Biomedical Data Analysis

BIOE 198 MI 2 credit hours/4 contact hours per week Spring Semester 2019

This computational laboratory provides hands-on experience with formatting, analyzing, and visualizing biomedical data. Based in Matlab, students learn basic matrix algebra to be able to read, simulate, visualize, and analyze data in one and two dimensions. Statistical methods are introduced for managing stochastic data. Lecturing is minimized to emphasize hands on problem solving. The objective is to gain experience solving fundamental engineering problems that focus on physical and medical applications. The course is designed for first year undergraduate students as a preview to upper-level BIOE courses.

Students will apply the following skills to a broad range of biomedical data:

1. Translating equations and visualizing data including plot and image rendering
2. Data simulation and file structures
3. Numerical methods for problem solving in physical, chemical, and statistical problems
4. Data formatting types, conversions, with examples in signal and image processing
5. Elementary matrix algebra and array manipulation
6. Basics of probability and statistics for managing data uncertainty and model fitting
7. Matlab syntax, user defined functions, and algorithm structure
8. Dynamic programming methods

Classes: Monday and Wednesday, 3:00-4:50 PM, 2101 Everitt Lab (Office hours: 5-6p M or W)
Credit: 2 credit hours with 4 contact hours each week.
Prerequisites: None
Course Website: http://ultrasonics.bioengineering.illinois.edu/courses.asp
https://compass2g.illinois.edu/
(We will only use Compass for assignment submission & grade reporting.)

Instructor: Prof. Michael Insana, mfi@illinois.edu

Teaching Assistants:
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Textbook: Students are required to purchase Matlab from MathWorks for $99 at https://www.mathworks.com/store/link/products/student/SV?s_tid=ac_buy_sv_but1_2 . On the website, the item is MATLAB and Simulink Student Suite:
Includes MATLAB Student, Simulink, Control System Toolbox, Curve Fitting Toolbox, DSP System Toolbox, Image Processing Toolbox, Instrument Control Toolbox, Optimization Toolbox, Parallel Computing Toolbox, Signal Processing Toolbox, Statistics and Machine Learning Toolbox, Symbolic Math Toolbox

This software will cover all of your coursework needs during your entire time at UIUC. If you choose to update the software or add additional toolboxes, there will be additional annual costs.

The software is the required textbook. Some of the following suggested reference texts are available at no cost for download at the Grainger Engineering Library. To access these books, go to the library webpage at https://www.library.illinois.edu/enx/ and type Matlab into the Engineering Easy Search. Under e-books, you will find a listing of more than 400 books. A good place to start is the Matlab Primer that you can find at https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf although you may need to request a Matlab account to obtain a login. The Primer is also on the course website.

All lab work must be prepared using Matlab. Code and figures prepared using Excel, Python, and other computing software will not be accepted.

Preliminary Schedule for Spring Semester 2019

Date	Class Meeting	Biomedical Data Analysis Schedule
Jan 14	**1**	Ia. Introduction to Matlab (MI)
Jan 16	**2**	|
Jan 21	**--**	MLK Holiday
Jan 23	**3**	Ib. Introduction to Matlab (MI)
Jan 28	**4**	|
Jan 30	**5**	|
Feb 4	**6**	II. Signal analysis A (YZ) Lab I due
Feb 6	**7**	|
Feb 11	**8**	|
Feb 13	**9**	III. Modeling projectile motion (YW) Lab II due
Feb 18	**10**	|
Feb 20	**11**	|
Feb 25	**12**	IV. Introduction to probability and random data (MI) Lab III due
Feb 27	**13**	|
Mar 4	**14**	|
Mar 6	**15**	V. Introduction to statistics (Midterm Grades Due) (MI) Lab IV due
Mar 11	**16**	|
Mar 13	**17**	|
Mar 18	**--**	Spring break (March 16-24)
Mar 20	**--**	Spring break
Mar 25	**18**	VI. Data fitting and modeling (MI) Lab V due
Mar 27	**19**	|
Apr 1	**20**	|
Apr 3	**21**	VII. Signal analysis B: filter design (YZ) Lab VI due
Apr 8	**22**	|
Apr 10	**23**	|
Apr 15	**24**	VIII. Introduction to data types and conversion(YW) Lab VII due
Apr 17	**25**	|
Apr 22	**26**	IX. Dynamic programming (YZ) Lab VIII due
Apr 24	**27**	|
Apr 29	**28**	|
May 1	**29**	Last day of class Lab IX due

Grading

Attendance and class participation 20%
Lab reports 80% (80 / # lab report = pts for each)
A 90%; A- 89-87%; B+ 86-83%; B 82-80%; B- 79-77%; C+ 76-73%; C 72-70%; C- 69-67%; D 66-60% F <60%

Attendance and Class Participation

- Students are expected to attend all lab sessions since virtually all of the work will take place during class. Missed labs must be preapproved by the instructor and documentation might be required. Missed labs must be made up the same week since concepts are developed cumulatively.
- Students must bring a laptop with Matlab installed to each class meeting.
- Students are expected to respect and contribute to the classroom environment. Cell phones must be silenced during class time. There are in-class assignments that students will be expected to perform in groups. Volunteers will be asked to discuss class topics. *****

- Participation score is based on participation in group work, presentations of group solutions, and asking and responding to questions raised in class. If the three instructors don't know you by the last day of class, participation points will be minimal.

Lab Reports

- Each student prepares a report for each of the labs.
- Lab reports adhere to high standards of organization and appearance that will be described in class.
- Lab reports are due on the first day of the next assignment at the beginning of class (3pm). For example, reports for Lab I are due at 3pm February 4 when Lab II begins.
- Late reports will not be accepted. The grade for that lab will be zero points.

Lab Report Format

- Each report will be begin with the TITLE from the write up distributed to students.
- The author's NAME and the DATE must appear at the top of the page.
- There will be a brief introductory paragraph explaining the assignment titled INTRODUCTION.
- Any analytical or conceptual development related to the results presented are described in the METHODS section. This text must embed any figures. Use the equation editors where necessary.
- Only critical elements of final CODE may copied into the METHODS section directly from Matlab to explain the approach. Entire CODE will be submitted as a separate m-file when requested.
- RESULTS should contain graphs or images, as appropriate. Each figure must be captioned and labeled beginning with Figure 1. The caption explains the figure contents, for example, any model parameters that are key to the solution for the assignment. The captions must also help the reader understand the meaning of the data presented.
- All figures must be labeled and titled. The labels and plot lines/characters must be large enough to be clearly visible. Multiple plots on a single graph must be label in a legend.
- Each lab must have a CONCLUSIONS section. Here, the conclusions or answer to the assigned problem is stated and explained. This sections must not be a summary of the work.
- The last section labeled ACKNOWLEDGEMENTS should give credit to others in the group in which you worked, and any other resources used to prepare the report.
- We suggest you use MS-WORD for preparing reports. However, we require all reports be submitted as pdf files uploaded to Compass. You may also submit MATLAB code as .m files to supplement your report, but these files must serve **supplementary role**. This means that we will only refer to the code as it is referenced by line number or section number in the report. Try to ensure that any code placed in your final pdf-file report runs in Matlab, so be careful about how characters transfer.

Statement on Academic Integrity

The university's policy on Academic Integrity can be found in the *Code of Policies and Regulations Applying to All Students* under Article One, Part IV which can be found at: http://admin.illinois.edu/policy/code/article1_part4_1-401.html. The following policies support and reinforce that policy.

1. Science cannot exist without honesty. We expect all students, as scientists-in-the-making, to hold the highest standards of scientific and academic conduct. Any form of cheating on any graded work in this course is unacceptable, and will be dealt with as outlined below, and in accordance with the University-wide standards in the *Code of Policies and Regulations Applying to All Students.*

2. We require that all graded work be entirely your own, and that anything you write using the words of other writers be correctly attributed. Some specific points follow:

   On assignments and presentations, the answers that you report for grading must be written in your own words, formulated from your own understanding of the material. Even working within a group,

you must contribute to the group's effort and not just have one person do all the work. Since we cannot monitor you as you complete your work, we have only the appearance of your work from which to judge. If the work you submit resembles that of another student/team too closely, we may conclude that it was not your original work. Failure to adhere to these standards may result in a grade of *zero for the entire assignment*, *for all persons involved.*

On assignments, if you use another source to obtain the facts and/or opinions necessary to complete your assignment, you must credit the source (see next point below) and rephrase the information so that your assignment is entirely your own words. A good practice is to read the source until you have a thorough understanding of the material, and then put it away. Write your assignment as if you are explaining the information you learned from reading the source to a classmate, member of your family, or to your teaching assistant. You may wish to look at the source again for clarification, but be certain that you do not use statements taken directly from the text in your assignment. Your entire assignment should be in your own words. Furthermore, paraphrasing does NOT mean replacing key words in a statement with synonyms. For an example of proper paraphrasing of a statement, consult the University's Code of Policies and Regulations Applying to All Students.

Failure to adhere to these standards may result in zero credit for the entire assignment.

On assignments, if you use the ideas and/or opinions from another author or source, you must provide the appropriate citation. That is, you must, using APA format, place a parenthetical reference to the source that provided you the information necessary to complete that portion of the assignment.

Failure to adhere to these standards may result in zero credit for the entire assignment.

On assignments, if you use a statement taken directly from any book or other publication, including the course textbook, you must provide a citation. That is, you must put the text in quotes and, using APA format, place a parenthetical reference to the source at the end of the quote. Direct quotations should be severely limited in your assignments; they should be used ONLY in the following situations:

- A definition of a term.
- A profound statement made by an expert in the field

Furthermore, any direct quotation should then be restated in your own words in order that your instructor may evaluate your understanding of the material.

Failure to adhere to these standards may result in zero credit for the entire assignment.