Foraging Behavior and Combinatorial Optimization

Ian Roberts
Nathan Weir

Simple Ant Assumptions

- Basic properties of foraging ants
  - Follow pheromone trails leaving nest
  - Lay trails returning to nest
  - Trail strength directly related to total ants that followed trail (zero trail degradation)

Probability of Choosing a path

- There is always a probability of taking an unmarked path
- Probability of taking a path increases with the number of ants that have taken it previously.
- $P_A = \frac{(k+A_i)^n}{(k+A_i)^n+(k+B_i)^n}$ = 1-P_B
- Where k is the desirability of an unmarked path, and n is the degree of nonlinearity of choice function

Shortest Path

- Shorter path implies lower cycle time for trips and thus more ants take that path due to increased pheromones
- If only pheromones are used to determine path choice additional paths after the original ones can be ignored even if shorter
- Pheromone degradation allows for more easily moving to shorter path as older unused paths lose attraction

Inter Nest Traffic and MST's

- Tendency of ants to follow already used paths removes redundant connections
- Shortest path methods create optimal links between nodes.
- These two rules yield an MST of nests and paths.

Raid Pattern of Army Ants

- Army ants form large platoons of individuals that forage for food as a swarm
- Different species of army ants forage in different patterns.
- Foraging patterns found to only depend on the environment, more specifically the arrangement of food.
- Ants of different species will forage in the pattern of similar species when placed in the similar species' environment.

Application issues

- Determining n and k is hard
- Determining pheromone degradation rates is hard
- Number of paths in reality is much larger than 2 or 3
- How many individuals before system fails to find solutions

Questions