CS5330 – Pattern Recognition and Computer Vision

Summer 2024

Instructor: Ryan Bockmon

Email: r.bockmon@northeastern.edu

Office Hours: Thursdays 1:00 – 3:00

(I will be on campus (Roux) in person. I will not have zoom open unless you email/teams me. I don't like sitting in front a zoom call by myself)

Online office hours: by appointment

Office Hours Zoom link:

https://us04web.zoom.us/j/2637694086?pwd=q6La5JOrAIEyUZQqi5q7iOCskBanlB.1

Roux Institute	Vancouver
Time: W 1:00pm – 4:20pm Room: 136	Time: W 10:00am-1:20pm Room: 1524
TA: TBA Email: TBA Office hours: TBA	TA: TBA Email: TBA Office hours: TBA

Course Description

Introduces the fundamentals of extracting information from digital images. Major topics include image formation and acquisition, gray-scale and color image processing, image filters, feature detection, texture, object segmentation, classification, recognition, stereo, optical flow, motion estimation, and object detection and recognition. The course will cover both classical and modern computer vision techniques built on deep networks.

Students will learn by developing small and medium-scale vision systems to solve practical problems such as image filtering, content-based image retrieval, image stitching, augmented reality, and object recognition.

Course Goals

- Students understand the fundamentals of image formation and image acquisition.
- Students understand and can implement image processing algorithms such as filtering, and feature detection.
- Students understand and can implement algorithms for segmentation, detection, tracking, and classification of objects.
- Students understand and can implement systems using deep networks to solve computer vision tasks such as object recognition and localization.
- Students work in a group to design and develop a medium-sized image analysis and computer vision application.
- Students present algorithms and results in an organized and competent manner, both written and orally.

Textbooks

- Computer Vision: Algorithms and Applications, Richard Szeliski
  - Available online for free: https://szeliski.org/Book/

Required Resources

- Python
- OpenCV computer vision SDK
- PyTorch deep learning toolkit
- Keras deep learning toolkit

Grading

HW (50%) – There will be a total of 5 homework assignments due throughout the semester. They will each be worth 10% of your final grade. You will have 2 weeks to complete each assignment. (Depending on the assignment, I might allow for group work on some assignments)

Labs (20%) – There will be 11 weekly labs that will be due throughout the semester. Your lowest lab grade will be dropped from your final grade. Each will be worth 2% of your final grade. Labs will be designed to give you more hands-on practice of the material that was covered during the class. Labs will be designed to take 1-2 hours to complete and will be designed to be done individually.

Active Learnings/Participation (10%) – There will be daily active learning. These active learning will be due during class time and is meant for you to practice the material that is

covered during class. You will only be graded on completion not if you got it right or wrong. I will check you off during class.

Final Project (20%) – We will be working on a project from LOOKOUT an AI computer vision start up company working on using real-time object detection to spot hazards for boaters. The goal of this project is to explore ways to reduce the number of images that will be needed to train/classify objects. You will work in teams of 2-3 students and will be required to turn in a final report and presentation.

      Final Report (10%) You and your team will be expected to write a final report about your project. This report will be treated as a report that you will hand into the company that is sponsoring this project and will go over the results that you found, a plan that you would like to explore further or develop based on the results that you found, and what you need to be able to move forward with those plans.

      Final Presentation (10%) – Record a 10 min online presentation about your project. Each team member will need to participate in the presentation.

Late Policy

I do not accept **unexcused** late work. However, I count any physical or mental health problems as a valid reason. If for any reason you are not feeling well or are struggling with completing an assignment, reach out to me and I will work with you to make sure that you will be able to complete it. I will not fail any student who is actively trying to pass this course.

Tentative Timeline

Week	Topic	Assignments
May 8th	Introduction, representing and manipulation images, Color Space	Lab 1 (due May 15th)
May 15th	Filtering/edge detection	HW 1 (due May 29th) Lab 2 (due May 22nd)
May 22nd	Histograms, grey scale	Lab 3 (due May 29th)
May 29th	PCA and K-means Distance Metrics	HW 2 (due June 12th) Lab 4 (due June 5th)
June 5th	Basic Pattern Recognition. K-Nearest Neighbor	Lab 5 (due June 12th)
June 12th	Video Recognition	HW 3 (due July 3rd)

		Lab 6 (due June 26th)
June 19th	No Class (Holiday)	
June 26th	Video Recognition Cont.	Lab 7 (due July 3rd)
July 3rd	Image Classification	HW 4 (due July 17th) Lab 8 (due July 10th)
July 10th	Image Classification Cont.	Lab 9 (due July 17th)
July 17th	Image Segmentation	HW 5 (due July 31st) Lab 10 (due 31st)
July 24th	No Class (Project Week)	
July 31st	Special Topic	Lab 11 (due Aug 7th)
Aug 7th	Special Topic	
Aug 14th	No Class	Turn in Final Project!

Academic Accommodations

If you have a documented need for an academic accommodation, please contact the professor within the first two weeks so we can have a conversation about how best to make appropriate arrangements.

If you require support during the course due to a disability, please ensure that you are already registered with the University's Disability Center, and contact your course instructors to coordinate any support needed during the course.

Mental health issues are real and can prevent you from doing your best work. Your Khoury advisor is your primary contact for accessing University resources. Do not hesitate to make use of them as needed.

Collaboration and Academic Honesty

Computer science, both academically and professionally, is a collaborative discipline. In any collaboration, however, all parties are expected to make their own contributions and to generously credit the contributions of others. In our class, therefore, collaboration on homework and programming assignments is encouraged, but you as an individual are responsible for understanding all the material in the assignment and doing your own work. Always strive to do your best, give generous credit to others, start early, and seek help early from both your professors and classmates.

The following rules are intended to help you get the most out of your education and to clarify the line between honest and dishonest work. The professor reserves the right to ask you to verbally explain the reasoning behind any answer or code that you turn in and to modify your project grade based on your answers. It is vitally important that you turn in work that is your own. Follow the guidelines for academic honesty or we're done.

If you have had a substantive discussion of any homework or programming solution with a classmate, then be sure to cite them in your report. If you are unsure of what constitutes "substantive", then ask us or err on the side of caution. You will not be penalized for working together. You must not copy answers or code from another student either by hand or electronically. Another way to think about it is that you should be talking natural language with one another, not C++ or Python.

The following rules apply to anything you hand in for a grade.

- You may not copy anyone else's code under any circumstances. This includes online sources.
- You may not permit any other student (unless they are team members) to see any part of your program.
- You may not permit yourself to see any part of another student's program, unless they are team members.
- You may not post a public question to a discussion board that contains any part of your code.
- You may consult online resources as part of your course work, but you may not copy code from online sources. If you get an idea of how to solve a problem from an online source, include that in your project acknowledgements.
- You may, at your own risk, use code generation/completion tools built into your IDE. Using these tools may speed your development time, but it may also inhibit your learning. Figuring out and writing code yourself forces you to understand it and what it is doing, which is the skill you need to build.

Tutoring and Workshops by Global Learner Support (GLS)

Global Learner Support offers one-to-one tutorials for NU learners in the areas of academic writing, academic presentations, APA/MLA citation, English language conversation, and professional communication. To make a tutoring appointment, please visit the GLS booking page: https://gls.northeastern.edu/gls-tutoring/

Global Learner Support (GLS) also offers monthly virtual and in-person workshops on topics related to avoiding plagiarism, paraphrasing, APA/MLA guidelines, grammar and punctuation, academic presentations, writing professional emails, etc. Please visit https://gls.northeastern.edu/gls-workshops/ to register for upcoming workshops.

To view additional GLS services, visit our website at https://gls.northeastern.edu/

Title IX

Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance.

Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff.

If you or someone you know has been a survivor of a Prohibited Offense, confidential support and guidance can be found through University Health and Counseling Services staff

Links to an external site. and the Center for Spirituality, Dialogue, and Service

Links to an external site. clergy members. By law, those employees are not required to report allegations of sex or gender-based discrimination to the University.

Alleged violations can be reported non-confidentially to the Title IX Coordinator within The Office for University Equity and Compliance

Links to an external site. at: titleix@northeastern.edu and/or through NUPD (Emergency 617.373.3333; Non-Emergency 617.373.2121). Reporting Prohibited Offenses to NUPD does NOT commit the victim/affected party to future legal action.

Faculty members are considered "responsible employees" at Northeastern University, meaning they are required to report all allegations of sex or gender-based discrimination to the Title IX Coordinator.

In case of an emergency, please call campus police.

Please visit the Office for University Equity and Compliance for a complete list of reporting options and resources

Links to an external site. both on- and off-campus.

Recording Policy

This course, or parts of this course, may be recorded for educational purposes. Prior to starting any recordings, the instructor will ask if anyone objects recording the session. If anyone objects, no recording will be made. These recordings will be made available only to

students enrolled in the course, the instructor of record, and any teaching assistants assigned to the course.

Only students who have arranged an accommodation with the Disability Resource Center may use mechanical or electronic transcribing, recording, or communication devices in the classroom. Students with disabilities who believe they may need such an accommodation may contact the Disabilities Resource Center.