

**FALL 2001**  
**MATH 285J SEMINAR Applied Mathematics**  
**Variational Methods & PDE's for Image Analysis and**  
**Curve Evolution**

**Instructor:** Luminita A. VESE

**Office:** MS 7354

**Office hours:** MWF 2-3pm or by appointment.

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**Lecture Time and Location:** MWF 1.00-1.50PM, in MS 5217.

**Class Web Page:** <http://www.math.ucla.edu/~lvese/285j.1.01f>

**Enrollment Restriction:** Graduate Students

**Units:** 4.0

**Course Description:**

The first part of the lecture will be devoted to *restoration* of images. We will present the Rudin-Osher-Fatemi model (they were the first to propose the minimization of the total variation); we may also discuss other related and more recent methods, by Chambolle-Lions, Aubert-Vese, Dibos-Koepfler, Chan-Wong. We will present the mathematical framework to solve these problems (the space of functions of bounded variation  $BV$ ), as well as numerical discretizations. Then, we will describe other PDE models of anisotropic diffusion (Perona-Malik, Alvarez-Guichard-Lions-Morel).

The second part of the lecture will be devoted to *segmentation*. We will discuss the Mumford-Shah model and related minimizations of functionals depending on jumps and elliptic approximations (Dal Maso-Morel-Solimini, Chambolle, Ambrosio-Tortorelli), and the mathematical framework for these problems, in the space  $SBV$  of special functions of bounded variation, together with numerical techniques.

The last part of the lecture will be devoted to *curve evolution* problems for image processing: geometric PDE's (e.g. motion by mean curvature), snakes, active contours, presented in the level set framework of Osher-Sethian and the theory of viscosity solutions.

**Note:** Problems, exercises and short numerical projects will be assigned from time to time. Papers can be read by the students and presented in class.

**Plan & References:** See the Class Web Page

**Software:**

**MegaWave** is a free software intended for image processing. It has been created by Jean-Michel Morel and his group (CMLA at E.N.S. Cachan, and CEREMADE, University of Paris IX-Dauphine, France).

MegaWave Web Page: <http://www.cmla.ens-cachan.fr/Cmla/Megawave/index.html>

MegaWave is installed in the Mathematics Department at UCLA! (thanks to François Malgouyres).

**Matlab:** images/images (Image Processing Toolbox), images/imdemos (demos and sample images).