ORACLE for Research + The World Bee Project

Technical Brief

Studying bee behaviour by loading hive data into Oracle Autonomous Database, creating visualisations with Oracle Analytics Cloud Service

Oracle UK has had a long-held relationship with The World Bee Project. Collaboration over several years and using multiple Oracle technologies have been able to demonstrate the science for good bee health.

Here at Oracle for Research (OfR) we have built upon this existing collaboration and taking it further with a research project led by the University of Reading. This research project extends the collaborators out to TWBP, University of Reading, Oracle, and BeeHero.

The initial project research question is:

To determine the optimal density and location of honeybee hives for maximising pollination benefits in different soft fruit crops.

Studying what makes bees effective as pollinators

The project is split down into a number of different phases. These are all linked and build upon the results and findings from the previous phases.

The fundamental question to be addressed is: -

What is the optimal density and location of honeybee hives for maximising pollination benefits in different soft fruit crops?

The subsequent research will ask the question: -

How do environmental stressors (disease and/or pesticide exposure) effect honeybee hive health and how can this be monitored using hive sensors?

Soft fruit growers, have a substantial spend on honeybee hives annually, yet evidence to supporting best practices for stocking densities, positioning and management of hives is often outdated or incomplete. Growers need to be able to confidently invest in the correct number of hives for their operation and avoid overspend (too many hives) and loss of product quality (too few hives). This is business critical, as for instance in 2018, a major southern England supplier suffered ~40% loss of their blueberry production which was linked to inadequate pollination. The overall aim: to develop a simple tool to improve the health of honeybee colonies and optimally deploy hives to maximise benefits to yield, quality, and profit in soft fruit production.

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Drawing data directly from a farm in the UK

The project is coming up to its first-year anniversary and a lot of excellent work has already been completed. It will be running over multiple years so still has several areas on which to build. As the data is analyzed a better understanding of the pollinator behaviour evolves and the experiments can become more focused. This year's work aims to focus on a single farm and study it more intensively. The OCI architecture used within the project so far is described within this section.

Data drives the project. Several diverse data sets are captured; the analysis of this data is fundamental to the research. The data is loaded into an Oracle Autonomous Database and visualised using Oracle Analytics Cloud Service.

The project focus is on a small selection of fruit farms. Managed beehives at these farms are instrumented with sensors and it is the data from these sensors that is captured and subsequently analysed.

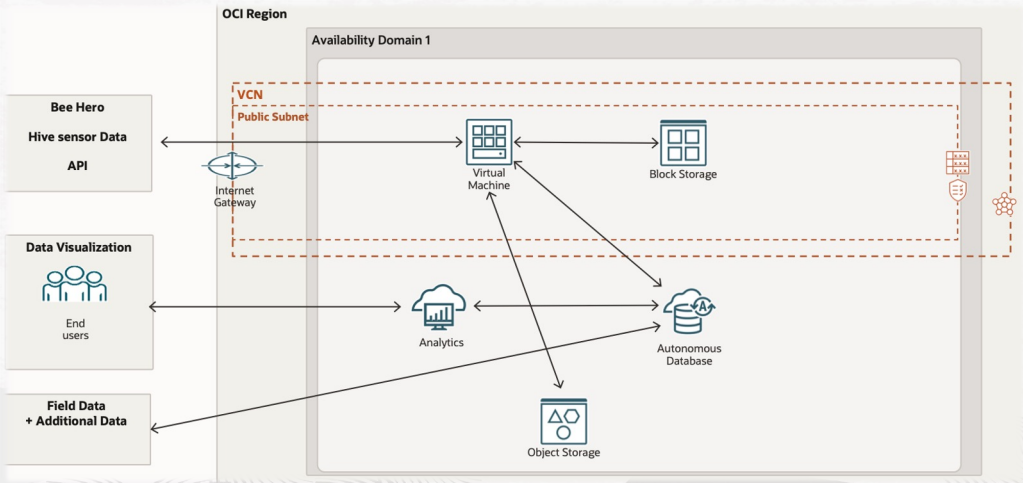
Field work at the farms also provides key data – sitings of pollinators, fruit flowering, fruit quality and yield are just a few of the key metrics that go into the data 'melting pot'. Additionally weather information for the farms is loaded into the database to be analysed.

The OCI services that have been used are: -

- Oracle Autonomous Database.
- Oracle Analytics Cloud Service.
- Compute
- Object Storage
- Block Storage

Solution Architecture

The implementation is best seen from the architecture diagram.



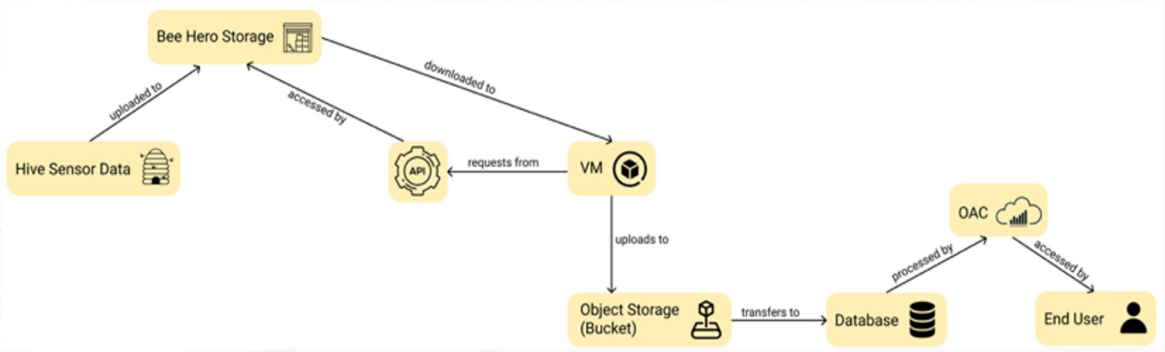
The solution components are shown in the architecture diagram. The key components for the solution are: -

- Autonomous database – all data is loaded into the database.
- Oracle Analytics Cloud Service – all data visualisations and data analysis have been shown within this.

The project started from scratch – there was no migration of any existing solution. To enable development and changes to be controlled a development environment and a production environment were created. The development environment enabled data loading, analysis techniques to be developed and tested. Once stable these were applied to the production database; the hive sensor data is then regularly loaded into this database. This approach will be followed as the data is to be captured over several different growing seasons – any data loading changes will firstly be proven within the development environment.

Capturing data via Oracle Autonomous Database

The key data ingestion into the Autonomous database is of the data from the Bee Monitoring. This data is captured by TWBP Technical Partner BeeHero by sensors on the beehives at the selected farms. These sensors capture temperature, humidity, bee entry and exit and in-hive acoustics. This data is captured and sent to BeeHero systems. It is transferred on a regular basis to the Autonomous database via batch processes which are scheduled on the Compute instance running within OCI. These batch processes use API calls to download the specific hive data from BeeHero into OCI; these are JSON files and acoustic recordings. The JSON files are loaded into the database whilst there is some pre-processing of the acoustic data using python before loading into the database. The process flow is shown below.



In addition to sensor data the Field Data and weather data are loaded directly into the Autonomous Database.

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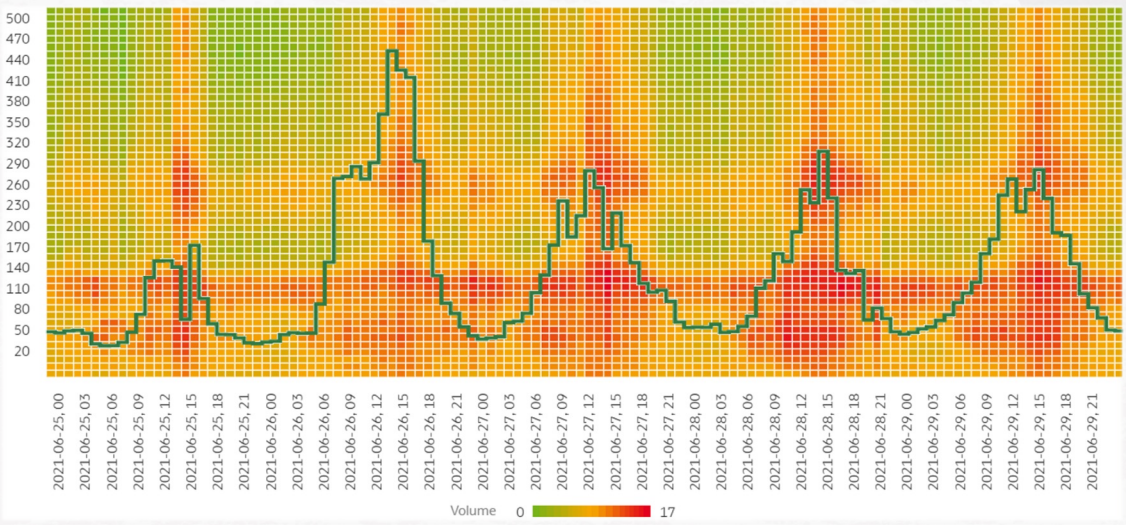
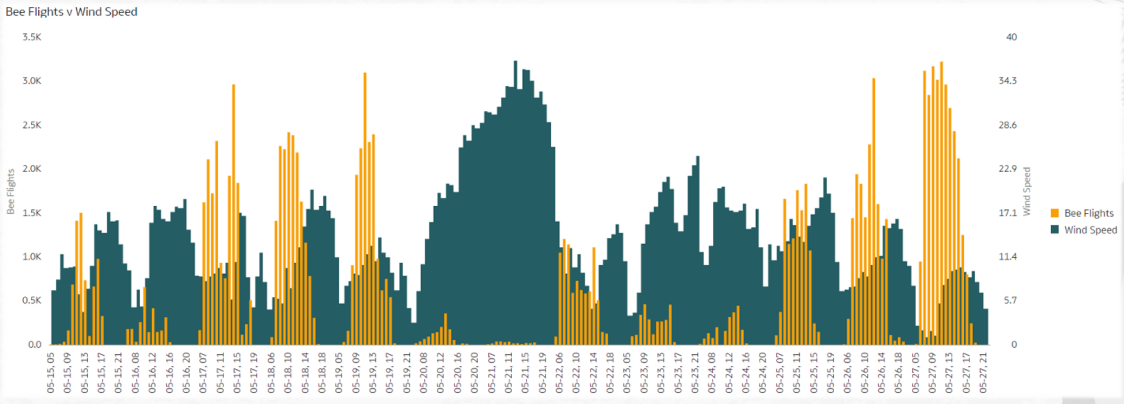
Using data to visualize the movement of bees

Oracle Analytics has provided several data visualizations that have provided valuable insights into the data. A couple are shown here: -



This graph overlays acoustic spectrum data with bee flight data. The background spectrum data is color coded by volume, with green as the quietest through to red being the loudest. The dark green line shows the bee flights. This graph represents about 500,000 acoustic records.



The bee flights are shown as orange bars, with the numbers rising and falling in line with daylight hours and dropping to almost zero each night. The green bars show the average wind speed so you can see in the middle 2 very windy days the bees hardly leave the hive compared to the other days.

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