Microsoft

AI for Earth Grantee Profile

Agustin Garcia Pereira

Curbing the decline of wild and managed bees

Summary

Honeybees are one of the most widely used pollinators, playing a vital role in maintaining the world's food supply. However, bee populations have declined dangerously, and modern intensive agriculture is one of the main causes—including pesticide use and monoculture crop production. Agustin Garcia Pereira saw these problems firsthand, growing up in a farming community in Argentina. Now, as a software engineer and researcher with the Insight Centre for Data Analytics at the National University of Ireland Galway, he is using remote sensing data, Microsoft Geo AI Data Science Virtual Machines, and GIS mapping to develop machine learning models that can identify agricultural practices at field level across wide areas. This information will help farmers, beekeepers, and governments shift to more ecological and sustainable agriculture that also helps sustain the bees.

Saving the bees with sustainable farming—and AI

"When I went to university and studied software engineering, nobody thought I was going to come back to something related with farming, or even less to beekeeping," explains Agustin Garcia Pereira, a researcher with the Insight Centre for Data Analytics and a research master's student at the National University of Ireland Galway (NUIG), under the supervision of Dr. Adegboyega Ojo and Dr. Edward Curry. "But I wanted as a researcher to focus my work on something that I feel very close to me" Garcia Pereira is from Guamini, a rural farming town southwest of Buenos Aires, Argentina, and both his father and mother come from farming families. His grandfather taught his dad beekeeping, and from childhood Garcia Pereira was used to helping around the farm and with beekeeping. That family connection has given him personal experience with a critical issue growing over the past couple decades: serious declines in honeybee colonies.

Agustin Garcia Pereira, a software engineer and researcher, is using machine learning to help the bees thrive again. [Photo courtesy Garcia Pereira]

Honeybees are the best-known and one of the most widely used pollinators around the world. Estimates vary on how central honeybees are to maintaining our food supply, but there's no doubt that they play a

significant role among pollinators. According to the American Beekeeping Federation, in the US alone honeybees contribute nearly $20 billion to crop production. At a broader level, the Food and Agriculture Organization (FAO) of the United Nations estimates that about 75 percent of the world's food crops depend on animal pollinators (including, but not exclusively, honeybees), accounting for between US $235 billion and $577 billion worth of annual global food production.

However, honeybees have been under increasing pressure for years, from invasive pests and diseases to habitat changes, agricultural practices, and climate change. Garcia Pereira says, "In my family's farm, it's been very tough to keep the bees alive and to have a profit out of them, to harvest honey. Most years, we need to feed them because they can't find the food they need. Finding promising places where to place the beehives has become a very important task." With the FAO finding that 40 percent of invertebrate pollinators—mainly bees and butterflies—threatened by extinction, it's urgent to take action to reduce that threat.

Helping bees by returning to sustainable farming

Although many factors are involved in honeybee decline, strong evidence shows that the industrialized agricultural practices widely adopted around the world in the 20th Century have been a major part of the problem. These practices favor monoculture production—raising just one type of crop over a large farm area, year after year—and rely on chemical fertilizers to sustain the soil, and pesticides and herbicides to protect the crop. This reduces the biodiversity of the farms, making it more difficult for the bees to gather sufficient pollen to feed themselves. And the effects of the pesticides are too indiscriminate, harming the bees as well.

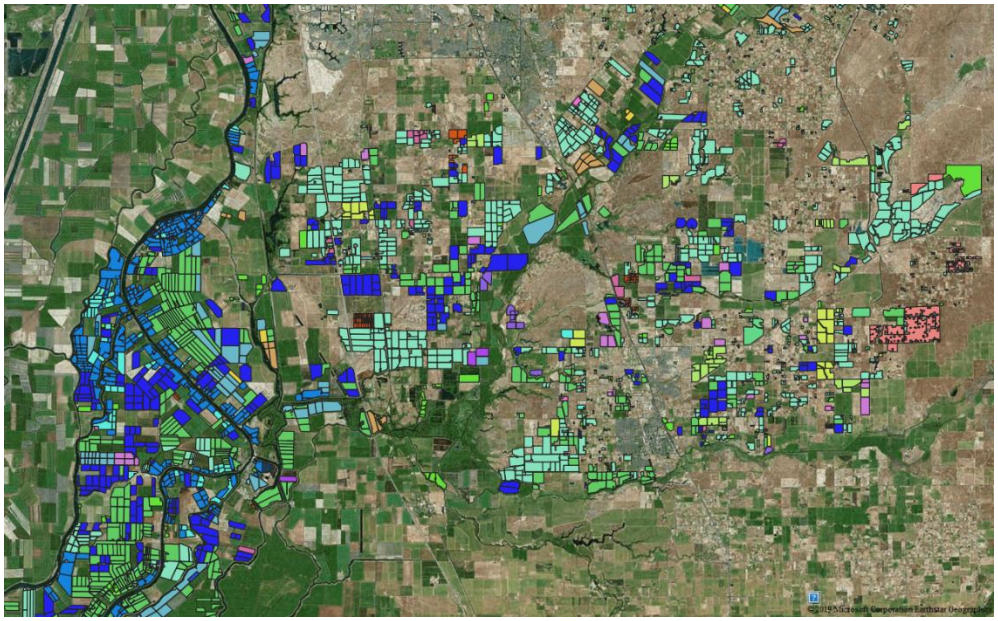
> "In my family's farm, it's been very tough to keep the bees alive and harvest honey. Most years, we need to feed them."—Agustin Garcia Pereira

In contrast, older traditional practices such as crop rotation, which involves planting different crops in sequence to help the soil recover nutrients, have proven more sustainable for both the farms and the bees. But after decades of the monoculture methodology being established, not only have the older practices been forgotten by many, but also farmers fear the financial risks of changing from the accustomed methods to unfamiliar ones. Garcia Pereira recognized what was needed was more information about where the different methods were being practiced—both to know which areas might need attention for encouraging more sustainable methods, and to compare the results side by side as evidence of which perform better. "There are some countries that keep track of the agricultural practices very well, like the United States is doing—specifically California, in my opinion, they have a very good system for tracking the agricultural practices," he says. "But in most countries, this does not exist. In Argentina we don't have any maps to observe what the farmers are growing and look at

the sustainability of the agricultural practices." Garcia Pereira believes this need can be met with modern technology, through satellite photography and AI.

Identifying farming practices with AI

A lot of work has been done in recent years with using AI to derive new information from static imagery, such as identifying animals or classifying land use. However, for this project, Garcia Pereira is developing a different approach. Because the differences between monoculture farming and crop rotation include how the land is used throughout the year, he is putting together time-based sequences of satellite images of specific fields to capture the changes. By training machine learning models on the patterns in these series, the system can identify with high accuracy not only the different types of crops being raised but also the different farming practices, such as distinguishing between monoculture farming and crop rotation, and identifying double cropping.



The models help identify patterns in farming practices by classifying twenty types of land use over time. [Image courtesy Agustin Garcia Pereira. Source: Earthstar Geographics]

Thanks to a Microsoft AI for Earth grant, Garcia Pereira can develop his deep neural network models using Microsoft Geo AI Data Science Virtual Machines. His initial work also used open source tools such as QGIS for visualizations; further work will make use of the industry-standard Esri ArcGIS Pro. The initial development has had promising results, achieving 89 percent accuracy in classifying twenty different land uses, and over 88 percent accuracy in classifying single and double cropping. The initial architecture for the models used one-dimensional convolutions; next, Garcia Pereira will transform the time series into two-dimensional data and

train the models again, which he believes will provide much better accuracy. "As far as we know, this approach has never been done in the remote AI area," he says. "We are very excited about seeing the results!"

Making more informed decisions for farming and beekeeping

The goal of the project is to provide this detailed information to farmers, beekeepers, and agricultural planners, to help them shift to more ecologically sustainable farming practices—and help the bees thrive again. For example, beekeepers will be able to find the best places to place their hives so that the bees have access to healthy and diverse habitats, plentiful pollen and close to water sources. When farmers (or beekeepers) are considering buying new land, they can judge its condition by what farming practices have been used there. And government officials can verify where sustainable practices are in use and promote them where needed.

> "The ecological farmers—who are my friends—have showed they don't need pesticides, and they are getting the same or better yields."—Garcia Pereira

For Garcia Pereira, it comes back to his hometown connections. "What I've learned from the ecological farmers—who are my neighbors and friends, we are a very small town, and now they've expanded to a national level—they have a lot of successful cases where they showed they don't need huge amount of fertilizers and pesticides to grow crops. And they are getting the same or even better yields than their neighbors that are using ridiculous amount of chemicals. I think raising awareness of these practices, that are related to a lot of solutions to actual issues, is very important, so that the farmers start to switch to this type of farming."

About the Insight Centre for Data Analysis

The Insight Centre for Data Analytics is one of Europe's largest data analytics research organizations, with 400+ researchers, more than 80 industry partners and over €100 million of funding. Insight is funded by Science Foundation Ireland, and is made up of four main centers: Insight@DCU, Insight@NUI Galway, Insight@UCC, and Insight@UCD, as well as a number of affiliated bodies. Machine learning and statistics is one of several key areas of priority research for the organization, and the organization's research aims to find solutions for the areas of connected health and the discovery economy.

Resources

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Websites

Insight Centre for Data Analytics home site

Documentation

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