Department of Applied and Computational Mathematics and Statistics Colloquium

Andrew Bernoff

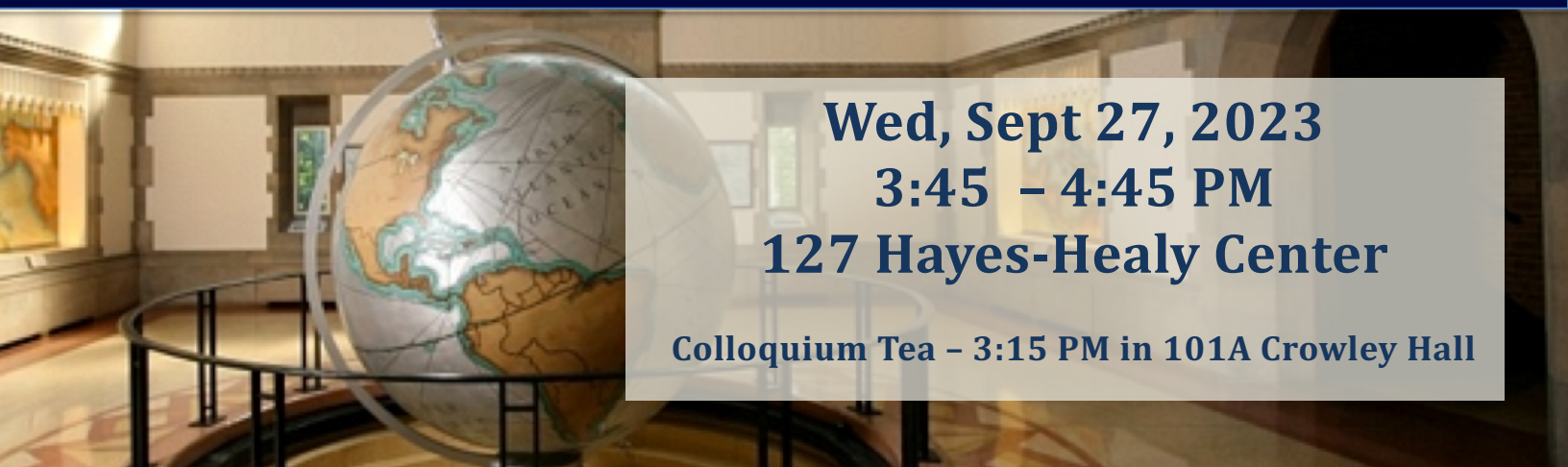
Harvey Mudd College

Modeling the Collective Behavior of Locust Hopper Bands

An outstanding problem in mathematical biology is using laboratory and/or field observations to tune a model's functional form and parameter values. These problems lie at the intersection of dynamical systems and data science. In this talk I will discuss an ongoing project developing models of the Australian plague locust for which excellent field and experimental data is available.

Under favorable environmental conditions flightless locust juveniles aggregate into coherent, aligned swarms referred to as hopper bands. These bands are often observed as a propagating wave having a dense front with rapidly decreasing density in the wake. These fronts slow and steepen in the presence of green vegetation suggesting the collective motion of the band is mediated by resource consumption. Exploiting the alignment of locusts in hopper bands, I will first describe a one-dimensional model of density variation perpendicular to the front. We develop two models in tandem; an agent-based model that tracks the position of individuals and a partial differential equation describing locust and resource density. By examining 4.4 million parameter combinations, we identify a set of parameters that reproduce field observations.

I will also discuss two ongoing efforts to improve this model. The first uses ideas from dynamical systems and continuum mechanics to extend this model into two dimensions by modeling locust alignment using ideas from the Kuramoto model of oscillator synchronization. The second, firmly based in data science, uses motion tracking of tens of thousands of locusts to shed light on how locust movement is influenced by social interactions.



Wed, Sept 27, 2023
3:45 – 4:45 PM
127 Hayes-Healy Center

Colloquium Tea – 3:15 PM in 101A Crowley Hall