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Droving, Driving, and Mustering: Phases of Optimal Herding[1]
ADITYA RANGANATHAN, ALEXANDER HEYDE, Harvard University, ANUPAM GUPTA, IIT Hyderabad, L MAHADEVAN, Harvard University — While flocking behavior—of cells, animals, robots etc. —is an area of growing interest, little is understood about how a few shepherds are able to control large groups of swarms, flocks, or herds. Here, we investigate how a shepherd (such as dogs, humans, or robots) should move in order to effectively herd and guide a flock towards a target. Using agent-based, ODE, and PDE models, we find that three distinct phases of control algorithms emerge as potential solutions—despite no specific control algorithm being prescribed—as a result of optimizing herd cohesion, distance to a target, and line of sight. Transitions between the phases are dependent on just two parameters: the scaled herd size and the scaled herd speed. Two of these phases—mustering and droving—show agreement with the behavior of sheepdogs in nature. The third, driving, is a novel phase that suggests an efficient control algorithm for the transport of a very large group of animals by a single agent. Several potential applications of driving can be seen in swarm robots.

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