Ant Navigation Model Based on Pheromone Detection

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Abstract

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I. Introduction

Ant colonies are well organized biological societies that rely on social and communication skills between each individual ant. One means of communication for the ants is through pheromones. Pheromones are a chemical produced by the ant in order to trigger the behaviors of other ants in the colony. Pheromones are found in a wide range of habitats, however, they are crucial to ant foraging, especially for species that rely on pheromone trails. Essentially, ants leave pheromone trails to communicate information about resources such as direction, distance, quantity, and so on. Utamitly, these pheromones create a network of paths that allow ant colonies to forage efficiently.

This paper aims to depict a mathematical model which mirrors the movements of foraging ants in a colony. The model relies on correlated and biased random walk algorithms which are dependent on the amount of pheromone present in the individual ants sensing region. This sensing area is derived from the half-angle β less than $\frac{\pi}{2}$ which Paulo Amorim et al. (2019) claims is necessary for stable trail following behavior. Considering the behavior of ants not always following trails, this model also uses a probability function from Dante R. Chialvo et al. (1995). Finally, this model uses pheromone depletion and created functions from Elton B. Bandeira et al. (2010).

II. Related Work

There is quite extensive research on the behavior of ant colonies considering their abundance within reach and the ease with which they can be analyzed in a laboratory setting. This paper focuses on a few ant navigation papers discussed below.

- Donec dolor arcu, rutrum id molestie in, viverra sed diam
- Curabitur feugiat
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- arcu eros accumsan lorem, at posuere mi diam sit amet tortor
- Fusce fermentum, mi sit amet euismod rutrum
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Table 1: *Example table*

Name		
First name	Last Name	Grade
John	Doe	7.5
Richard	Miles	2

- Pellentesque bibendum pretium aliquet

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Text requiring further explanation[1].

III. Methods

When beginning the foraging process, ants will obviously start at their colony's nest. In order to depict the behavior of ants navigating away from their nest we apply a correlated random walk. At each random walk step, the velocity of the individual ant is determined by:

$$\triangle X_{i+1} = v[cos(\theta_i + \theta_i^{CRW})] \tag{1}$$

$$\triangle Y_{i+1} = v[sin(\theta_i + \theta_i^{CRW})] \tag{2}$$

where v is the step size and θ_i^{CRW} is a random angle from a uniform probability distribution function with mean 0 and variance θ^{CRW} (Peleg, 2022).

[1]Example footnote

As the ant is navigating away from the nest it lays pheromones at a rate of $\eta = 0.07$. At each time step the pheromone concentration is determined by:

$$C_i[k+1] = C_i[k](\kappa) \tag{3}$$

where $C(x, y)$ is the pheromone concentration at point (x, y) in our sample field and $\kappa = 0.015$ is the rate of evaporation.

IV. Results

i. Subsection One

A statement requiring citation [Figueredo and Wolf, 2009]. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

ii. Subsection Two

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References

[Figueredo and Wolf, 2009] Figueredo, A. J. and Wolf, P. S. A. (2009). Assortative pairing and life history strategy - a cross-cultural study. *Human Nature*, 20:317–330.