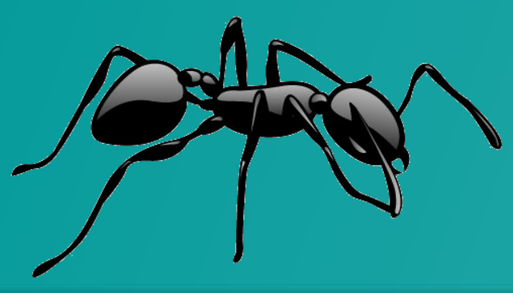
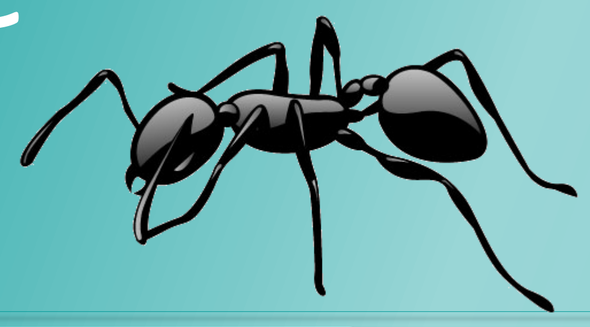
Swarm Intelligence



The Ant Colony Optimisation Metaheuristic

Defining a Unified Framework



What is Swarm intelligence?

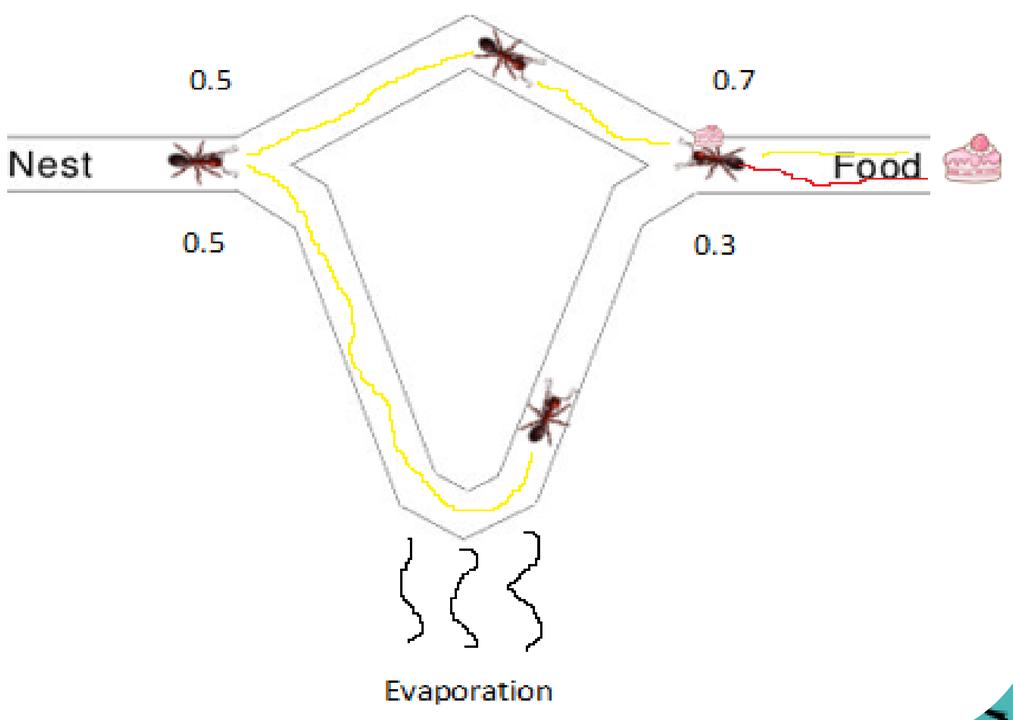
Swarm Intelligence (SI) is defined as the emergent complex behaviours of autonomous agents of which exhibit a low level of individual intelligence. SI is a field within Artificial Intelligence in which nature-inspired algorithms are applied to problems of a NP-time hardness. As metaheuristics such as SI are problem independent, one solution can be applied to solving many problems. While swarms are typically associated with insects these algorithms take inspiration from many natural formations including flocking birds to schools of fish.

Ant Colony Optimisation

First proposed by Marco Dorigo (1992) Ant Colony Optimization (ACO) is a Metaheuristic algorithm based on ant foraging behaviours. Metaheuristics change over time as the algorithm runs iterations allowing for adaptive solutions.

$$p_{ij}^{k} = \frac{[t_{ij}]^{\alpha} * [n_{ij}]^{\beta}}{\sum l \in N_i^k [t_{il}]^{\alpha} * [n_{il}]^{\beta}}$$

Figure 1. ACO Solution Equation
(Shekhawat, Poddar, Boswal 2009)



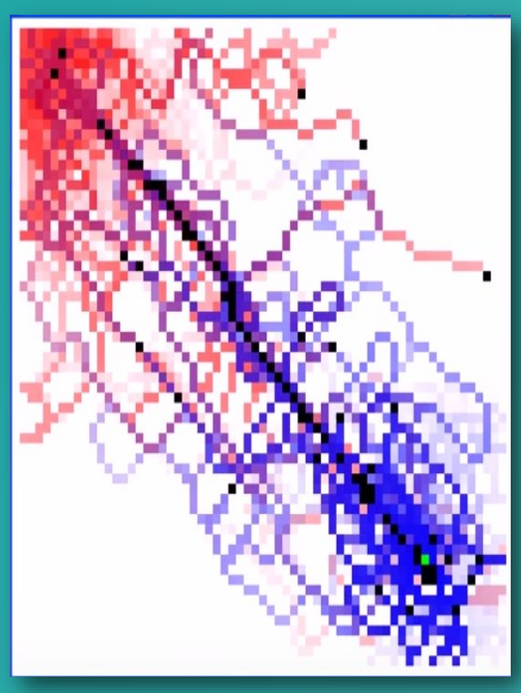
Communication

Ants use pheromones to communicate indirectly via their environment. This allows the passage of information over time as well as space. These pheromones vary in strength dependent on how many ants re-initialise them and on the quality of food discovered leading to a naturally occurring shortest-path optimisation which has been proven in solving problems such as The Travelling Salesman Problem and is currently being applied to problems such as: cloud based load balancing, route planning and training feed-forward neural networks.

ACO is advantageous as it allows for agents to act alone without the need for centralised intelligence or human interjection whilst maintaining the ability to perform larger tasks the likes of which a single agent would otherwise be unable to complete alone.

Defining the project

Ant Colony Optimisation is a relatively new approach to optimisation problems. Much of the research in this area has been conducted within the last two decades as the interest in Artificial Intelligence increased. As such there is no unified framework, this leads to many different implementations of varying optimality. While Dorigo and Caro (1998) define a design framework for the algorithm this project aims to implement a library to allow for a more simplistic application of the algorithm whilst exploring the practicality of such an algorithm dependent on the problem applied to.



ACO: Shortest Path Implementation

ACO: The Algorithm Basis

```
Initialize
While stop criterion not met do
    Position each ant at starting node
    Repeat
        For each ant do
            Choose next node by applying transition state ru
            Apply step by step pheromone update
        End for
    Until every ant has built a solution
    Update best solution
    Apply offline pheromone update
End While
End
```

ACO: Routing Optimisation

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