# Math 8843 - Convergence of Markov Chains

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| **Instructor** | : | Ravi Montenegro |
| **Office** | : | Skiles 258 |
| **Office Hours** | : | Mon, Wed 1-2:30pm (subject to change) |
| **Office Phone** | : | 404-894-1833 |
| **Web Page** | : | Syllabus, notes, homework and other materials will be posted at *http://www.math.gatech.edu/~monteneg/8843/* |
| **Prerequisites** | : | Linear Algebra and some probability. Other material taught when needed. |

**Textbook** : No textbook. Material will be drawn from course notes of other instructors, notes of my own, and perhaps the occasional research paper. See links on the web page. Jerrum's book (available online) is a good source for the fundamentals, but will only be useful on occasion. Aldous & Fill's online book is too abstract, but covers more of what we will do in this course.

## Grading

There will be 3-4 homework assignments. The difficulty should be moderate and is primarily intended to make sure that everyone learns the material. Also, each student will be required to scribe (type up notes) for one lecture, when I teach material not available elsewhere. Finally, each student will be expected to give a 30 minute presentation, with an accompanying 3-4 page write-up, in the final few weeks of the course, on a topic of the student's choice.

## Description

Markov chains (or random walks) are widely used for sampling, with applications including calculations in Bayesian statistics, approximate counting in computer science, and expectations in statistical physics. In this course we will study the most important parameter in these applications, the rate at which Markov chains converge to stationarity, also known as the mixing time.

The primary focus will be on the mathematics used to study mixing. As such we will not spend too much time on clever uses of "elementary" methods, but rather will spend our time developing a deeper theoretical background. However, I highly recommend that students at some point take the time to read about some of these "clever uses of elementary methods", for instance via some of the notes on Dana Randall's page:

`http://www.math.gatech.edu/~randall/mccourse.html`

## Syllabus

The following is a rough approximation at what will be covered.

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| Aug 16-Aug 20 | : | Introduction to Markov chains<br>(definitions and simple examples such as coupon collector, coupling, etc.) |
| August 23-Sep 8 | : | Analytic methods for studying mixing<br>(spectral methods, logarithmic Sobolev inequalities, Nash inequalities) |
| Sep 10-Sep 17 | : | Geometric methods<br>(evolving sets, average and blocking conductance) |
| Sep 20-Oct 1 | : | Volume and integration of log-concave functions<br>(localization lemma, hit-and-run, ball walk) |
| Oct 4-Oct 15 | : | Walks on groups, Cayley graphs and other highly symmetric objects<br>(various methods of Diaconis, Pak, etc.) |
| Oct 20-Nov 3 | : | Dealing with subsets of permutations<br>(contingency tables, knapsack, transportation polytopes, voting indices) |
| Nov 5-Nov 22 | : | To be determined |
| Nov 24-Dec 3 | : | Student presentations |