Project Melissa

Agent-Oriented Engineering of a Biological System using JaCaMo & JavaFX

Simulation Objectives

Survival Goal

The primary objective is the collective survival of the hive. Agents must autonomously collaborate to maintain energy levels and regulate homeostasis against environmental threats.

Producer-Consumer Economy

A complex economic model where resources (pollen) are collected, processed into capital (honey), and consumed to fuel the workforce and fund population growth (larvae evolution).

The JaCaMo Architecture

Jason (Agents)

Defines the reasoning logic (BDI architecture). Agents like **Queen** and **Worker** use plans (.asl) to achieve goals based on beliefs.

CArtAgO (Env)

Provides the artifacts (tools and sensors). The **Hive** and **Map** artifacts manage state variables like temperature and inventory.

Moise (Org)

Specifies the organizational structure. Defines roles (e.g., Sentinel), groups, and the normative obligations for missions.

The Agents: Queen & Worker

The Monarca (Queen)

A singleton agent responsible for high-level management. She commits to the renovation mission, creating larvae to sustain the population when energy permits.

The Workers

The workforce of the hive. They are instantiated dynamically and change their behavior (Plans) and Organizational Roles based on their age property.

Worker Agent Lifecycle

Workers dynamically adopt new roles and norms as they age.

Feeder

Age 0-18

Processes pollen, feeds larvae, and tends to the Queen.

Sentinel

Age 18-22

Guards the hive. Actively heats or cools the hive to maintain 25°C.

Explorer

Age 22+

Navigates the Map artifact to find and collect pollen from fields.

End

Age 45

Agent executes `!suicide` plan to simulate natural death.

CArtAgO Artifacts

HiveArtifact

Manages the internal state variables:

- **Inventory:** Honey and Pollen levels.
- **Population:** List of living Larvae.
- **Homeostasis:** Internal Temperature.
- **Operations:** `aquecer()`, `createLarva()`

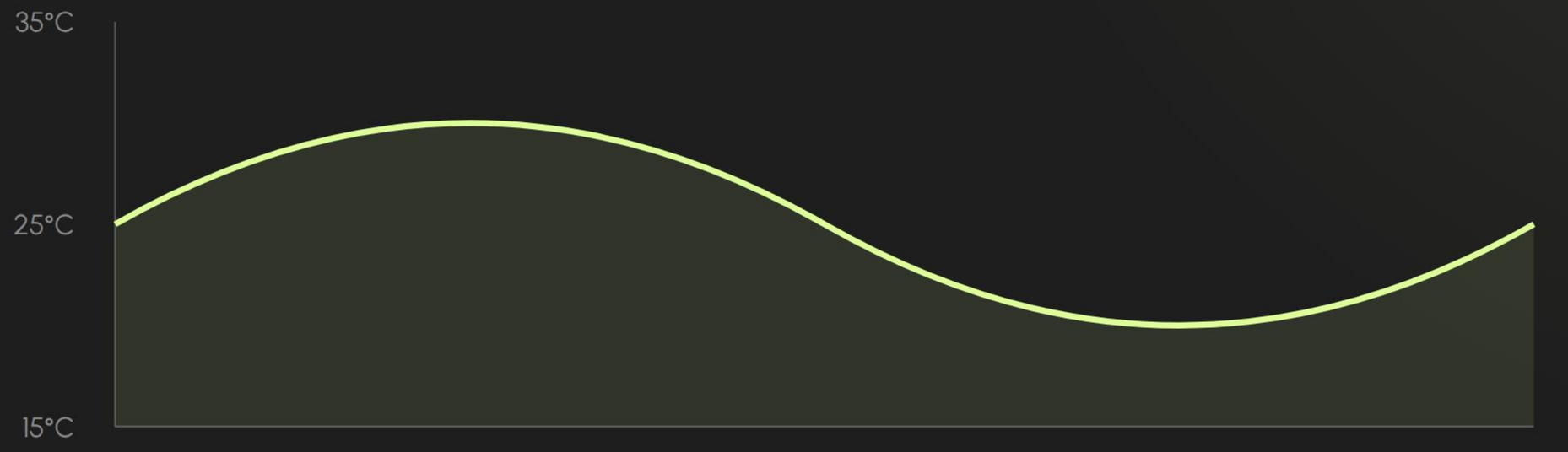
MapArtifact

Manages the external environment:

- **Geography:** 2D Grid coordinates.
- **Dynamics:** Seasonality and Days.
- **Resources:** Pollen Field locations.
- **Operations:** `flyTo(x,y)`, `collect()`

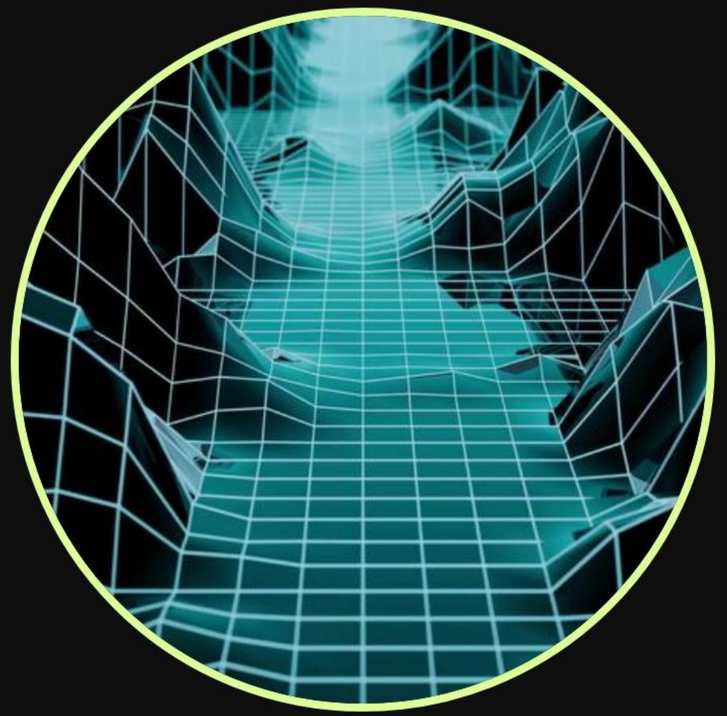
Seasonal Dynamics

External temperature fluctuates sinusoidally, forcing Sentinels to adapt.



Visualization of `MapArtifact` temperature calculation: `25 + 10 * sin(2*PI*(month/12))`

Moise Organization



Structural & Functional Specs

The behavior is regimented by the `organisation.xml` file.

- **Groups:** `colmeiaGroup` defines role cardinalities.
- **Scheme:** `doSimulation` defines the goals tree.
- **Missions:** Agents must commit to missions like `mSentinela` or `mExploradora`.
- **Norms:** Obligations link roles to missions (e.g., `nExploradora`).

The Resource Cycle

From Pollen to Honey

The simulation runs a continuous producer-consumer loop:

1. **Collection:** Explorers locate colored pollen fields on the grid.
2. **Transport:** Pollen is physically transported back to the Hive coordinates.
3. **Processing:** Feeders (Babas) convert raw pollen into honey stock.
4. **Consumption:** Honey is deducted for every action (energy cost) and for creating new agents.

Biological Loop

Reproduction

The Queen initiates the `!porOvos` plan, creating a generic Larva object in the HiveArtifact.

Feeding

Feeders execute `!alimentarLarvas`. Once a Larva consumes 20 units of honey, it triggers evolution.

Evolution

The system instantiates a new Jason agent (`worker.asl`) into the workspace, expanding the population.

JavaFX Interface

The `EnvironmentApplication` renders the real-time state of the MAS.

- **Queen:** Purple Agent
- **Feeder:** Light Blue Agent
- **Sentinel:** Dark Blue Agent
- **Worker:** Orange Agent

Dashboard: Displays Temperature, Time, and Honey levels (Red to Green indicators).

Questions?

Project Melissa: A JaCaMo Demonstration

Image Sources

https://media.istockphoto.com/id/454130651/photo/queen-bee-woking-on-a-honeycomb.jpg?s=612x612&w=0&k=20&c=F-jBLvuoDI25cwSCS3OM33mrbZWi_XJNRv1eMgjr65o=

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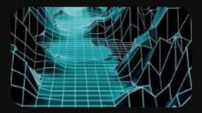

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