MIMICKING BIOMIMICRY: WHAT CAN WE LEARN FROM A SWARM OF HUMANS?

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MIMICKING BIOMIMICRY

- Biomimicry
  - Good ideas from Natural World
  - Humans part of Natural World
HUMAN SWARMS
HUMAN SWARM IN ACTION
HUMAN SUDOKU

- 81 participants
- 9 groups of 9
  - Colored T-shirts
  - Numbers
- Only Instructions:
  - Get on grid
  - Make no conflicts
SUDOKU VIDEO 1

Observed Low-Level Behaviors
Homesteading
Wandering
Conflict Discoverers

Human Swarm begins Sudoku Puzzle
Observed High-Level Behaviors
  Decentralized Efforts
  Centralized Take-over
  Decentralized correction

Centralized Take-over of Swarm
HUMAN SWARM SOLVING JIGSAW PUZZLE

- Connectors
- Detectors
- De-selectors
- Transporters
- Leaders
Digital Jigsaw Puzzle
Agent Population Ratio Control
Humans address “big picture”
Swarms leverage parallelism and randomness
AGENT TYPES

- Connectors
- Sorters
  - + Color
  - + Edge
  - + “Shape”
- Finishers
SWARM PROGRAMMING

- Writing Agent Rules
  - Low level actions

- Realizing Global Behavior
  - High level actions

- Most Difficult Aspect of Swarms
EMERGENCE-ORIENTED PROGRAMMING

Baseline Swarm System

Human Observation of Swarm Behavior

EOP Complete

Goal Emergent Behavior

Codify Human Assistance Becomes New Baseline

Human Assists Swarm

Evaluate Performance

Roll Back to Previous Swarm System

No Improvement

Improvement

Restart Cycle

Start Cycle

Restart Cycle
EMERGENCE-ORIENTED PROGRAMMING

Baseline Swarm System

Codify Human Assistance Becomes New Baseline

Human Observation of Swarm Behavior

Human Assists Swarm

Evaluate Performance

Restart Cycle

Start Cycle

EOP Complete

No Improvement

Roll Back to Previous Swarm System

Goal Emergent Behavior

Improvement
EOP - ITERATION 1, CONNECTORS ONLY

Baseline Swarm System

Restart Cycle

Start Cycle

Human Observation of Swarm Behavior

Codify Human Assistance Becomes New Baseline

Improvement

Evaluate Performance

No Improvement

Roll Back to Previous Swarm System

Restart Cycle

EOP Complete

Goal Emergent Behavior

Human Assists Swarm

Human Observation of Swarm Behavior

Baseline Swarm System

Codify Human Assistance

Becomes New Baseline

EOP Complete

Roll Back to Previous Swarm System

Human Assists Swarm

Evaluate Performance
EOP – ITERATION 2, ADD SORTERS

- Baseline Swarm System
- Human Observation of Swarm Behavior
- Start Cycle
- Human Assists Swarm
- Evaluate Performance
- Improvement
- No Improvement
- Codify Human Assistance Becomes New Baseline
- Restart Cycle
- Roll Back to Previous Swarm System
- EOP Complete
- Goal Emergent Behavior
EOP - ITERATION 3, ROLL BACK

Baseline Swarm System

Human Observation of Swarm Behavior

EOP Complete

Goal Emergent Behavior

Codify Human Assistance Becomes New Baseline

Restart Cycle

Human Assists Swarm

Evaluate Performance

Roll Back to Previous Swarm System

No Improvement

Improvement

Start Cycle

Restart Cycle
EOP – ITERATION 4, ADD CHILDREN

1. Baseline Swarm System
2. Restart Cycle
3. Human Observation of Swarm Behavior
4. Human Assists Swarm
5. Evaluate Performance
6. Improvement
7. No Improvement
8. Roll Back to Previous Swarm System
9. EOP Complete
10. Goal Emergent Behavior
11. Codify Human Assistance Becomes New Baseline
12. Restart Cycle

- Start Cycle
- Restart Cycle
EOP - Iteration 5, Add Finishers

- **Baseline Swarm System**
  - Restart Cycle
  - **Human Observation of Swarm Behavior**
  - **Codify Human Assistance Becomes New Baseline**
  - Improvement
  - No Improvement
  - **Restart Cycle**
  - **EOP Complete**
  - **Goal Emergent Behavior**
  - **Human Assists Swarm**
  - **Evaluate Performance**
  - **Roll Back to Previous Swarm System**
EOP – Iteration 6, Wrap Around

- Baseline Swarm System
- Start Cycle
- Human Observation of Swarm Behavior
- Human Assists Swarm
- Evaluate Performance
  - Improvement
  - No Improvement
- Codify Human Assistance Becomes New Baseline
- Restart Cycle
- Roll Back to Previous Swarm System
- Goal Emergent Behavior
- EOP Complete
Comparison of Algorithms as the Puzzle Completes

- **Connecting Only Without Children**
- **Dynamic distribution without wrapping**
- **Human with finishers and wrapping**
- **Connecting only without wrapping**
- **Dynamic distribution with wrapping**
- **Human with manual connections and wrapping**
THANK YOU! QUESTIONS?