OPTI 556a: Computational Imaging

Fall 2024, Wyant College of Optical Sciences

Course Instructor: David J. Brady

Location: OPTI 305

Email: djbrady@arizona.edu (Please Note: Include "Course Prefix and Number" in the subject line of emails)

Course Description

Computational imaging consists of joint design of measurement strategy and estimation algorithms for image formation from radiation fields. This course reviews principles of forward models and inversion algorithms for computational imaging and analyzes imaging systems for geometric and wave field models. Forward models, consisting of discrete representations of continuous image and measurement spaces, are fundamental to computational imaging. The course reviews how to form and evaluate such models. Since convolutional neural networks are the most important tool in modern inverse models, their use and application in concert with linear and regularized regression is explored. Coded aperture and structured illumination systems are considered for X-ray imaging. Snapshot compressive measurement systems are introduced. Holographic imaging, phase retrieval, and decompressive tomography are discussed for wave fields. Optical system analysis with coherent fields is introduced.

Course Outcomes

Upon successful completion of this course, students should be able to:

1. develop mathematical models that accurately describe physical measurements using radiation fields
2. compare and optimize measurement strategies
3. computationally estimate images from measured data
4. describe and compare imaging systems based on geometric field analysis
5. model holographic and diffraction tomographic imaging systems
6. describe and compare imaging systems based on coherent analysis
7. model imaging systems in python and create written reports using Jupyter notebooks.

Course Materials

The course will use notes and code notebooks posted online. The course also relies on video lectures posted on YouTube and on D2L

Grading

Students will model systems using python in biweekly homework assignments. In the final third of the course, students will develop a detailed computational imaging system model and simulation for a course project. The 5 homework assignments will be weighted equally for grades, the overall course grade will be weighted with 75% due to homework and 25% assigned to the term project. Each assignment will receive a numerical score between 0 and 100.

Grading Scale

A weighted grade of >90% will be grade A, <90% and >80% graded B, <80% and >70% graded C, <70% and >60% graded D.

Late Work Policy

Students should turn work in on time. Late homework may be accepted with prior approval.

Policies

Absence and Class Participation Policy

Absences for any sincerely held religious belief, observance, or practice will be accommodated where reasonable: Religious Accommodation Policy.

Absences pre-approved by the UA Dean of Students (or dean's designee) will be honored.

Accessibility and Accommodations

It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center at their website: Disability

Resource Center. You can also call: 520-621-3268 or email: uadrc@email.arizona.edu to establish reasonable accommodations.

Confidentiality of Student Records

Copyright

Students are advised that all lecture notes, lectures, study guides and other course materials disseminated by the instructor to the students, whether in class or online, are original materials and reflect intellectual property of the instructor or author of those works. All readings, study guides, lecture notes and handouts are intended for individual use by students. Students may not distribute or reproduce these materials for commercial purposes without the express written consent of the instructor. Students who sell or distribute these materials for any use other than their own are in violation of the University of Arizona's Intellectual Property Policy. Violations of the instructor's copyright may result in course sanctions and violate the Code of Academic Integrity.

Subject to Change Statement

Information contained in the course syllabus, other than the grade policies, may be subject to change with reasonable notice, as deemed appropriate by the instructor. If any changes are made, they will be provided immediately in writing to students via posting to the D2L course website.

Threatening Behavior

The University seeks to promote a safe environment where students and employees may participate in the educational process without compromising their health, safety or welfare. The Arizona Board of Regents' Student Code of Conduct, ABOR Policy 5-308 prohibits threats of physical harm to any member of the University community, including to one's self. Threatening behavior can harm and disrupt the University, it's community and its families.

Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed (e.g., the collaborative learning experience is, by nature, not an independent assignment). Students are expected to adhere to the Code of Academic Integrity

Grade Appeals

If you would like to appeal a grade for an exam or assignment, you should do so within 7 days from the day the grade was returned to you. Any appeal that does not come within 7 days will not be considered. If you make an appeal, you should state either (a) why you believe your exam or assignment was incorrectly scored, or (b) why you believe your answer to a question or item is correct.

Incomplete Grade Policy

Incomplete grades will be given only in special circumstances as outlined in university policy as stated in The University of Arizona Academic Policies

Student Responsibility for Managing their Course Progress

Although I try to help guide you through the course, it is ultimately the responsibility of the student to direct their course progress, including following the course schedule, minding due dates, keeping up with required readings, and participating in all class components. All due dates are listed in the syllabus and on the course calendar. If you find that you are having trouble keeping up with course material, please feel free to sign up for Remind text message reminders (more information about how to sign up will be provided via email and posted to the News board at the beginning of the semester).

Class Courtesy

It is expected that students may disagree with the research presented or the opinions of their fellow classmates. To disagree is fine but to disparage other views is u