# SRA Track 10

**Diagnostic AI: Transforming healthcare using image processing and learning from biomedical images**

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Required text:
Relevant papers will be posted on canvas for each week's preparation during the course.
Course website:

Course meeting schedule:

- Lectures: MTWR 9:30 – 11:00 AM PDT
- Discussions/Labs: MTWR 12:00 – 3:00 PM PDT
- Development Workshops: TR 5:00 – 6:00 PM PDT
- GRIT Talks: MW 5:30 – 6:30 PM PDT

Course Description:
Physicians often utilize images for disease diagnosis, from microscopic images of blood samples to whole brain MRI scans. However, early and accurate diagnosis, quantification, and disease monitoring need more than just qualitative assessment. Artificial Intelligence (AI) in medical imaging makes this possible. In this interdisciplinary course, students will learn the mathematical tools and concepts of feature extractions, image registration, segmentation, and classification to analyze images ranging from molecular/cellular imaging to tissue/organ imaging. This course will introduce software tools, imaging modalities, and publicly available image data sources. Students will learn image processing, enhancement, visualization, and advanced deep-learning methods for biomedical applications. Through collaborative research, students will apply AI diagnostic tools to real-world problems such as brain tumor study, cell counting in cancer, and much more.

Related Disciplines:
Computer Vision, Biomedical Engineering, Computational Biology, Computer Science, Electrical Engineering

Students Learning Outcomes:
By participating in the course, you are expected to:

1. Gain an appreciation for the vast array of images and data collected in healthcare.
2. Visualize the intricate details of the images from CT, X-ray, microscopy, and MRI.
3. Apply image processing theories to biomedical images to extract diagnostic features.
4. Apply and evaluate deep learning models quantitatively and qualitatively.
5. Reflect on the usage and shortcomings of AI in real world applications.

Course Structure:
In this course, emphasis is placed on active engagement and participation of students through interactive activities such as think-pair-share discussions, interactive demonstrations, hands-on activities, and group discussions. The use of interactive tools and software for image processing and machine learning enables students to gain practical experience and apply AI techniques to real biomedical images. Throughout the course, ethical considerations and future challenges are explored, fostering critical thinking and informed decision-making.

| Grade breakdown | |
|---|---|
| Participation | 10% |
| Assignments | 25% |
| Final presentation | 25% |
| Final paper | 30% |
| Teamwork | 10% |
| Total | 100% |

**Important course policies**

1. Participation:
   Active participation in all lectures, discussions, and labs are essential components of this course. Throughout the sessions, the instructor or TA may assign in-class activities such as problem-solving, coding, or engaging in discussions with peers and instructors. It is crucial to actively participate in these activities to enhance understanding of the course materials. Please note that not all materials will be shared as PowerPoint presentations, as the lectures will also involve board-based explanations and discussions. These materials may not be available on the course platform, emphasizing the significance of attending class. Participation in the class activities will contribute to a portion of the final grade. We understand that unforeseen circumstances may arise, and accommodations will be considered on a case-by-case basis if communicated in advance. If unable to attend a class, it is important to inform the instructor beforehand.

2. Assignments:
   To improve learning quality and help you reach the goals of the course, a weekly reflection, survey, lab, and after or in-class assignments may be given by the instructor or TA with a specific due date. It is important that you finish your assignment by the posted due date. If you encounter challenges in completing the assignments, it is recommended to reach out to the instructor or TA for assistance before the due date, so appropriate accommodations can be made. The surveys and reflections are designed to aid in the development of course materials and your personal growth; although they won't be graded, they hold significant importance and should be completed weekly.

3. Final Presentation:
   A major objective of this course is the production and presentation of a university-level collaborative research project. The course lectures will provide comprehensive knowledge on image processing and computer vision techniques for biomedical image analysis, covering various research methods, software tools, and relevant topics. Labs will offer hands-on experience in applying specific methods, working with research materials, and coding using Python and PyTorch, all of which can be utilized in your project. Discussion sessions will focus on guiding you in developing essential research skills and monitoring the progress of your project. Your final paper will explore a topic pertaining to AI in the healthcare industry, which will be determined through discussions with your group members and TA during Week One.

4. Research Drafts:
   To assist you in developing your project and to give you the opportunity to receive regular feedback, draft versions of your final project will be due at regular intervals throughout the course. Most of these assignments will be drafts of specific sections for your final paper. We acknowledge that you may utilize online software and tools for your research in this course. It is essential to adhere to proper citation practices and acknowledge the resources you are utilizing. Please ensure that you provide appropriate citations and acknowledgements for all the resources and tools you employ throughout your work.

5. Team Work:
   Collaboration with your team members is an important facet of academic research and will be part of your assessment for the course. You are expected to communicate regularly with your group, contribute equitably to shared work, and approach research and collaboration issues in a respectful, constructive, and positive manner. Discussion sections will offer some guidance on distributing and synthesizing your work as a group, and instructors will be available in office hours throughout the course to advise you on teamwork issues. In addition to your TA’s observations, evaluation of your teamwork will come from group dynamic surveys, due at the end of each week, where you and your peers will reflect on each other’s contributions as collaborators and any challenges you

are facing.

6. Communicate:
   If you are facing any difficulty in the course including but not limited to problems with understanding the material, lack of background, difficulty in finishing your assignment, etc. please communicate with the instructor or TA and ask for help.

7. Student Wellbeing
   If you are dealing with outside circumstances that are affecting your ability to participate fully in class or complete readings and assignments, you are encouraged to talk to the instructor as soon as possible so we can work with you to get things on track or consult with your TA and other campus resources to provide you with the support you need. We try to maintain an open, confidential, and non judgemental space for communication wherever possible.

8. Class Conduct
   Students are expected to contribute to a respectful, courteous, and intellectually stimulating class environment. Language or behavior that prevents any student—especially those from marginalized, minority, or vulnerable populations—to participate fully in class is not acceptable. It is important to remain open to each other's thinking and engage in rigorous, challenging discussion about issues of shared concern. This is distinct from participating in oppressive behaviors—racism, sexism, homophobia, transphobia, ableism, and so on—that are designed to keep people out of conversations, not bring them in.

9. Technology
   Laptops and tablets are allowed during lectures for the purposes of readings, taking notes, doing quick searches relevant to discussion, or running the demo code presented during class. We expect phones to be set to silent and to be put away for the duration of lecture; you should not be texting, chatting, or emailing during class time. Your use of electronic devices should not impinge on you or your classmates' ability to focus during lecture.

10. Email
    Email should be used for getting responses to "yes" or "no" questions and for simple clarifications. Please allow 24 hours after sending a message to receive a response. Additionally, please only send emails concerning graded assignments 24 hours after an assignment has been returned to you, after reading all comments and the assignment in full. Communication about course work and course issues should be sent only by the student, not by parents or guardians; college-level courses expect your direct engagement and responsibility in navigating your educational experience.
    If you would like more extensive feedback on drafts of written work, please see me or your TA office hours. Be aware that if you email one of us on the day an assignment is due, it is unlikely that we will be able to respond fully. Do your best to read assignment

guidelines, consider topic ideas, and seek help early, when we will have adequate time to respond to your questions and you will be able to best incorporate any feedback.

To ensure prompt recognition and response to your email, please include "<Track 10>" in the subject line when contacting the instructor and TAs. Failing to include this information in the subject line may result in delays in receiving a reply.

**Important University Policies**

Academic dishonesty:
Honesty and integrity in all academic work are essential for a valuable educational experience. The Office of Judicial Affairs has policies, tips, and resources for proper citation use, recognizing actions considered to be cheating or other forms of academic theft, and students' responsibilities. This information is available on http://studentconduct.sa.ucsb.edu/academic-integrity.

Academic dishonesty will not be tolerated in any form in this class. Please note that the first incidence of dishonesty will result in a grade of 0 for the assignment; a second incidence will result in a direct meeting between the student and a UCSB Committee on Student Conduct. Instances of academic dishonesty include, but are not limited to:

- Copying solutions from other students during homework or during exams.
- Copying solutions from an outside source. Doing the questions yourself will assist in your understanding of the course material and will be crucial in your in-class tests.
- Including part of a paper in your research project without citation.

Collaboration policy
You are encouraged to work with other students on your assignments, and to help other students, provided that you comply with the following conditions:

- Honest representation: The material you turn in for course credit must be a fair representation of your work. You are responsible for understanding and being able to explain and duplicate the work you submit.
- Active involvement: You must ensure that you are an active participant in all collaborations, and are not merely dividing up the work or following along while another student does the work. For example, copying another student's work without actively being involved in deriving the solution is strictly prohibited.
- Give help appropriately: When helping someone, it is important not to simply give them a solution, because then they may not understand it fully and will not be able to solve a similar problem next time. It's always important to take the time to help someone think through the problem and develop the solution.
- If in doubt, ask your instructor: Be sure to ask in advance if you have any doubts about whether a certain type of collaboration is acceptable

Accommodation
Students with disabilities may request academic accommodations for exams online through the UCSB Disabled Students Program, and reasonable accommodations will be made. To take advantage of available accommodations, students must register with the Disability Services Office. For more information, please visit http://dsp.sa.ucsb.edu/.

Harassment
UCSB is committed to providing an equal opportunity environment for all students and employees that remains free of all forms of discrimination, harassment, and exploitation. Discrimination and harassment based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. If you witness or experience any form of harassment, please seek support and guidance. For more information, please visit https:// titleix.ucsb.edu/.

Course schedule
The tentative course schedule (*lecture, discussion, lab, and assignments*) is subject to change at the instructor's discretion.

| Week 1 | Lectures | Discussion | Lab | Assignment |
|---|---|---|---|---|
| Monday Jul 3, 2… | Introduction | - Ice breaking<br>- browse publicly available dataset<br>- browse papers | No lab | • Research Interest<br>• Reading<br>• Reflection |
| Tuesday Jul 4, 2… | Independence Day Holiday | No Discussion | Holiday | Holiday |
| Wednesday Jul 5, 2… | Image Processing | - group formation<br>- writing resources | No Lab | Numerical and conceptual problem |
| Thursday Jul 6, 2… | Pre and Post processing | No Discussion | Python | Lab quiz |
| Friday Jul 7, 2… | | | | Lab 1 report |

| Week 2 | Lectures | Discussion | Lab | Assignment |
|---|---|---|---|---|
| Monday Jul 10, … | Convolutional neural network (CNN) | -Go over a relevant paper<br>-Reuse and Reproduce NN code | No Lab | -Reading |

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|---|---|---|---|---|
| Tuesday Jul 11, … | -Building blocks of CNN cntd. | No discussion | - Pytorch | -Lab quiz |
| Wednesday Jul 12 | Neural network for biomedical images, Segmentation, Classification | -What to avoid and keep in mind<br>-Method comparison | No lab | Lab 2 report |
| Thursday July 13 | Evaluation of your model, Transfer Learning, ResNet | No discussion | - Pytorch | |
| Friday July 14 | Group research | | | Lab 3 report |

| Week 3 | Lectures | Discussion | Assignment |
|---|---|---|---|
| Monday July 17 | ResNet, UNet | - project preparation | |
| Tuesday July 18 | UNet Demo | - project preparation | Methods section |
| Wednesday July 19 | Graphs in biomedical images | - project preparation | |
| Thursday July 20 | Guest lecture 1 | No discussion | |
| Friday July 21 | Group research | | Results |

| Week 4 | Lectures | Discussion | Assignment |
|---|---|---|---|
| Monday July 24 | Guest lecture 2 | - project preparation | Conclusion |
| Tuesday July 25 | Recent research in biomedical image analysis | - Final revision | |
| Wednesday July 26 | | - Presentation practice | Final paper due |
| Thursday July 27 | Capstone seminar | | |
| Friday July 28 | Capstone seminar | | |