

Syllabus for Math 410: Applied Combinatorics

We focus on **algebraic graph theory**. The goal is for students to develop a working knowledge of the analytic-algebraic tools used in graph models. E.g., how do eigenvalues of the adjacency matrix give information on graph parameters?

This knowledge will be grounded in three diverse solution methods of applied mathematics:

- 1. The Analytic Hierarchy Process (AHP)**
- 2. PageRank (PgRk)**
- 3. Kernel Networks**

The technical issues addressed are:

- (i) accuracy and feasibility of computation
- (ii) using graphs to model complex situations
- (iii) visual/conceptual representations of graphs
- (iv) Mathematica (8.04) as development platform.

Theoretical disciplines involved include linear algebra and matrices, graphs and digraphs, and eigenvalues and eigenvectors. As time permits, we will also study combinatorially-defined polynomials, formal power series, q -series, and number theory.

After a one-week review of basics, we will take around 7 weeks to cover most of pp. 7–113 of Bigg's **Algebraic Graph Theory, Cambridge Mathematical Library, 2nd edition, 1993**. During the same approximately 8 weeks, students will (in groups) carry out experiments/examples of AHP and PgRk, and report to the class.

In the remaining 4 to 5 weeks, neural networks consisting of kernel-function units will be considered (Kernel Networks), including integral formulas which facilitate the analysis and link it with results from mathematical physics. Rates of convergence for finite sums which approximate the integrals turn out to be related to the eigenvalues of related operators.

To compare and possibly to combine this third method with the two preceding, students will create graph models of the U.S. health care system - or portions of it. And they will report to the class on their conclusions.

The course will have a *cumulative final exam*. **Grade for the course** is based equally upon the best n out of 4 of the three in-class projects and the final exam. The value of n depends on attendance; students who are there for almost every class will have $n = 3$, while those who attend rarely will have $n = 4$.

The text is **Algebraic Graph Theory**, see above. We will also read portions of a text by F. Chung and several papers, available on-line. References to the AHP and PgRk will also be given, but an interested student is encouraged to look them up on Google. (By the way, PgRk is related to the tools by which Google prioritizes information desired by a searcher!)

Paul Kainen, November 28, 2011
St. Mary's 315-D, 687-2703, kainen@georgetown.edu