36-785: State Space and Hidden Markov Models

Instructor: Jing Lei
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Office hours: Wednesdays 2:30-3:30
Class time: Mon-Wed-Fri 1:30-2:20
Location: WEH 5312
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TA Office Hours: Friday 11-12 in the statistics tutoring room in FMS

Website: http://www.stat.cmu.edu/~jinglei/Spring12.html
Please check frequently for updates and announcements!

Course description:
This course will introduce main concepts and tools for modeling and inference in hidden Markov models. We will start from basic definition and properties of Markov chains and hidden Markov models. We will cover topics from classical discrete state space models including forward-backward recursion and Viterbi algorithm, to continuous state space models (Kalman filters, particle filter, forgetting and convergence properties). We will also talk about parameter estimation and applications.

Background:
I assume you have taken upper division or first year graduate probability and statistics classes.

Textbook:
Cappé, O. and Moulines, E., and Rydén, T. *Inference in Hidden Markov Models*, Springer, 2005.

Other texts (more links can be found on the course website):
Shumway, R. and Stoffer, D., *Time Series Analysis and Its Applications*, 3rd Ed., Springer, 2011.
Künsch, H. *State space and hidden Markov models*, Chapter 3 of *Complex Stochastic Systems*, O. E. Barndorff-Nielsen, D. R. Cox and C. Klüppelberg, eds., CRC Press, (2001), 109--173.

Grading
25%: Homework 1 (Due Feb 6, in class)
25%: Homework 2 (Due Feb 20, in class)
25%: Homework 3 (Due March 5, in class)
25%: class participation.
There will be no exams.

Homework policy
Homeworks are due bi-weekly on Wednesday at the beginning of class. If you cannot come to the class, please email me an electronic version (photocopy or pdf) of your homework before class starts. If the homework involves coding and programming, please also attach your code. **Late homework will not receive full credit**. **Please do NOT wait until the last minute to start working on it.**

Lecture notes
Lecture notes will be posted on the course website either before or soon after the class. Please check frequently on the website.

Schedule (tentative):

Week	Content
Jan 16	Background. Basic concepts of Markov chains and HMM.
Jan 23	HMM in discrete state spaces. Forward-backward algorithm, Viterbi algorithm.
Jan 30	HMM in continuous state spaces. I: Gaussian models and Kalman filters.
Feb 6	HMM in continuous state spaces. II: particle filters and sequential Monte Carlo methods.
Feb 13	Convergence of particle filters.
Feb 20	Parameter estimation and model selection in HMM.
Feb 27 and Mar 5	Review and applications