Chapter 1

DESCRIPTION OF MODEL

This Matlab based programme simulates a basic bee foraging behaviour model. In the square environment of simulation hive is defined in the centre and is populated with bees based on the user defined number and two food sources are placed at distances from the hive defined by user.

1.1 Agent Memory and functions

Agent : Bees
Agent memory parameters:

- **food -** food storing parameter of the agent.

- **pos -** current position of agent in Cartesian coords[x y]

- **knowSource -** parameter to keep track of the potion of hive know by agent, used in waggle dance for going to the source of food.

- **visionRange -** parameter used to estimate the area in which agent can look, used in food search and for moving accordingly for food search.

Rule set for each agent:

- **do_WagglDance -** describes interaction between agents to pass the information of more profitable food sources for migration towards those source for food collection.

- **goto_source -** describes which direction will agent choose to go to based on the waggle dance performed.

- **migrate -** describes the agents movement toward the selected source based on waggle dance for food collection.

- **eat -** describes how agent performs food collection at the source.

- **migrate_back -** describes the agents movement back to hive from the source after nectar collection.

These rules can be summarised as:

Do Waggle Dance - specified in functions @bees/do_waggleDance.m

1. Functions sets up a waggle radius for bee using the profitability and distance of the source visited by the bee.

2. Information of the source is than passed to all the bees present in that waggle radius.

Go to Source - specified in functions @bees/goto_source.m

Information of the source acquired by waggle dance is used to get the random position inside the source for food collection.

Migrate - specified in functions @bees/migrate.m

1. Bees will only collect food when there eaten status is set to zero.

2. Bees move towards the position in the source acquired by do_waggleDance function and goto_source function.

3. Bees will extract the distribution of food in that source(at distance less than or equal to its visionRange).

4. If the food is found the flag for foodFound is set to *true*.

5. Else if no food is found the knownSource is set to empty and agent will migrate back to the hive.

Eat - specified in functions @bees/eat.m

1. If the foodFound is true in the migrate function than food is collected by the bee and the value of food at that location is set to zero. Parameter eaten is also set to 1.

2. If foodFound is false than eaten parameter is set to zero.

Migrate Back - specified in functions @bees/migrate_back.m

Once food is collected form the source and eaten status is set to 1, random position is selected inside the hive and bee migrate back to that position for waggle dance.

1.2   Environment

The model environment is represented as:

ENV_DATA.shape - shape of Environment

ENV_DATA.units - fixed as meters

ENV_DATA.bm_size - length of environment edge

ENV_DATA.environment(1:end,1:round(size*sizeA)) - defines food source A

ENV_DATA.environment(1:end,round(size*sizeB):end-1) - defines food source B

ENV_DATA.environment(round(size*0.45):round(size*0.55),round(size*0.45):round(size* - defines Hive

ENV_DATA.sourceApos - position of source A in environment

ENV_DATA.sourceBpos - position of source B in environment

ENV_DATA.hivePos - position of Hive in environment

ENV_DATA.hiveSize - size of Hive

ENV_DATA.distanceA - distance from hive to source A

ENV_DATA.distanceB - distance from hive to source B

1. Food value for each cell in source matrices is set to 1.

2. Value -1 is set to all the values of cells in hive matrix.
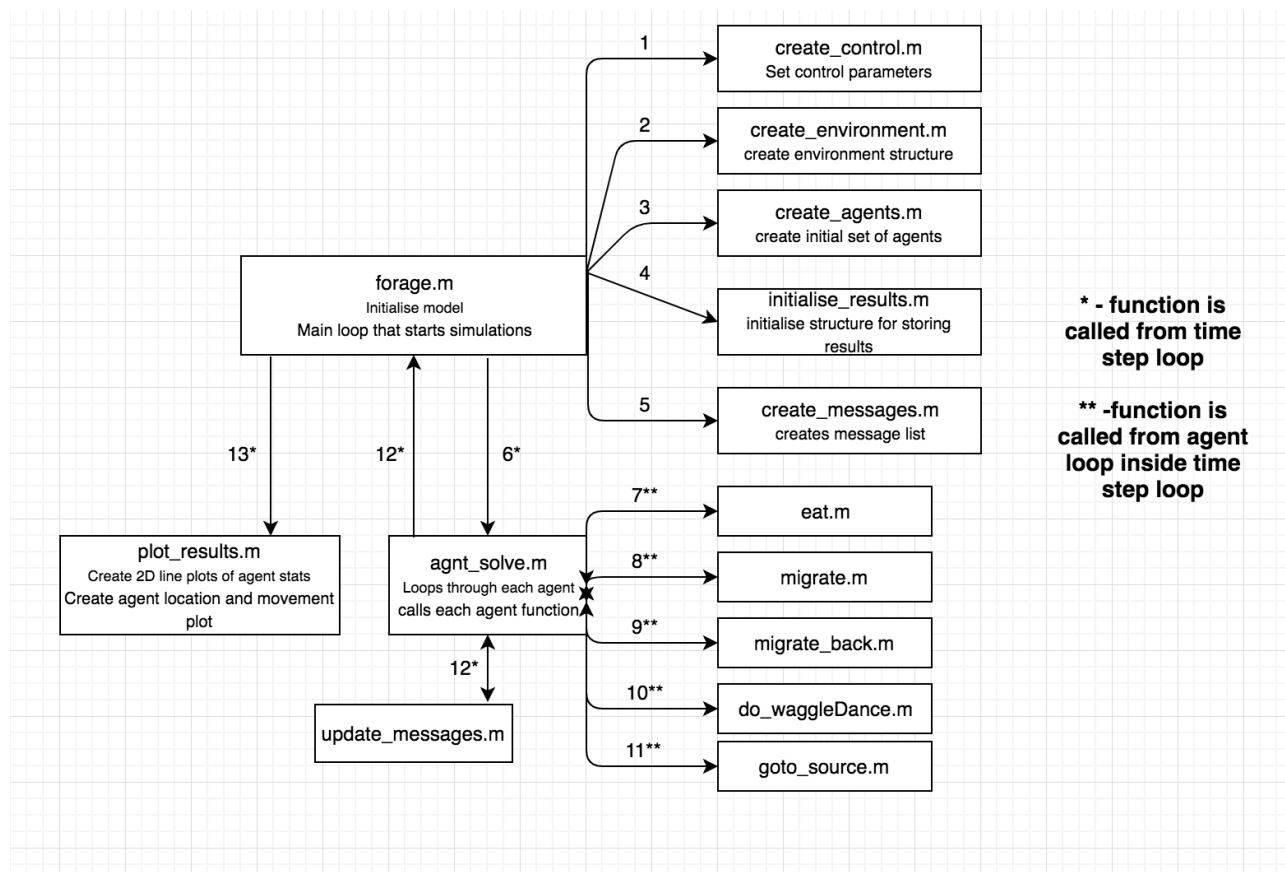
1.3   Communication and timing

Global parameter *MESSAGES* contains following fields:

1. **MESSAGES.pos** - List of agents position in Cartesian coord[x y].

2. **MESSAGES.wSourceXmin, MESSAGES.wSourceXmax, MESSAGES.wSourceYmin, MESSAGES.wSourceYmax** - List of coordinates of the sources perceived by waggle dance.

Chapter 2

DATA FLOW

Chapter 3

RUNNING THE MODEL

After opening the model folder in the working directory of Matlab the function that is needed to be called to run the model is **forage** with the input in following format:

forage(size, nr, nsteps, sizeSourceA, sizeSourceB, distA, distB, fmode(optional), outImages(optional))

where,

- *size* is size of model environment in meters.

- *nr* is number of agents.

- *nsteps* is number of iterations.

- *sizeSourceA* is size of source A to be specified in a value less than 1 (recommended 0.25).

- *sizeSourceB* is size of source B to be specified in the value less than 1 (recommend 0.75 this will create a source on the other side of hive and the size factor of this source will be 0.25 but 0.75 is specified so that the source B is defined from 0.75*size position of matrix to the end.)

- *distA* is the distance of sourceA from the hive.(between 0-20 units)

- *distB* is the distance of source B from the hive.(between 0-20units)

- *fmode* is a boolean(true/false) to turn on or off the fast mode.[default set to *true*]

- *outImages* is a boolean(true/false) to turn on or off the output images. [default set to *false*]

Once you start running the model two new images are going to appear one showing the working model simulation depicting the environment and agents and there movements and functionalities. Second figure shows the output line graphs of the acquired results. Figure below shows the depiction of running model.
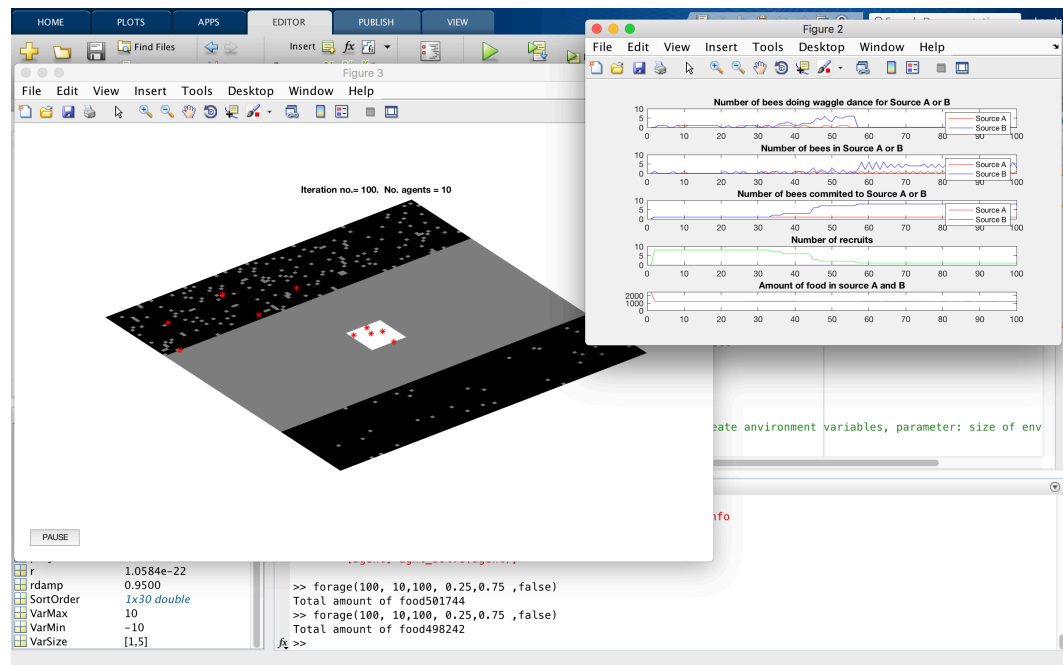
In the above figure the black portions in environment simulates food sources A and B on each side of hive and white portion signifies the hive. Red markers are agents.