Chapter 5
Optimizing Neural Networks With Ant Colony Intelligence:
A Bio-Inspired Approach to Deep Learning Architecture and Hyperparameter Tuning

M. Robinson Joel
https://orcid.org/0000-0002-3030-8431
KCG College of Technology, Chennai, India

P. Getzi Jeba Lillipushpam
https://orcid.org/0000-0002-7270-6796
Karunya Institute of Technology and Sciences, India

V. Ebenezer
https://orcid.org/0000-0002-0801-6926
Karunya Institute of Technology and Sciences, India

M. Vargheese
https://orcid.org/0000-0002-5003-364X
PSN College of Engineering and Technology, India

J. Immanuel Johnraja
Karunya Institute of Technology and Sciences, India

Belfin Robinson
University of North Carolina, USA

ABSTRACT

An effective bio-inspired method for resolving challenging optimisation problems is Ant Colony Optimisation (ACO). With an emphasis on network topology, layer configurations, and parameter tweaking, this paper investigates the use of ACO in neural network design optimisation. Neural networks may be dynamically constructed to attain higher accuracy, shorter training times, and cheaper computing costs by using the ACO's ability to traverse search regions through collective learning

DOI: 10.4018/979-8-3373-0523-3.ch005

and pheromone-based pathfinding. We look into how ACO can be integrated with deep neural networks and how it affects architectural design and hyperparameter selection. Our findings show that, especially for workloads involving large-scale data processing, ACO-driven designs provide a notable performance benefit over conventional techniques. By offering a fresh approach to neural network optimisation, this work advances the area of artificial intelligence and creates opportunities for future investigations into bio-inspired methods in deep learning architecture design.

INTRODUCTION

Nature offers straightforward solutions to a lot of the difficult and complicated issues that arise in everyday life. "Nature Inspired Algorithms"(Korani, W., & Mouhoub, M. 2021) are algorithms that are modelled after natural systems and processes. Because these algorithms readily adjust to the dynamic changes in nature, they aid in the process of finding answers. For the purpose of resolving intricate optimisation issues, they can draw inspiration from both biological and natural systems. Algorithms that draw inspiration from nature are used to tackle practical issues and arrive at the best possible answer. Techniques for optimisation play a significant part in resolving challenging technical issues. Numerous algorithms inspired by nature have shown to be highly effective in solving a wide range of technical challenges pertaining to optimisation.

According to earlier research, the potential of contemporary methods and sophisticated algorithms for problem-solving has not yet been fully applied to address the difficulties encountered in the discipline of controlling water resources(Castelletti et al., 2023). Given the geographical and temporal complexity of the optimisation issues that remain in the fields of hydrology including hydrogeology, it is critical to examine the possible use of existing evolutionary algorithms. The primary areas of study in hydrology and hydrogeology are urban drainage as well as storm network development, long-term subsurface monitoring, coastal aquifer oversight, reservoir operation, water transportation systems, and parameter estimates. By moving across a search space and leaving behind virtual pheromones that direct other ants towards potential areas, artificial ants in ACO build solutions to optimisation issues (Dorigo & Stützle, 2010). The collaborative finding of almost ideal solutions is made possible by this positive feedback process.

Swarm-based methods(Ma et al., 2022) are one of the most often utilised method for complicated optimisation issues among the numerous nature-inspired algorithms(Tzanetos, A., & Dounias, G. 2021). Nature inspired optimization algorithms or simply variations of metaheuristics?. *Artificial Intelligence Review*, *54*(3), 1841-1862.. Researchers have widely employed swarm-based optimisation, particularly in