**New York University Tandon School of Engineering**

Finance and Risk Engineering Department FRE 9743

Course Outline Markov Processes in Finance

**Fall 2018**

**Professor Kevin Atteson**

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Office hours: by appointment

Course Pre-requisites

* Linear Algebra
* Probability Theory

Course Description

This course will motivate a solid foundation in the theory of Markov processes with numerous applications in finance. Applications will be taken from: mortgage modeling, credit modeling, dynamic programming, Monte Carlo Markov chain and Hidden Markov Models. Theory will be taken from: stationary distributions, absorption probabilities, convergence, etc. We will focus heavily on finite Markov chains but also discuss various divergences from this type of model.

Course Objectives

1. Gain a solid understanding of the theory of Markov processes

2. Learn how to apply Markov processes in a variety of areas of finance

3. Learn how to perform statistical analysis for various kinds of Markov processes

4. Learn how programming is done in a professional setting

Course Structure

The course will consist of a series of lectures in theory, applications and programming

Readings

Required: the required readings for the course are the lecture notes which are [here](http://www.atteson.com/Markov). Note that these notes are still fluid and changing. The order of lectures on the website is more likely to keep up with the course than this document. The speed at which we cover material in the course may vary from a priori assumptions. It is recommended that you read the lecture notes after the corresponding lecture and not before.

Optional: there are references at the end of each page of lecture notes. I’ve tried to point out specific chapters of books where possible. Most of these should be available electronically or physically from the library. If you have difficulty obtaining any of the material, please contact me. All of this material is optional.

The required text for the course is: [Full citation for book(s)]

An optional and recommended text is: [Full citation for book(s)]

Course requirements

Theory Homework, available 9/12/18, due 9/26/18, 15% of final grade

Programming Homework, available 10/3/18, due 10/17/18, 25% of final grade

Exam, due 10/24/18, 25% of final grade

Project proposal, due 11/7/18, no grade

Project, due 12/12/18, 35% of grade

**9/5/18 Mortgage models of default and absorption probabilities**

**9/12/18 Classification of states, stationary distribution and convergence**

Theory homework assignment distributed

**9/19/18 Fitting Markov chains**

**9/26/18 Markov chains in credit modeling**

Theory homework assignment due

**10/3/18 Coding practicum**

Go over homework

**10/10/18 Algorithms and dynamic programming**

**10/17/18 Hidden Markov models, expectation maximization and regime-switching models**

**10/24/18 Exam**

**10/31/18 Optimal trading strategies**

Go over homework

**11/7/18 Bayesian Analysis and Markov chain Monte Carlo**

Go over exams

Discuss projects

**11/14/18 Coding practicum**

Project proposal due

**11/21/18 THANKSGIVING; NO CLASS**

**11/28/18 Hamiltonian Monte Carlo and convergence and diagnostics in MCMC**

Return project proposals

**12/5/18 Continuous Markov processes**

**12/12/18 Markov chain miscellanea**

**12/13/18** Projects due

**Moses Center Statement of Disability**

If you are student with a disability who is requesting accommodations, please contact New York University’s Moses Center for Students with Disabilities (CSD) at [212-998-4980](tel:212-998-4980) or [mosescsd@nyu.edu](mailto:mosescsd@nyu.edu).  You must be registered with CSD to receive accommodations.  Information about the Moses Center can be found at [www.nyu.edu/csd](http://www.nyu.edu/csd). The Moses Center is located at 726 Broadway on the 3rd floor.

**NYU School of Engineering Policies and Procedures on Academic Misconduct**

* + 1. Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School’s rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School’s Policy on Academic Misconduct.
    2. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:
       - 1. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person’s work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
         2. Fabrication: including but not limited to, falsifying experimental data and/or citations.
         3. Plagiarism: intentionally or knowingly representing the words or ideas of another as one’s own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
         4. Unauthorized collaboration: working together on work that was meant to be done individually.
         5. Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.
         6. Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.