

Sara Pollock
Department of Mathematics

College of Liberal Arts and
Sciences

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MAT 4930/6932 (S23) Syllabus

Special topics: Computational methods for ill-posed problems General Information

Instructor: Dr. Sara Pollock

email: s.pollock@ufl.edu,

office: LIT 444

spring 2023 office hours: posted on [home](#) page, or by appointment

(Scheduled) Class Time and Location

M W F Period 5 (11:45-12:35pm), Little Hall (LIT) 205

Required Text

Deblurring Images: Matrices, Spectra, and Filtering, A. Quarteroni, Per Christian Hansen, James G. Nagy, Dianne P. O'Leary. Published by SIAM, 2006.

Description and Goals

Description. (Credit hours: 3), We will use matrix analysis to develop techniques to recover lost information from blurry images based on models of common imaging problems. In the process we will learn about important tools in applied and computational mathematics, including structured matrix computations and the fast Fourier transform. Image recovery techniques will be focused on general tools such as the truncated singular value decomposition and Tikhonov regularization, both of which have broad applications to ill-posed problems throughout the mathematical sciences. Further topics relating to computational methods for ill-posed problems will be explored through student projects.

Topics.

Introduction to regularization for ill-posed problems

Ch. 1: The image deblurring problem

Ch. 2: Manipulating images in Matlab

Ch. 3: The blurring function

Ch. 4: Structured matrix computations

Ch. 5: SVD and spectral analysis

Ch. 6: Regularization by spectral filtering

Ch. 7: Color images, smoothing norms, and other topics

Goals. Introduce and motivate computational methods for ill-posed problems, and develop hands-on experience with implementation and basic theoretical properties of these methods.

Prerequisites. A previous class in linear algebra (MAS3114, MAS4105, MAS4115, MAD6406), plus some programming experience in Matlab

Grading Policy

Grades will be calculated according to the following percentages ('+' and '-' may be assigned at upper and lower 2-point ranges of each grade):

Homework	50%	90%-100%	A
Final project	25%	80-89%	B
Class participation	25%	70-79%	C
		60-69%	D
Total	100%	<60%	F

Class Participation. The class participation grade is broken down as follows.

10% General participation: *Missing class when you are not feeling well, or even think you may be contagious to others, will not affect your grade. You are encouraged to stay home if you are not well.* You will receive full credit for general participation if you: (1) Turn in your homework on time, on a regular basis. (2) Regularly attend class and maintain the appearance that you are paying attention. (4) Fill out a *lecture feedback response survey* for at least 10 different lectures over the course of the semester. At the end of the semester you will have the opportunity to tell me what your general participation grade should be, based on these criteria.

10% Journal presentation: Each student will present a journal article to the class in a 10-20 minute presentation. The article should be on a topic related to the class, such as: Image deblurring, image processing, regularization methods for ill-posed problems, inverse problems, etc. A collection of suggested articles will be made available to the class; or, you may select another (published) article or book chapter, subject to instructor approval. You may work with and do this presentation with a partner if you like.

5% Homework presentation: Each student will present a homework problem to the class. Each presentation should be 5-10 min.

Homework. Problem sets will be assigned. You are welcome to discuss problems with each other and/or with me, but the solutions you turn in must be your own. Any code turned in must be your own or modified from presented examples. You are discouraged from searching the internet for solutions. If you do refer to an outside source, you should cite that source. Wikipedia, blogs and tutorial websites are not valid sources.

Exams. There will be no exams.

Projects. Projects will explore topics of students choosing. Students may work alone or with a partner.

Class Policies

Attendance. Class attendance is encouraged, *subject to your best judgement.*

Computers. You will need to use one.

Cell phones. Please don't use your cell phone in a distracting way during class.

Excused absences. Make-up exam/quiz work is allowed only when written evidence of an official University excused absence is provided. Notification in writing (acknowledged email is acceptable) prior to the date of the absence, or as soon as possible thereafter, is required. If these conditions are met and the solutions are not yet posted, the student may take the quiz/exam. If the solutions are already posted, the student may take an alternate quiz/exam, although no guarantee can be made that the alternate quiz/exam is no more challenging than the original (basically, the make-up quiz/exam may be harder). Alternately, if the student chooses, the percentage grade earned on the final exam can be substituted for the missed quiz/midterm.

Academic Integrity

Honor Code. 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 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. You can find the honor code here: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/> If you have any questions or concerns, please consult with the instructor.

I take academic integrity very seriously. If a homework solution or take-home portion of an exam you turn in is not your own work as outlined above, you will receive a zero on that assignment. If multiple assignments are found not to be your own work, you will receive an F in the class.

SUGGESTION. Seek outside help on a problem only after thinking about it for at least 40 minutes.

Additional UF Policy Information

UF Policy on Grade Points. Grading will be in accord with the UF policy stated here: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Class Attendance. Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found here: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

Accommodations for Students with Disabilities. 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.

U Matter We Care. Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392- 1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Contact information for the Counseling and Wellness Center.

<https://counseling.ufl.edu/>, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Online Evaluations. Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>

Links to an external site. . Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/> **Links to an external site.** . Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>

Links to an external site..

Diversity, Equity and Inclusion Statement. The Mathematics Department is committed to diversity and inclusion of all students. We acknowledge, respect, and value the diverse nature, background and perspective of students and believe that it furthers academic achievements.

It is our intent to present materials and activities that are respectful of diversity: race, color, creed, gender, gender identity, sexual orientation, age, religious status, national origin, ethnicity, disability, socioeconomic status, and any other distinguishing qualities.

UF Policy on In-Class Recording: Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a

complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

THIS SYLLABUS IS SUBJECT TO CHANGE.