

# Ants and Ant Eaters

## Overview

Design a simulation of ants and ant eaters within a closed area (piece of ground).

## Key Objects and Their Relations

- An area is defined by a width and height and divided up into a grid of small, uniform ground cells
- Ants are part of ant colonies
- There may be many colonies in an area
- A colony has a base nest, located at some position in the area
- An ant has a position, i.e., is in one and only ground cell
- Many ants be in a cell at the same time
- Some cells may contain piles of food, quantized into units of 1mg each
- An ant can carry up to 5mg of food
- An ant may be moving in a direction
- When carrying food, an ant creates pheromone and drops it on the ground
- There may be zero or more ant eaters roaming the area
- An ant eater is always at some position (in some cell) and multiple ant eaters may be in the same cell.
- Time in a simulation is quantized as “ticks”.
- When running a simulation, the user must be able to specific the duration of a tick, e.g., 100 milliseconds.

## Behaviors

### Ant Behavior

- Can only be created in the nest of the colony with the initial weight of 1 mg and a position that is the same as the nest
- After being created, an ant must eat some food (1mg at a time) to gain weight. It cannot move out of the nest until its weight greater or equal to 3 mg
- Every 50 ticks, an ant decrease's its weight by 1 mg
- During a tick, an in the nest behaves as follows:
  - If there are 1 or more milligrams of food in the nest, the ant can retrieve 1 mg of food from the nest, consume it, and add 1 mg to its weight but can't increase its weight beyond 5 mg.
  - If its weight is equal to or greater than 3 mg, it may leave the nest in a random direction, but with a preference towards a cell that contains pheromone.

- On entering the nest, if the ant is carrying food, it drops the food, adding it to the nest's stock pile
- During a tick, if an ant is outside of nest, it behaves as follows:
  - If on a cell with food and not carrying food, then the ant picks up as much as it can, limited by the amount is available and the maximum it can carry
  - Else if not carrying food, then look for food.
    - If pheromone present at current location, then the ant determines the direction of decreasing pheromone strength by sample the pheromone in neighboring cells and moves to the cell with the lowest non-zero amount of pheromone.
    - Else if a neighboring cells have pheromone, then the ant chooses one of them at random to move into.
    - Else the ant choice a neighborhood cell at random to move into, with a preference in the direction it was heading when it came into the current cell
  - If carrying food, look for nest
    - The ant samples for pheromone in neighboring cells.
    - If pheromone present in current cell, then it follows the pheromone trail in direction of increasing strength. It may cut corners or wander off course occasionally. If pheromone is not present in the current cell, but with a preference towards a cell that contains pheromone.
    - The ant creates and drops pheromone, at a maximum level, in the current cell before moving the next cell.

### Ant Eater Behavior

- When hungry and not eating, wander
  - If enter the same position as an ant, begin eating
  - Otherwise, wander
- When eating,
  - The ant eater suck in an ant at the current location and ponders its delicate favors for 10 tens.
  - After 10 ticks,
    - If the ant eater has consumed 50 ants since sleeping last, it goes to sleep
    - Else if there is another ant in the same cell, then the ant eater consumes it and digests another 10 ticks
    - Else if there are no more ants, the ant eater goes back to being hungry and not eating
- When sleeping
  - After 600 ticks, the ant eat goes back to being hungry and not eating.

### Pheromone Behavior

- Only allow an ant to create it and when created, it must start out at full strength (level = 100)
- When it exists,

- Allow anything to get its level
  - Its level decreases by 1 every tick
- Ceases to exist when the level reaches zero

## Food Behavior

- Only allow a food pile to create it with an amount of food, measured in milligrams
- When it exists, allow anything to learn of its amount
- Cease to exist when the amount goes to zero.

## Food Pile Behavior

- Come into existence with a certain amount of food, measured in milligrams
- When ant request an amount of food,  $x$ , specified in milligrams, then
  - If there is the amount in the pile is greater or equal to  $x$ , decrease the amount of food in pile by  $x$  and create and return a Food object with the amount of  $x$ ; otherwise, create and return a Food object with what's left in the pile and set the amount of food in the pile to zero,
- When the amount reaches zero, cease to exist.

## Nest (Ant Hill) Behavior

- Allow an ant to place food into the nest
  - If there is already food in the nest, add the amount of food to the existing pheromone; otherwise, associate the food with the nest
- If there are 5 or more milligrams of food in the nest, create a new ant with an initial weight of 1 milligram, decrease the units of food by 5, and adds the ant to the colony.

## Ground Cell Behavior

- Allow an ant to drop pheromone on the cell
  - If there is already pheromone on the cell, add the level new pheromone to the existing pheromone; otherwise, associate the pheromone with the cell