Stochastic Processes Project

Math 365 Prof. Leise

Goal: To delve deeply into a topic of interest by finding and studying an article or part of a book on that topic and then writing a report, which should include some mathematical analysis and/or computations.

This project is 15% of your course grade, and, more importantly, is your opportunity to learn about something of interest to you that involves stochastic processes. Feel free to propose a topic that is completely different from anything we have discussed, but also feel free to choose a project that delves deeply into a topic that we did discuss.

Topic suggestions (you are not limited to these; an internet search will yield many topics):

- Queues (deeper analysis of M/M/1 or M/M/k queues, or look at other types like M/G/1 or G/G/1 queues), applications to telecommunications
- Optimal stopping with cost and discounting
- Ergodic theory (with connections to dynamical systems and statistical physics)
- "Chinese restaurant process"
- Ornstein-Uhlenbeck processes
- Lévy processes (continuous-time analog of random walk)
- Stochastic calculus (Ito calculus or Malliavin calculus)
- Feynman-Kac formula relating PDEs and stochastic processes
- Markov chain Monte Carlo algorithms (Gibbs sampler or Metropolis-Hastings algorithm)
- Gillespie algorithm for simulating stochastic equations of molecular reactions
- Other applications, including economics, finance, physics, biology, social sciences

Feel free to talk to me at any point about finding sources and what material should be included in the final report.

Timeline:

- Choose a topic by **4pm Monday April 14** and email me a proposal of what you want to do (a few sentences describing your proposed project).
- Submit outline of project and sources (by email is fine) by **4pm Monday April 21**.
- In-class 10-minute presentations start on **Monday April 29**.
- Final report due **4pm Wednesday May 7**. Emailing me your file is fine.

Report guidelines: The report should be roughly 5-7 pages double-spaced, using Word, LaTeX, R Markdown, Mathematica, or some other appropriate format. The report should include significant mathematics (theoretical or computational), but may also include less technical explanations and relevant historical or scientific background (why the method was developed, who developed it, how it's currently used, etc).

Sources: You should use at least two sources of information, which may include your textbook, other books, and scholarly articles. You may not use a website as a source of information (since websites often contain incorrect information), but searching the web may

be helpful initially as an idea-generator of interesting topics and for basic information. Searching JSTOR and MathSciNet may also be helpful, in addition to a general 5 College library search (start looking for books and articles early in case you need to ask for an interlibrary loan or order an article to be delivered).

Your report should list **all sources** used in to writing your report. You may use any standard style to cite them, for example:

Baker, G.L., and Gollub, J.P. *Chaotic Dynamics: An Introduction*, Cambridge University Press, Cambridge, 1990.

Li, T.-y., and Yorke, J., "Period Three Implies Chaos." *American Mathematical Monthly* **82** (1975), 985-992.

There are two purposes in citing your sources: first, to give credit to those who did the work and published it, and second, to enable readers to find these article or books if they want to read further about that topic.

When you refer to a source of information in the text of your report, cite that source using a standard style, as in the following examples:

One author: How fireflies oscillate in synchrony can be explained using a relatively simple nonlinear system (Strogatz, 1994).

Two authors: Tyson and Novak (2001) discovered a bifurcation that explains the cell cycle.

More than two authors: Tyson et al. (2004) found that something interesting occurred.

If you copy a figure, cite the source in the caption.