

## COMP 6839 Topics in Computer Science

**Instructor:** Robert Acar

**Office hours:** MJ 14:00-17:00, Monzón 115.

**Course objective:** study of methods for image processing based on Partial differential equations and the Calculus of variations.

**Prerequisite:** vector calculus and elementary differential equations, basic skills in programming in a high-level language (such as C++) or a scientific programming environment (such as Matlab), some familiarity with analytic geometry and numerical methods. There lurks in the background of the course many concepts from partial differential equations, and the interplay between geometry and analysis, but we will usually cover enough ground to gain at least a cursory understanding of the ideas and tools involved.

**Topics covered:**

### Mathematical preliminaries

- The heat equation: continuous setting
- The heat equation: discretisation and approximation
- Elements of calculus of variations
- Elements of function spaces, notions of convergence

### Image restoration

- Energy methods
- PDE-based methods: smoothing PDEs
- Smoothing-enhancing PDEs
- Space of functions of bounded variation
- Enhancing PDEs

### Image segmentation

- Mumford-Shah functional
- Elements of Differential geometry
- Geodesic active contours and level-set method

**Other topics** depending upon interest:

- Image classification models
- Sequence analysis

**Evaluation:** homework, project.

**Text:** “Mathematical Problems in Image Processing”, Gilles Aubert and Pierre Kornprobst, Springer-Verlag 2002.