Project Proposal: Swarm Intelligence in Distributed AI Inspired by Bees

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1 Introduction

Swarm intelligence is a decentralized and self-organizing approach to problem-solving inspired by the collective behavior of social organisms. This project aims to explore a distributed AI system inspired by the behavior of honeybees. The goal is to model and simulate their communication, resource allocation, and decision-making processes to develop a robust distributed AI framework.

2 Background and Motivation

Honeybees exhibit remarkable collective intelligence through behaviors such as foraging optimization, hive thermoregulation, and decision-making for nest selection. Their decentralized yet efficient coordination makes them an ideal inspiration for designing distributed AI systems. By leveraging these biological principles, this project seeks to create a novel swarm-based AI model applicable to domains such as robotics, logistics, and distributed computing.

3 Objectives

- Develop an AI model based on honeybee swarm intelligence principles.
- Implement a distributed simulation where agents (representing bees) interact dynamically.
- Analyze emergent behaviors and optimize decision-making mechanisms.
- Compare the performance of the proposed model with traditional distributed AI approaches.

4 Methodology

4.1 Data Collection & Literature Review

Study honeybee behavior, focusing on swarm coordination, foraging patterns, and decision-making strategies.

4.2 Algorithm Design

Develop a decentralized AI model inspired by bee communication methods such as the waggle dance and quorum sensing.

4.3 Simulation & Implementation

Utilize a multi-agent simulation framework (NetLogo) to model bee interactions.

4.4 Evaluation & Optimization

Measure system performance in terms of efficiency, robustness, and adaptability to dynamic environments.

5 Expected Outcomes

- A functioning simulation demonstrating swarm intelligence in a distributed AI system.
- Insights into how bee-inspired coordination can improve decentralized problem-solving.
- A potential foundation for applications in distributed robotics, network optimization, and autonomous agent coordination.