Amundson Lecture Series 2018
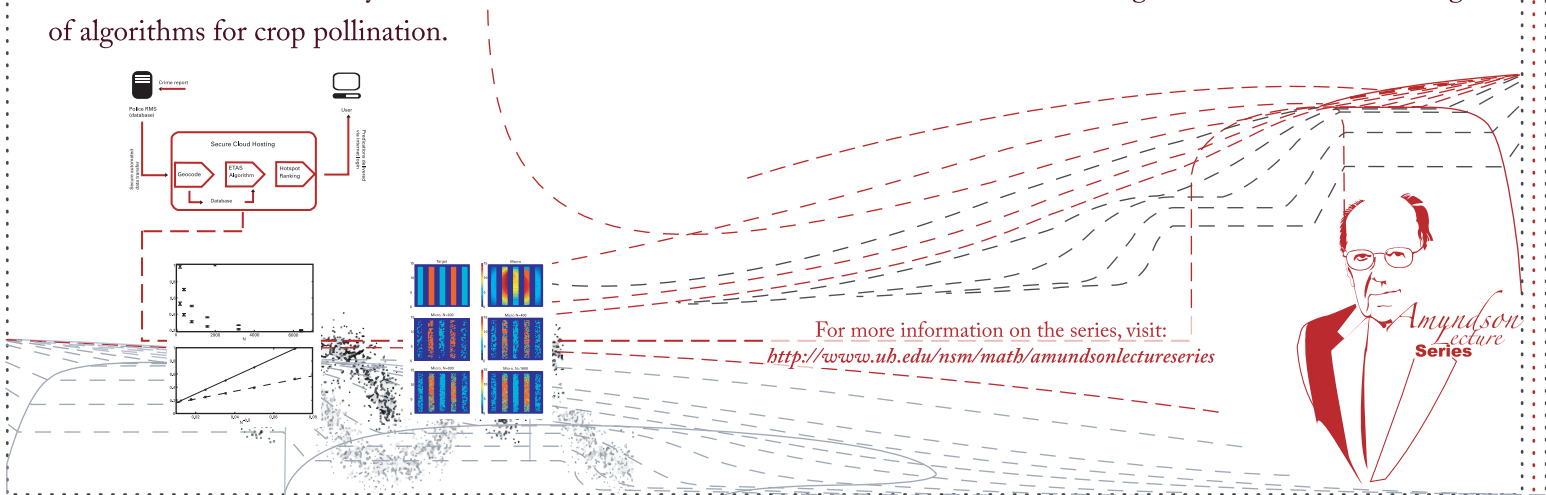# Abstracts

Mathematics of Crime

Dr. Bertozzi will talk about the fascinating story behind her participation on the UCLA team that developed a "predictive policing" computer program that zeros-in on areas that have the highest probability of crime, now used in over fifty cities worldwide. The diverse use of mathematics in studying residential burglaries, gang crimes and other criminal activities will also be discussed as well as new problems in machine learning related to crime data analysis for prediction and classification.

Geometric Graph-based Methods for High Dimensional Data

We present new methods for segmentation of large datasets with graph-based structure. The method combines ideas from classical nonlinear PDE-based image segmentation with fast and accessible linear algebra methods for computing information about the spectrum of the graph Laplacian. The goal of the algorithms is to solve semi-supervised and unsupervised graph cut optimization problems. The methods make parallels between geometric ideas in Euclidean space such as motion by mean curvature, ported to a graphical framework. These ideas can be made rigorous through total variation minimization, and gamma convergence results, and convergence of time stepping methods in numerical analysis. We show diverse examples including image processing applications such as image and video labeling and hyperspectral video segmentation, and machine learning and community detection in social networks, including modularity optimization posed as a graph total variation minimization problem.

Swarming by Nature and by Design

The cohesive movement of a biological population is a commonly observed natural phenomenon. With the advent of platforms of unmanned vehicles, such phenomena have attracted a renewed interest from the engineering community. This talk will cover a survey of models ranging from aggregation models in nonlinear partial differential equations to control algorithms and robotic testbed experiments. We will show how pairwise potential models are used to study biological movement and how to develop a systematic theory of such models. We also discuss how to use "designer potentials" to orchestrate cooperative movement in specific patterns, many of which may not be observed in nature but could be desirable for artificial swarms. Finally we conclude with some recent related work on emotional contagion in crowds and on design of algorithms for crop pollination.

For more information on the series, visit:
http://www.uh.edu/nsm/math/amundsonlectureseries