Math 285J / Sec 1

Algebraic Methods in Combinatorics

Time and Place:

Monday, Friday 3:00-4.50 P.M., MS 5127. First class - ~~April 2~~ MARCH 31

Instructor:

Benny Sudakov, MS 6921, bsudakov@math.ucla.edu

Course description:

Combinatorics is a fundamental mathematical discipline as well as an essential component of many mathematical areas, and its study has experienced an impressive growth in recent years. While in the past many of the basic combinatorial results were obtained mainly by ingenuity and detailed reasoning, the modern theory has grown out of this early stage and often relies on deep, well-developed tools.

One of the main general techniques that played a crucial role in the development of Combinatorics was the application of algebraic methods. The most fruitful such tool is the dimension argument. Roughly speaking, the method can be described as follows. In order to bound the cardinality of of a discrete structure A one maps its elements to vectors in a linear space, and shows that the set A is mapped to linearly independent vectors. It then follows that the cardinality of A is bounded by the dimension of the corresponding linear space. This simple idea is surprisingly powerful and has many famous applications.

This course provides a gentle introduction to Algebraic methods, illustrated by examples and focusing on basic ideas and connections to other areas. The topics covered in the class will include (but are not limited to):

Basic dimension arguments, Spaces of polynomials and tensor product methods, Eigenvalues of graphs and their application, the Combinatorial Nullstellensatz and the Chevalley-Warning theorem. Applications such as: counterexample to Borsuk's conjecture, chromatic number of the unit distance graph of Euclidean space, explicit constructions of Ramsey graphs, ~~and many others~~. KAKEYA PROBLEM IN FINITE FIELDS AND MANY OTHERS

Math 285J, Section 2, Spring 2008
Seminar Applied Mathematics: Mathematical Models in Image Analysis
Lecture Meeting Time: MWF 3.00PM - 3.50PM, MS 5138.

Instructor: Luminita A. Vese

Course Description:
This seminar is devoted to mathematical models arising in image analysis.
- Theory topics: calculus of variations, energy minimization, duality theory, Euler-Lagrange equations, optimality conditions, functions of bounded variation, functionals with linear growth and with jumps, geometric non-linear partial differential, viscosity solutions, oscillatory functions, Sobolev gradients.
- Applications: image restoration (denoising, deblurring), image decomposition into cartoon and texture, image segmentation and edge detection, snakes, curve evolution, active contours, level set methods.

The lectures will not follow one particular textbook. The topics presented can be found in research papers or graduate textbooks.

Textbook References:
- G. Aubert and P. Kornprobst, Mathematical Problems in Image Processing, (Partial Differential Equations and the Calculus of Variations), Springer, 2002 or 2006.
- Y. Meyer, Oscillating Patterns in Image Processing and Nonlinear Evolution Equations, AMS 2001.
- J.-M. Morel and S. Solimini, Variational Methods in Image Segmentation: With Seven Image Processing Experiments (Progress in Nonlinear Differential Equations and Their Applications), Birkhauser 1994.
- S. Osher and R. Fedkiw, Level Set Methods and Dynamic Implicit Surfaces, Springer-Verlag, 2002.
- J. Sethian, Level Set Methods and Fast Marching Methods : Evolving Interfaces in Computational Geometry, Fluid Mechanics, Computer Vision, and Materials Science, Cambridge University Press, 1999.
- S. Osher and N. Paragios (Eds), Geometric Level Set Methods in Imaging, Vision, and Graphics, Springer-Verlag Telos, 2003.
- R. Kimmel, Numerical Geometry of Images: Theory, Algorithms, and Applications, Springer-Verlag, 2003.
- L. Ambrosio, N. Fusco, D. Pallara, Functions of Bounded Variation and Free Discontinuity Problems (Oxford Mathematical Monographs), Oxford University Press, 2000.
- F. Andreu-Vaillo, V. Caselles, J.M. Mazon, Parabolic Quasilinear Equations Minimizing Linear Growth Functionals, Birkhauser, 2004.
- Book manuscripts by J.-M. Morel and collaborators:
http://www.cmla.ens-cachan.fr/Membres/morel.html
- T.F. Chan and J. Shen, Image processing and analysis, SIAM 2005
- R. Malladi (Ed.), Geometric Methods in Bio-Medical Image Processing, Springer 2002.
- G. Sapiro, Geometric Partial Differential Equations and Image Processing, Cambridge University Press, January 2001.