1-General introduction to the aplication domain:

Colonies of social insects – ants, bees, wasps, and termites – can be viewed as highly parallel, distributed systems for solving the problems intrinsic to colony survival and reproduction. Colonies are highly parallel in that large numbers of individual colony members are interchangeable: the system is composed of redundant individuals behav- ing according to a stereotyped set of rules. Although the workers of many species exhibit a behavioral flexibility that allows them to perform more than one job in the course of their lives, all of the individuals engaged in any one job, such as foraging for food or feeding the brood, seem to follow essentially the same set of behavioral rules.

\*Stigmergy concept:

The subject of stigmergy is best approached by considering the ways in which embodied agents (call them robots) can interact. At any instant, a robot can affect another robot directly and immediately in three main ways:

̄ by affecting the other robot’s sensors: for example, by being sensed as an obstacle

̄ by applying force to the other robot, actively or passively (possibly through the environment): for example, by colliding with it

̄ by communicating with the other robot

A robot can also affect another robot indirectly, and with a delay, by changing a part of the environment which the other robot may subsequently encounter

\*Foraging concept:

Foraging consists in searching and collecting items in an environment and move them to storage point(s).

- Searching Robots inspect the search space for targets (or food). While the random walk is the most adopted strategy of search in unknown environments, several other search strategies can be used according to the environment structure and the amount of information provided to robots.

- Homing Robots have to return home with the collected food by using prior information and/or onboard sensors, following a pheromone trail or even exploiting specific tools (e.g. compass).

In this model, a colony of ants forages for food.

Though each ant follows a set of simple rules, the colony as a whole acts in a sophisticated way

2- PEAS specification

-Performance - A colony of ants forages for food. Though each ant follows a set of simple rules, the colony as a whole acts in a sophisticated way.

-Environment - The MAS works in a simple environment that consists of a nest of ants and food clusters. When an ant eats a piece of food, the cluster lowers until it ends and disappears.

-Actuators - The ants look for food and when they find it they leave pheromones on the way to the nest. This action makes it easier for other MAS ants to find food clusters. The actuators are in ants, equipped with a pheromone secretion system that leaves a temporary trace.

-Sensors - The ants are equipped with a pheromone tracking system, when they find the trail of pheromones left by other ants, it reacts by following the trail to the food.

3- Model description ant.logo

When an ant finds a piece of food, it carries the food back to the nest, dropping a pheromone trail as it moves. When other ants smell the pheromone, they follow the trail toward the food. As more ants carry food to the nest, they reinforce the trail.

This question from the protocol ODD+D describes the behaviour of the MAS:

What entity does what, and in what order?

- Ants come out of the nest.

- They move around looking for food (they look for the trail of pheromones)

- When they find food, they segregate a trail of pheromones from the cluster to the nest.

- If the ants find the trail, they follow it.

- If the ants lose the trace, they move by a random search algorithm.

4 - **Design of the MAS with AML**

-Entity diagram : The main aim of the diagram is to model entity tyoes and relation between them. This diagram offers the basic view on the structure of the MAS.

-Society diagram : Society diagram emphasises representation of social roles, social relations between entity types, membership of social groups and social interactions.

-Perceptor-Effector diagram : Behavioural entity types perceive their environment with the perceptors (sensors). They react on the stimuli coming from the environment with the effectors (actuators). Perceptor-effector diagram is able to represent the components that the entity type (most often the agent type) can use for sensing the environment and reacting on stimuli.

ENTITY:

In the entity diagram is represented the collective of ants and each individual ant with enough operations to implement their tasks. I opted for an option without inheritance to avoid modifying variables such as "poblacion", although it could also have been implemented with it. In this way, making certain variables static, the modifications on them will not have repercussions according to their implementation.

SOCIETY:

In this society diagram the 3 different roles that an ant can adopt within the colony are shown:  
-Explorer: If you do not bring food to the nest or are following a trail, you will have a default movement to explore.  
-TrailFollower: in this case is following a trail of pheromones left by another ant with role "FoodCarrier".  
-FoodCarrier: This ant leaves the pheromone while carrying the piece of food to the nest (drop trace

PERCEPTOR-EFFECTOR:

*In this diagram, the functioning of the effectors and perceptors is simply represented:*

*1-an ant feels a piece of food with its antennae*

*2-take that piece with your arms*

*3-leave the trace of pheromones through your gland as you move with your legs around the nest back to the nest.*

*4-leave the piece and while it progresses it smells if there is a trace to change its direction*