

EEL 5934 - Biomedical Signal Processing

Dr. Jianbo Gao

Fall 2008

Goal: Biological systems, including heart and brain, are complex interconnected systems, exhibiting both highly nonlinear deterministic as well as stochastic characteristics and being regulated hierarchically. They generate signals with complex characteristics such as nonlinearity, sensitive dependence on small disturbances, long memory, extreme variations, and nonstationarity. This course aims to cover fundamental non machine learning–based approaches for biomedical signal processing. After the course, students are expected to readily understand cutting-edge research papers and skillfully analyze real biomedical signals.

Topics:

- The nature of biomedical signals
- Biomedical signal processing by Fourier analysis
- Biomedical signal processing by wavelet multiresolution analysis
- Biomedical signal processing by random fractal theory
 - (1) Long-range correlation and the Hurst parameter
 - (2) Structure-function–based multifractal formulation
 - (3) Cascade multifractal formulation
- Biomedical signal processing by chaos theory
 - (1) Feature identification using Lyapunov exponent
 - (2) Feature identification using fractal dimension
 - (3) Feature identification using entropy formalism (including Kolmogorov entropy, approximate entropy, sample entropy, permutation entropy, Lempel-Ziv complexity)
- Introduction to multiscale analysis of complex data
 - (1) Multiscale entropy analysis
 - (2) Scale-dependent Lyapunov exponent

Computer requirement: Some problems will require MATLAB or equivalent. Students may want to purchase student versions of these programs, as departmental computer resources are limited. Not being able to get on a computer is not a valid excuse for late work.

Meeting Time: Period 4, Tuesday; Period 4-5, Thursday

Meeting Room: CHE 237

E-mail: gao@ece.ufl.edu

Class Web page: <http://www.gao.ece.ufl.edu/eel5934/>

Personal Web page: <http://www.gao.ece.ufl.edu>

Office: 427 New Engineering Building

Phone: (352) 392-0918

Office hours: Before or after class, and by appointments

Textbooks:

- J.B. Gao, Y.H. Cao, W.W. Tung, and J. Hu, *Multiscale Analysis of Complex Time Series – Integration of Chaos and Random Fractal Theory, and Beyond*, Wiley, Interscience (available August 24, 2007) (required).
- R.M. Rangayyan, *Biomedical signal analysis*, IEEE Press, 2002 (recommended).

Grading:

Homework – 30%

Midterm exam 30%

Course project, term paper 40% (real data will be provided)

In relation to the purpose of the course, students are reminded and strongly encouraged to pay special attention to the course project and the term paper — this is a great opportunity to learn how to do research effectively and publish in top journals.

Attendance: Attendance, although not mandatory, is strongly encouraged, as it is more effectively to learn in class than to read by yourself. Furthermore, the instructor reserves the right to give unannounced “pop” quizzes with no make-up option. Students who miss such quizzes will receive zeros for that grade. If an exam must be missed, the student must see the instructor and make arrangements in advance unless an emergency makes this impossible.

Approval for make-up exams is much more likely if the student is willing to take the exam early.

Calculators: Students may bring a calculator to class and to the exams. Cellular phones, PDAs, etc. will NOT be allowed.

Academic Honesty: All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action.

The Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.

Pledge: On all work submitted for credit by students of 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." This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others. Honor statements on tests must be signed in order to receive any credit for that test. Collaboration on homework is permitted unless explicitly prohibited, provided that:

1. Collaboration is restricted to students currently in this course.
2. Collaboration must be a shared effort. I.e., it is not permissible to copy someone else's work.
3. Each student must write up his/her homework independently.
4. On problems involving MATLAB programs, each student should write their own program. Students may discuss the implementations of the program, but students should not work as a group in writing the programs.

I have a zero-tolerance policy for cheating in this class. If you talk to anyone other than me during an exam, I will give you a zero. If you plagiarize (copy someone else's words or someone else's work), I will give you a failing grade for the class. Furthermore, I will be forced to bring academic dishonesty charges against anyone who violates the Honor Code.

ADA Statement: The University of Florida provides high-quality services to students with disabilities, and we encourage you to take advantage of them. Students with disabilities needing academic accommodations should 1) Register with and provide documentation to Disability Resources (392-1261), and 2) Bring a letter to the instructor from this office indicating that you need academic accommodations. Please do this as soon as possible, preferably within the first week of class.