Swarm AI: A Solution to Soccer

Alex Kutsenok

Advisor: Michael Wollowski

Senior Thesis

Rose-Hulman Institute of Technology

Department of Computer Science and Software Engineering

May 10th, 2004

Definition of Swarm AI

Swarm intelligence is a relatively new AI method, modeled after Swarm-like insects like bees and ants.

- A sophisticated group behavior that emerges from a multitude of simple individual behaviors

- Swarm AI: The 3 Principles
  - 1) split problem into parts and assign them to agents
  - 2) agents are given a simplified or incomplete view of the environment
  - 3) agents communicate with each other

My Objective

I want to use Swarm AI as a tool to control artificial agents playing soccer.

- 3 soccer sub-problems:
    - defensive coverage
    - moving without the ball on offense
    - deciding when to pass
- For comparison, I will play it against a centralized rule-based AI architecture (CRAI)

Why Do This Project

- Swarm AI has mostly been used to solve path-finding problems like the TSP, VRP, and even real-life networking issues

- Alexis Drogoul came up with Swarm Chess
  - a simple approach
  - the pieces think for themselves
  - a different use for Swarm AI

- Are there other unlikely uses for insect thinking?

- I am seeing if Swarm Intelligence can work in a dynamic strategic environment where things change on the fly and the agents have a limited amount of time to decide how to act

Why This Is Swarm Intelligence

- Swarm Defense
  - no centralized algorithm to tell them who to guard
  - players only think about locations, not velocities because they use the Openness Heuristic
  - they communicate by painting enemies

- Swarm Defender and Forward Runs
  - each player decides where he should go
  - forwards ignore teammates, defenders ignore enemies
  - works without communication, but can be improved with it, so a good area for Future Work. Is flocking for now.

- Swarm Passing
  - players without the ball do thinking in addition to passer
  - players only think about locations, not velocities
  - communicate by painting themselves

Questions?

Thank you for your time!

Swarm AI: Defensive Coverage

Each shift turn, the players on the Swarm AI team individually decide whom or what they will be covering defensively

- 5 enemies and the friendly penalty zone = 6 targets
- Each Swarm player looks at the costs and benefits of guarding each target and chooses appropriately: Individual Paint Decision Algorithm (IPDA)
- Openness Heuristic:
  - how many enemies are within a radius of 100 pixels
  - how close are those enemies

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SAI: More on Defensive Coverage

- Reward Heuristic
  - more reward for covering enemies who are open, close to the friendly goal, and who are ball carriers
- Cost Heuristic
  - is time to intercept the target
  - is distance/speed if can't intercept
- IPDA calculates the profit of guarding each target; it's run separately by each player
  - a covered target is "painted" by that player
  - Initial Profit = Reward- Cost for a player target
  - Initial Profit = 100 for guarding the zone
  - if target has being painted by another teammate, Profit= Initial Profit / 4
    - if painted target is the ball carrier, then only divide by 2
  - cover the target with largest Profit, paint it your color
- IPDA Example

Swarm AI: Offensive Player Movement Without the Ball

In soccer it is a good idea for players without the ball to make runs to get open; this inspired the Swarm strategy.

- 2 Kinds of roles: Forward and Defender
  - a player is pulled in several directions based on role
  - sum up these vectors to get the direction for the player's movement velocity
- Forwards
  - away from enemies within 200 units
  - toward enemy goal
  - toward ball
- Defenders
  - away from friendlies within 200 units
  - toward friendly goal
  - toward ball