Evolving Sheepdog and Cutting Horse Behavior with a Simulated Flock

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Flocking behavior has long been established. Are there simple rules that define herd behavior?

This project uses genetic algorithms to attempt to discover simple rules for describing sheepdog-herding behavior. A population of sheepdogs was randomly generated, tested (Fig 1), and bred, thus producing a new generation. Each new group was re-tested and re-bred for over 160 generations.
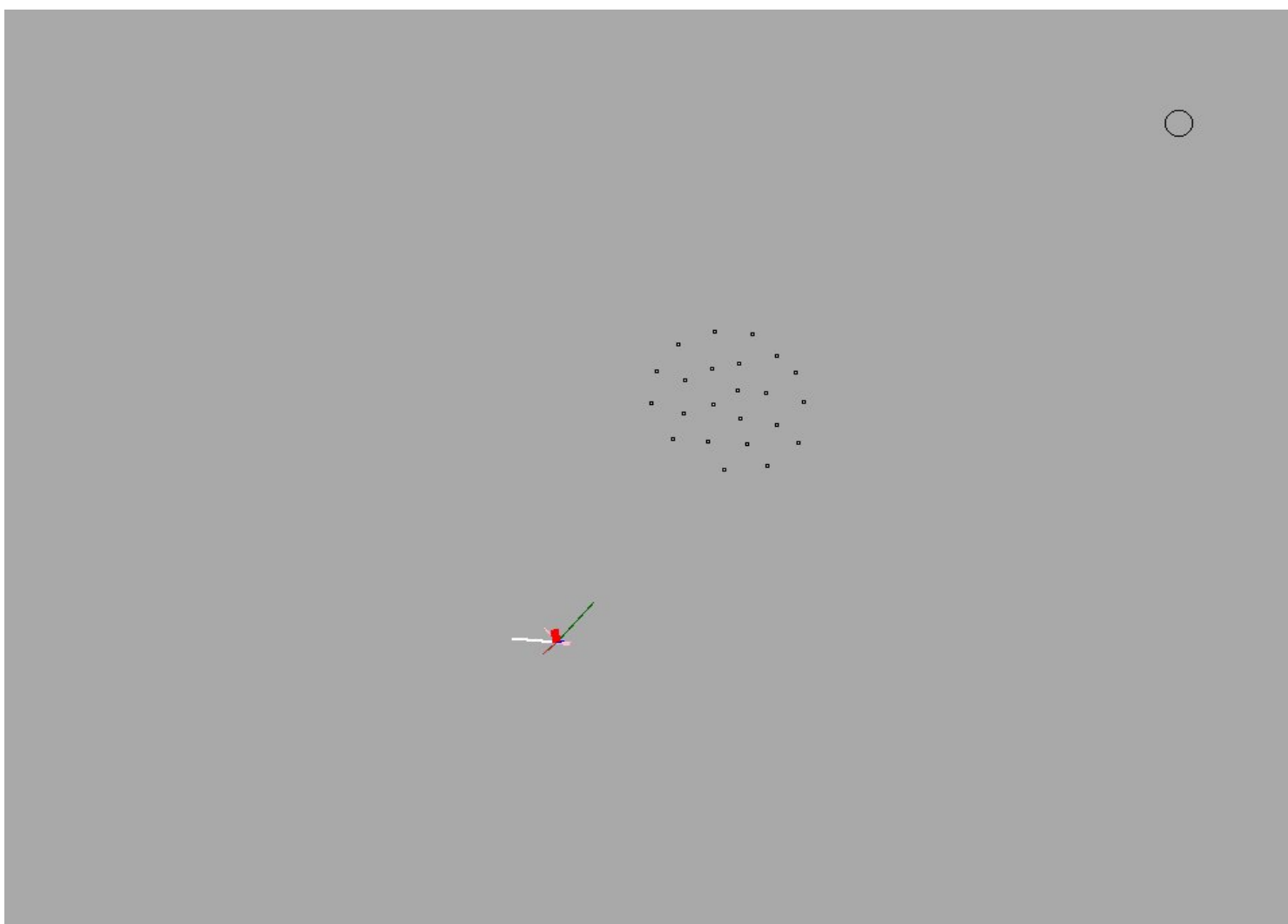

Fig 1 A sample trial, the sheepdog (red) is judged by how close it can get the flock (black dots) to the goal (black circle) in the time alloted.

Genetic Code

The genes were implemented as a set of coefficients and exponents for an group of vectors calculated from the simulation. The coefficients and exponents determined how much weight was given to each vector, and thus how strongly that vector determined the behavior of that sheepdog. Sample vectors: direction to the goal, random direction, direction to the flock, and a 'favorite' direction.

Vocab

• **Flock:** Group of agents whose behavior is based on the natural movements of fish, birds and cattle. Flocking behavior depends on three basic "rules": Separation, Cohesion and Alignment.

• **Sheepdog**: An agent who's behavior is intended to direct a flock through its own motion. A sample task for a sheepdog might be getting the flock as close to a goal location as possible.

• **Cutting Horse**: An agent whose goal is to separate a single member from the flock so that it can be easily accessed

Further Reading:
• **Flocking:** "Flocks, Herds, and Schools: A Distributed Behavioral Model, Craig Reynolds

• **Cattle Herding:** "Low Stress Methods for Moving and Herding Cattle on Pastures, Paddocks, and large Feedlot Pens", Temple Grandin
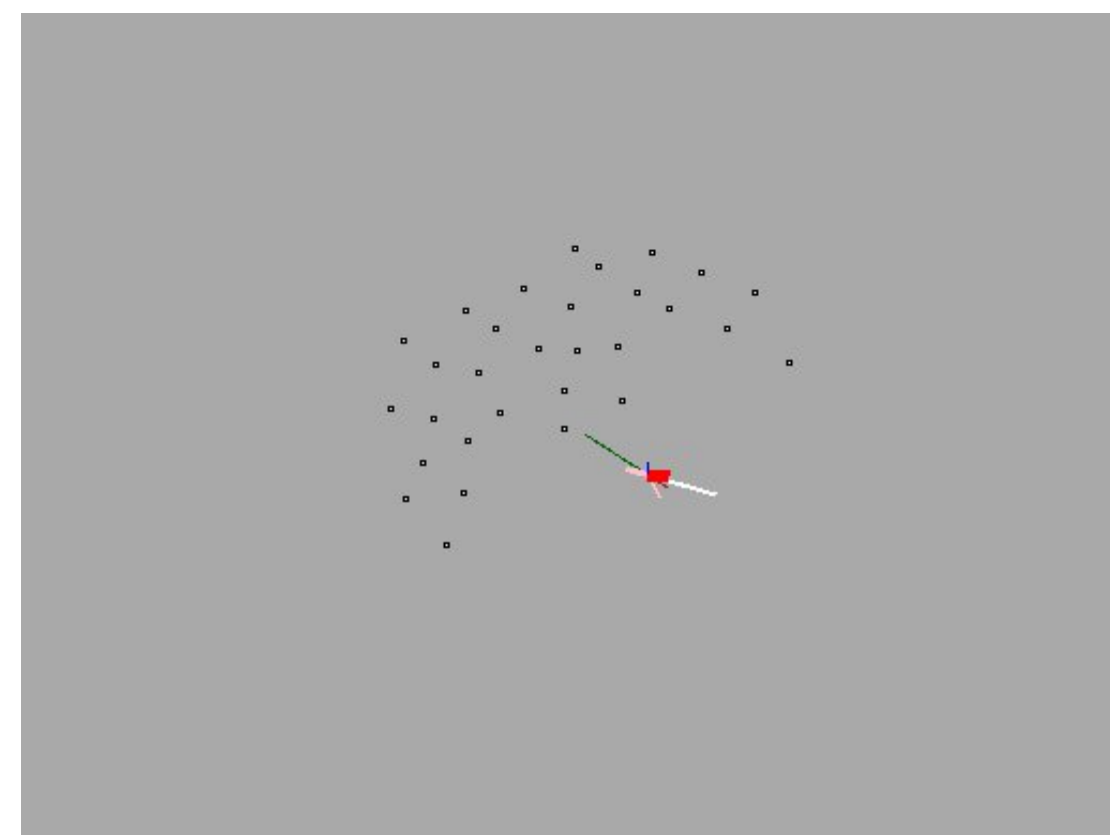

Fig 2 Final evolved strategy for herding. Two main vectors drive the movement, one attracted to the flock, the other repulsed from the goal. The behavior works surprisingly well and can chase a moving goal.
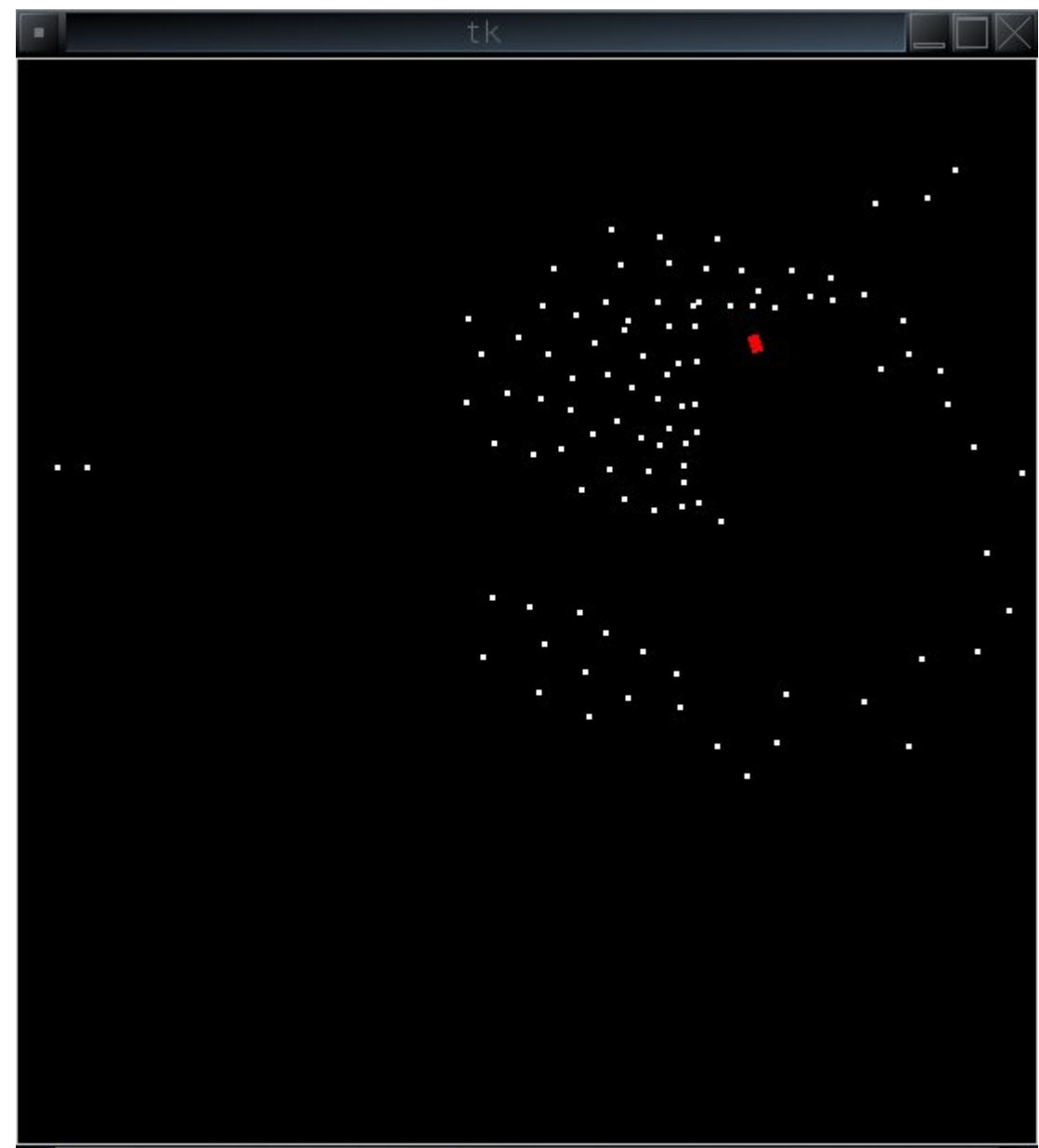

Fig 3 Herd reacting to the presence of a sheepdog in their midsts.

Results

A number of novel strategies emerged over the course of the trials:

• **Bubble –** Sheepdog moves to center of flock and moves towards goal, bringing the flock with it.

• **Spinning Wheel –** Evolved from bubble. This spins in a rapid circle and drives the flock ahead of it

• **Southeast –** Through exploiting the random goal generation, moving southeast often allowed for an easy victory.

• **Wall Bounce-** An inexplicable strategy, the sheepdog bounces off the edge of the simulation, then travels to the flock and pushes it slightly toward the goal, then repeats.

• **Final Strategy- Fig 3** Sheepdog drives the flock ahead of it, chasing any stray members back into the flock. It retains control of the flock and can chase a moving goal.