honeyB

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Abstract

honeyB is a proof-of-concept demonstration of Swarm Intelligence, a rapidly developing branch in Artificial Intelligence research. Swarm Intelligence, also known as distributed intelligence, demonstrates the ability of many autonomous entities to make simple decisions that culminate in a decision that is beneficial for the group. This project uses 3D graphics to simulate the interaction of bees with each other and their hive.

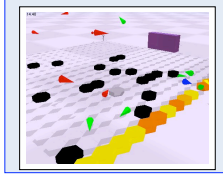


Fig. 1. honeyB screenshot detailing bees working together to perform various tasks which maintain and develop the hive

Software Tools

The breve toolkit is a programming suite, or Integrated Development Environment (IDE) which powers honeyB by providing a 3D environment and the steve scripting language designed specifically for running simulations and artificial life projects. Breve is an open source program currently available to Windows, Mac OS X, and Linux platforms.

One special feature of the Mac version of breve is the ability to load a Carbon files, which are the basis of the Mac user interface. This allows breve users to add extra windows to their simulations, as demonstrated with the hive census data window (fig 2). Apple's Interface Builder tool can produce Carbon files.

Fig. 2 : the custom honeyB hive census data window

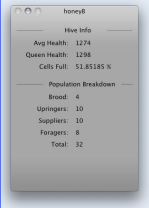
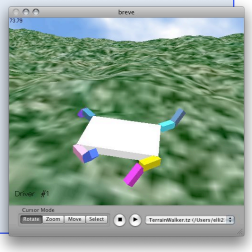


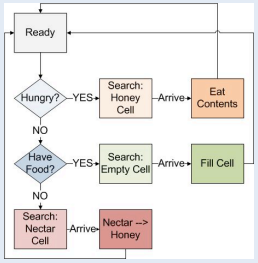
Fig. 3 : breve Simulation Environment running the Terrain Walker demo



Swarm Intelligence

This is a new branch in the field of Artificial Intelligence (AI) which departs significantly from many traditional AI models. Swarm Intelligence relies on the premise that multiple simple individuals, or agents, can make simple individual choices that are oriented towards group success. The collective decision make via this process can be comparable to the same decision made by a singular, complex, and monolithic AI.

Fig. 4. Flowchart representing the AI for one of the worker classes. Using Swarm Intelligence, this represents the logic to do 1/3 of the work in the hive.



The chief advantage of using Swarm Intelligence over traditional AI is that the simpler agents each do fewer things, making them easier to develop and maintain. This reduces the development cost of adding AI to a project, increasing reliability and efficiency of the end product.

Real world applications of swarm intelligence have included Airport scheduling, weather prediction, and robotics.

Project Overview

The project was broken down into a series of modules, each corresponding to a class of agents within the hive. Each agent class went through a planning phase before being implemented in code. Implementation generally took two steps, one for functions for use within that class, and a second covering interactions with other agent classes.

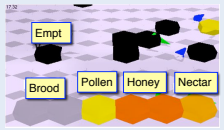
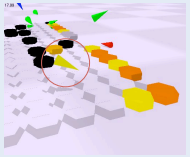


Fig. 5: Honeycomb cells are stationary objects which can contain Brood, Pollen, Nectar, Honey, or nothing. Cells containing brood will develop over time into adult bees.

Fig. 6: The Queen's sole responsibility is to place brood into empty cells.



The remaining hive duties are split among three roles: Upbringer, Supplier, and Forager.

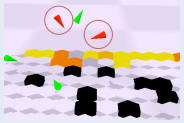
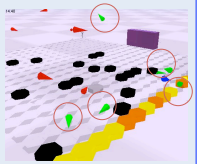


Fig. 7: Upbringers attend to the needs of brood and the Queen. They must eat pollen to replenish their energy.

Fig. 8: Suppliers construct new honeycomb cells and transfer food to them for long term storage. Honey is their source of energy.



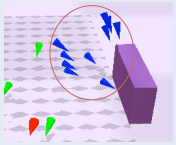
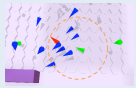


Fig. 8: A Forager's duty is to journey outside the hive (purple gate) to gather food, then return laden with pollen or nectar. They do not always return to the hive.

Workers advance through these roles in order as the simulation runs. Promotions happen more quickly when there are few bees present of the next worker class. This way if there is a sudden loss of one class of workers, lower ranking bees will promote to fill in the ranks.

Fig. 9: Bees use everything within their neighborhood, a sphere of space centered around each bee, as input when making decisions. This includes promotional decisions.



Conclusions

Swarm Intelligence is a good system for managing multiple agents without relying on a monolithic, centralized control system. Splitting the hive workload into multiple distinct roles reduced the complexity of developing honeyB down to manageable levels.

Altering assorted user-accessible variables, such as promotion and forager success rates, significantly changes how the simulation runs. This makes honeyB a viable experimental tool for studying multi-agent interactions.

The use of neighborhoods as the basis of single-agent decisions reduces the computational complexity of honeyB, as well as more accurately simulating bee perception than calculating against all other agents globally.

External Sources

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For further information

Please contact *elliott@pacificu.edu* More information on this and related projects can be obtained at *benford.bluhelix.com* and *spiderland.org* . The Computer Science website can be found at *zeus.cs.pacificu.edu*

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