Multivariate Biomedical Signal Processing

BME 6522

Class Periods: Tuesday Period 4 (10:40 am to 11:30 am) and Thursday Period 4-5 (10:40 am to 12:35 pm)

Location: Online

Academic Term: Fall 2020

Instructor

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Office Hours: Tuesday and Thursday 9:30 am to 10:30 am

Teaching Assistants

N/A

Course Description

This 3-credit course deals with statistical analysis of biomedical signals from a multivariate time series analysis perspective. Starting from the theory of stochastic processes we introduce concepts and methods both in the time domain and in the spectral domain. Whenever possible actual recordings from biomedical applications will be used to demonstrate the methods.

Course Pre-Requisites / Co-Requisites

Multivariate calculus and basic knowledge of probability and statistics.

Course Objectives

This course will acquaint the student with all the major methods for analyzing multivariate biomedical signals from a time series analysis perspective. Upon completion the student will be able to (1) understand the concepts in multivariate time series analysis and (2) analyze multivariate biomedical signals independently.

Materials and Supply Fees

None.

Required Textbooks and Software

No textbooks. Course notes and handouts will be distributed. Matlab programming is required.

Recommended Reading

The Analysis of Time Series: An Introduction by Chatfield; *Spectral Analysis and Its Applications* by Jenkins and Watts

Course Schedule

1. Gaussian Random Variables (7-8 lectures)
- i. Concept of random variables
- ii. Review of univariate Gaussian distributions
- iii. Multivariate Gaussian distributions
- iv. Assessing the relations among random variables: correlation, multiple correlation and partial correlation

2. Multivariate Time Series: Time Domain Approach (6-7 lectures)
- i. Concept of stochastic processes
- ii. Stationarity and ergodicity
- iii. Time series models: (a) AR Models and (b) ARMA Models
- iv. Estimating time series models from data
- v. Assessing the relations among time series

3. Multivariate Time Series: Spectral Domain Approach (7-8 lectures)

i. Spectral representation of stationary time series
ii. Assessing the relations among time series in the spectral domain: coherence, multiple coherence and partial coherence
iii. Estimating spectra: data based estimation versus model based estimation
iv. Examples

4. Evaluating Causal Relations Among Multiple Time Series (6-7 lectures)

i. Wiener-Granger causality
ii. Geweke's spectral decomposition
iii. Statistical assessment of significance
iv. Examples from neurophysiology

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

F2F Course Policy in Response to COVID-19

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.
- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
- If you are experiencing COVID-19 symptoms (Click here for guidance from the CDC on symptoms of coronavirus), please use the UF Health screening system and follow the instructions on whether you are able to attend class. Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms.
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is strongly encouraged. Students are expected to take careful class notes.

Evaluation of Grades

70% homework, 30% term project.

Grading Policy

Curved grading will be applied.

Students Requiring Accommodations
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation
Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.