

Artificial Intelligence in Entomology

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ABSTRACT

Artificial intelligence (AI) is gaining it importance across all sectors which includes Energy, Transportation, Agriculture, Retail, Healthcare, Finance, Manufacturing, Education and Robotics. Particularly in Agriculture its been used to Site Specific Nutrient Management, Precision Farming, Crop yield prediction and forecasting, soil and crop managent etc. This technology is also used in entomology i.e. study of insects (Identification, Monitoring and Management). There for this article provides the basic information about the use of AI in the study of insects i.e. Entomology.

INTRODUCTION

Technology has advanced so much that it has become an integral part of everyone's daily life. This technology uses and understands methods, instruments and frameworks to address issues that continuously which alter accordingly to societal dynamics. A wide range of newer technologies are available to us every day. The notion that a machine might think and work like a person was a pipe dream when

McCarthy first proposed the term artificial intelligence (AI) in 1956. Where, Artificial means 'non-biological' and intelligence mean 'ability to fulfil complex goals or tasks; However, because of its wide application in different disciplines, AI is currently revolutionizing science and research. AI is a branch of computer science that enables the creation of machines capable of thinking, acting intelligently, and making decisions

similar to humans. AI is formed of two terms Artificial -man-made and intelligence-thinking capability.

Components of AI:

- Machine Learning
- Deep Learning

These are important for completing a task or solving a problem.

Machine learning (ML)

Machine Learning (ML) is a specialized field within AI that enables computers to learn and improve from their experiences without being programmed. The fundamental goal of ML is to create algorithms which allow machines to learn from historical data and make predictions or decisions based on this information.

There are three primary categories of Machine Learning:

- 1. Supervised Learning:** Such models are based or developed from labeled data that is both the Input Data and the Output data as are provided to the model. It is used in training the model, then the model forecasts on data points which have not been put into use. This technique is useful for problems such as – regression, which means predicting values, which are continuous or; classification of the data into given categories.
- 2. Unsupervised Learning:** Unsupervised learning mainly uses unlabelled data to train the algorithms or machines. The model discovers the basic features from the data which are specific and provides the output data. These types of ML are used in solving clustering and association problems.
- 3. Reinforcement Learning:** These types of ML trains a machines based in the actions which are suitable at that particular point and maximise rewards in a particular

situation. This uses an agent and environment to provide certain actions and rewards.

Deep Learning

Deep learning is type of ML and AI that is inspired or imitates the way how humans gain knowledge. It is extremely deals with collecting, analysing and interpreting large amount of data.

Artificial Neural Network (ANN)

ANN referred as neural networks or neural nets which resembles the animal's brain. Similarly, as the human brain is connected with each neuron similarly, ANN consists of layers which are interconnected. Each layer consists of neurons that are interconnected to one another in various layers of the networks. These neurons are known as perceptrons or nodes. It consists of 3 layers: - An input layer, one or more Hidden layers and an Output layer. These layed helps in providing the output in a precise manner.

Convolution neural networks (CNN)

CNN is similar to ANN but consists of an input layer, an output layer, many hidden layers and millions of parameters that can learn complex objects and patterns with many artificial neurons. CNN is distinguished because of its superior performance in image, speech and audio signal inputs and provides high accurate data. CNN consists of an input layer, an output layer, many hidden layers and millions of parameters that can learn complex objects and patterns.

Application of AI in Entomology

Insect diversity represents a significant part of total biodiversity on Earth. Identifying and monitoring pests in the field in real-time is challenging and demands expertise to distinguish the signs of various pests. Recently, AI is playing a key role starting

from the identification of insects to pest management.

AI in insect identification:

Traditional methods and the declining number of insect taxonomists have seriously affected the efficiency of insect identification. Initially, the period of AI order-level identification of insect images was done using certain algorithms (Wang et al., 2012). Later many algorithms came into practice for image identification. In the recent past, CNN has been used widely as it extracts complex features automatically and is found effective in image identification. Thenmozhi and Reddy, 2019 developed a CNN model for classifying three different classes of insect image data sets. Sagar *et al.* (2021) developed an application and portal PATANGASUCHAKA using CNN for the identification of butterflies and moths. Similarly, CNN was used for the identification of termites (Huang et al., 2021), coconut pest identification using a drone (Chandy, 2019), rice pest detection (Bhoi *et al.*, 2020), apple pest and disease identification (Abbaspour-Gilandeh *et al.*, 2022)

AI in detection and monitoring

Detecting the presence of internal boring insects or sub-terrestrial insects such as termites is difficult. Monitoring of these pests plays a crucial role in effective management. Wood boring insects and different termite species, including dry wood and subterranean termites (Nanda *et al.*, 2019). Similarly, the detection of *Sitophilus zeamais* in maize grain (Silva *et al.*, 2021), detection and density assessment of bruchids (Banga *et al.*, 2020)

AI in pest management

Crop advisory mobile applications are connecting bridges to solving problems of farmers by agricultural experts. Many applications such as Plantix detects pests and diseases of various crops and provide

information regarding control measures. Similarly, applications such as Cashew Protect, Tumaini for banana farmers and FASAL application help farmers to get information about pest and disease management.

Other applications used in Agriculture based on AI

• Agrio • Plant village • Rice doctor • AI-DISC ICAR • Agri app • Krish- E

Artificial intelligence is now impacting numerous scientific fields, yet it has only recently started to aid entomology. Image reorganization through CNN offers significant potential role in identifying pest images, necessitating data and investment in interdisciplinary approaches that can unlock the power of AI in entomology. With the deeper integration of AI in entomological studies, the goal of real-time identification, monitoring and interpreting insect behaviour may become a reality, leading to a revolution in insect ecology and pest control. AI is unveiling new research niches, providing access to unforeseen scales that will benefit future advancements in the discipline of entomology.

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