee Happy Dashboard to inform actions and enhance convenience while performing beekeeping tasks.
- Provide an improved understanding of the beekeeping process and behaviors occurring within the beehive through observing the neat visualization of beehive data.
- Observe whether beehive behavior is influenced by factors such as weather, air pollution, and seasonal changes in Germany.

The following depicts a usage scenario of the Bee Happy Dashboard:

Sylvie is a beekeeper that maintains a beehive in her backyard. She wishes for the beekeeping process to be more time efficient and convenient. She grows tired of the time-consuming process of having to put on and take off her protective gear each time she wishes to check on the status of her beehive. Additionally, she finds it inconvenient to carry out this process and physically check on her hive even when it is cold or raining outside.

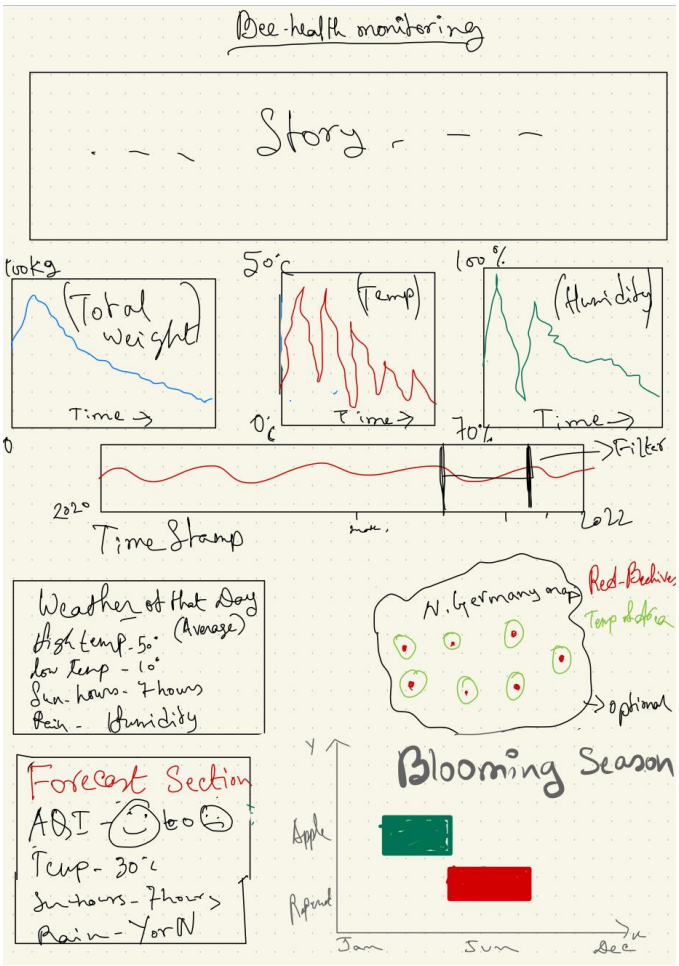
Using the Bee Happy Dashboard, Sylvie is able to monitor key information relating to the status of her beehive in a more time-efficient and convenient manner from within the comfort of her home. Using the data visualization on the Bee Happy Dashboard, she checks the total weight of her beehive, alongside its internal temperature and humidity. She wants to analyze how this data compares to the status of her hive during the same month last year. She then uses the timestamp tool to filter the data being displayed to this same month last year.

Sylvie notices the weight of her beehive has decreased since two months ago. She uses the Bee Happy Dashboard to observe if there is any correlation between the activity occurring within her beehive and the weather in her region. She also uses the map tool to observe any increase or decrease in air pollution levels over this period.

By using the Bee Happy Dashboard, Sylvie is able to look for trends and patterns between key variables and the activity within her beehive. She is also able to check on its general health in a more time-efficient and convenient manner.

5. Visualization Design

The following depicts a sketch outlining the core features of the Bee Happy Dashboard. The features depicted in the sketch are further specified in the schedule section.



- Implementation of time-series line graphs plus filtering (which is connected to all charts) https://bl.ocks.org/robyngit/89327a78e22d138cff19c6de7288c1cf

6. Schedule

1. Planning and Analysis (2 Days). Estimated date of completion: 12/03.
    a. Understand the project requirements and identify key functionalities, variables, and associations.
    b. Clarify required platforms, IDEs, frameworks, languages and datasets.
2. Design (1 Day). Estimated date of completion: 12/04.
    a. Sketch core functionalities of the Bee Happy Dashboard.
3. Documentation (3 Days). Estimated date of completion: 12/06.
    a. Complete project proposal outlining project idea and associated details.
4. Development and implementation of key features (2 weeks). Estimated date of completion: 12/18.
    a. Time-series line graph of the total weight of the beehive
    b. Time–series line graph of the temperature inside the beehive.
    c. Time-series line graph of the humidity inside the beehive.
    d. Story explaining the usage of the visualization tool.

    e. Time-series line graph of weather in Germany during the same timeframe as recorded beehive data. Weather chart includes common weather metrics such as, temperature, humidity, sun hours, sun set/rise.
    f. Filter to select time period that data is being shown for on time-series line graphs using a timestamp tool.
    g. Choropleth map depicting air pollution in Northern Germany.
5. Testing (1 day). Estimated date of completion: 12/19.
    a. Conduct user testing.