UROP projects in the Imaging and Computing group (Prof Demanet)

State your interest and qualifications in the application. Deadline: first Friday of the term.

Inversion of light patterns

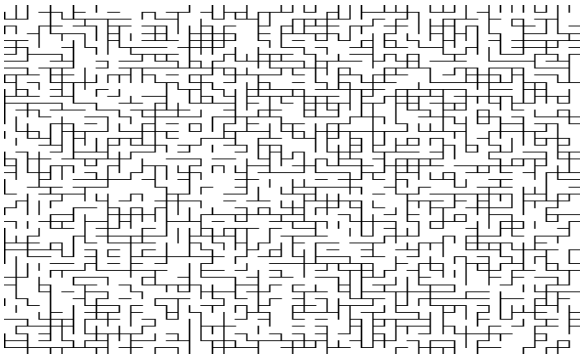
Even if the surface of a swimming pool slightly departs from horizontal, light reflected from the sun creates intricate patterns at the bottom. Given a photograph of these patterns, you will consider the problem of recovering the height of the water's surface. The project will involve a numerical implementation of the pattern-forming map in 1D, and a careful study of the minimization problem of recovering the height function. Prerequisites: a good background in ***optimization***; some numerical analysis; and familiarity with Matlab.

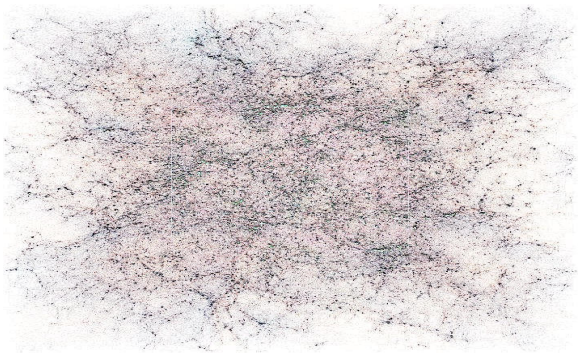
Booming sand dunes

In Death Valley park, there are sand dunes that make a very specific, loud noise when you slide down them at particular times of the year. This nonlinear resonance phenomena is poorly understood at the moment. You will experiment numerically with particular families of nonlinear partial differential equations that may model sound in dry sand, and try to reproduce the sound signature heard in nature. Prerequisites: a good background in ***numerical analysis*** and physics; and familiarity with Matlab.

Combinatorics of network reduction

Resistor networks can be solved by applying reduction rules such as combining resistors in series and parallel. This project will tackle the open problem of finding the minimum number of reductions necessary for solving a square lattice, and whether optimal reduction is NP hard or not. This problem is related to direct sparse LU solvers in matrix theory. Prerequisites: a good background in ***combinatorics*** and linear algebra; and familiarity with Matlab.





Algebraic geometry of multivariate interpolation

Reconstructing a smooth function from its samples on a cloud of points is a hard problem in dimensions greater than 1. You will focus on the difficulties of performing polynomial interpolation when points locally align along or near certain algebraic curves. The goal is to develop an understanding of the conditioning of the underlying matrices, analytically and numerically. Prerequisites: a good background in ***algebraic geometry*** and linear algebra; and familiarity with Matlab.