UNIVERSITY of HOUSTON | ECE

ECE 6397 Selected Topics: State-Space Estimation with Physiological Applications

Course description: 3 credit hours. (3-0). Prerequisites: Probability theory, Signal processing, and MATLAB. State-space modeling, state-space estimation, Kalman filtering, theory of point processes, estimation of point processes, maximum likelihood, expectation maximization, point process filtering and smoothing, and sparse signal processing.

Course topics: This advanced-topic course will present signal processing and statistical methods used to study neural systems and analyze pulsatile physiological signals. Core topics include state-space models, theory of point processes, estimation methods, and inverse problems. Emphasis on developing a firm conceptual understanding of advanced signal processing and statistical methods primarily through analyses of actual experimental data in form of a course project. Applications of these theoretical techniques include dynamic analyses of neural encoding, neural spike train decoding, and pulsatile physiological data analysis.

Learning objectives and expected course outcomes: Students who successfully complete this course are expected to develop the following skills:
(1) State-space Modeling and Estimation,
(2) Point Process Modeling and Estimation of Static Point Processes,
(3) Point Process Filtering and Smoothing,
(4) Sparse Signal Processing.

Textbook: The course will be based on the material covered in the lectures.

Recommended Textbooks: The following books are also valuable resources:
Kass RE, Eden UT, Brown EN. Analysis of neural data. New York: Springer; 2014 Jul 8.
Chen Z, Sarma SV, editors. Dynamic neuroscience: statistics, modeling, and control. Springer; 2017 Dec 27.
Schiff SJ. Neural control engineering: the emerging intersection between control theory and neuroscience. MIT Press; 2012.

Tentative Topics (This is subject to change; how we adhere to this depends in part on the pace that we feel is reasonable for the class.)

State-Space Modeling and Estimation: Deterministic and stochastic state-space models; Kalman filtering; non-causal beliefs; Kalman Smoothing.
Point Processes: Theory of point processes; conditional intensity functions; generalized linear models; point process likelihoods; maximum likelihood; model selection; multivariate point processes.

Point Process Filtering and Smoothing: Expectation maximization; point process filtering; point process smoothing; neural decoding; applications in analyzing heartbeat, behavioral data, and brain machine interfaces.
Sparse Signal Processing: Introduction to sparse signal processing; applications in analyzing hormone data and electrodermal activity.

Disclaimer
Information contained in this document is subject to change without notice. Students are expected to read the course syllabus handed out on the first day of classes and to be aware of any additional course policies presented by the instructor during the course.