# Fall 2020 – COS 598: Computer Vision

**Instructor:** Dr. Terry Yoo (terry.yoo@maine.edu)
Boardman 325 (x1-4883)

**Office Hours:** TBA
or by appointment or anytime my door is open

**Prerequisites:** COS 226 or permission of instructor.

**Text:** There is no required textbook for this class. All of the slides used in class will be distributed here through Blackboard or its equivalent so that you can use them for reference.

Other electronic readings, especially original papers in the field, will also be assigned. Video lectures will also be assigned as mandatory material.

Required reading or viewing of video should be completed BEFORE the first date listed below for maximum benefit.

Optional supplemental text: *Machine Learning: an algorithmic approach* (Chapman & Hall/CRC Machine Learning & Pattern Recognition) 2nd Edition, Stephen Marsland, 2015, ISBN-13: 978-1466583283, ISBN-10: 1466583282

**Description:** Are you looking for a practical introduction to the world of machine learning? Computer Vision is an accessible sub-field of computer science that is rising in importance and accelerating on the strengths of machine learning methods that have become the 21$^{st}$ century model for artificial intelligence. In this course, we will explore the uses of tools and techniques to understand our world through computing using images as our data. The first half of the course will introduce machine learning and convolution neural networks for object recognition and classification, photogrammetry and reconstruction, and multimodal and hyperspectral imaging. As the course progresses, we will delve into the topics of image acquisition, mathematical analysis, the Fourier transform and frequency space, statistical pattern recognition, and other foundations of the field. This course is a fast-paced, hands-on, practical exploration of computer vision. Students from the class are organized into teams to work on a computer vision project.

## Course Objectives

**Instructional Objectives –** By the end of this course, students should be able to:

1. Read and discuss current and seminal technical papers about computer vision techniques, systems, and applications.
2. Be familiar with a diverse set of computer vision approaches and techniques, together with situations when they are appropriate.
3. Work with a team to solve a computer vision problem using techniques and methods presented throughout this course.
4. Describe the design, implementation, and evaluation of prototype visualization solution in an interactive presentation and technical paper suitable for publication.

**Student Learning Outcomes** – After completing the material in this course, students should acquire or develop the following knowledge, skills, and dispositions:

- SO1: Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
- SO2: Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of computer science.
- SO3: Communicate effectively in a variety of professional contexts.
- SO6: Apply computer science theory and software development fundamentals to produce computing-based solutions.

## Tentative Schedule

| Date | Topic |
|---|---|
| **Week 1** | Overview |
| **Week 2** | Machine Learning – back-propagating networks |
| **Week 3** | Deep learning networks, Convolution Neural Networks |
| **Week 4** | Photogrammetry |
| **Week 5** | Shape from X |
| **Week 6** | Hyperspectral imaging, classification |
| **Week 7** | Images acquisition, intensity, photons, noise, LIDAR, structured light, resolution, laser, ultrasound |
| **Week 8** | Sampling and Noise, Frequency space, the Fourier Transform, Shannon-Nyquist, Shannon-Hartley, Regularization, the Matchless Gaussian |
| **Week 9** | Vision – human visual system, pigeon vision, cameras, distortion, optics |
| **Week 10** | Feature points, Local Invariant Descriptors |
| **Week 11** | Statistical pattern recognition |
| **Week 12** | Scale |
| **Week 13** | Segmentation, Registration |
| **Week 14** | Hot Topics and Research Challenges |
| **Week 15** | Project Presentations |

## Grading and Course Expectations

Grades will be assigned on the basis of attendance, homework, quizzes, individual contribution to the project presentation, the project artifacts (proposal, input data review, results), project presentation, and final project write-up. The components of the grade are normalized to 100%.

- Individual Grades (60% total)
    - Attendance (5%)
    - Homework (25%)
    - Quizzes (25%)
    - Final Project Delivery and Demonstration (5%)
- Project Grades (40% total)
    - Project Artifacts (15%)
        - Project proposal (5%)
        - Analysis of input data and methods (5%)
        - Preliminary results review (5%)
    - Prototype, Design Delivery, Demonstration, and Presentation (10%)
    - Final Project Write-up (15%)

Those taking the course for undergraduate credit may complete the graduate assignments for extra credit. Letter grades will be assigned according to the following distribution (grades with + or – designator will be given at instructor discretion):

A 90-100, B 80-89, C 70-79, D 60-69, F 0-59.

**Piazza:** This term we will be using Piazza for class discussion. The system is designed for getting you help fast and efficiently from classmates and myself, as well as encouraging a lively dialogue about course topics. Rather than emailing questions to me, I encourage you to post questions of general interest on Piazza. You will receive an email invitation to join the course page.

**Peer Evaluations:** A peer survey will be solicited from all class members, with confidential assessments of how each team performed. Your Team Grade may be adjusted to reflect poor participation or performance up to 25%.

## Course Policies

**Policy on Late Assignments:** Assignments that are late without prior approval will have 20% deducted for the first week they are late. No assignment will be accepted more than one week late.

Since circumstances may intervene, preventing you from getting your work done some week, you are permitted one unscheduled late individual assignment, up to one week late, no questions asked. However, you may only use this unscheduled late individual assignment if you

have an unblemished record of delivering assignments on time. That is, the first time you submit an individual assignment up to one week late, it will not cost you. Use it wisely.

These policies do not apply to the final project report. That deliverable is due on the date of the final exam. Following the same policy that exams will not be rescheduled, no late final reports will be accepted.

**Regrading:** Homework assignments and project artifacts (other than the final project report) may be corrected and re-submitted within one week of the return of their graded copy. Updated, corrected submissions must be accompanied by the original marked copy of the assignment, Code Inspection Report, Administrator Manual, or User Manual.

No late assignments or project artifacts will be accepted for regrading.

**Attendance:** Full, regular attendance is expected of every student. If you must be absent, please send e-mail in advance explaining your absence. Guest speakers are planned on topics including career development and on seeking post-graduate employment. Your attendance is mandatory at guest lectures.

Attendance is an official component of your grade. As such, it will be monitored and recorded both explicitly and implicitly throughout the semester.

**Participation:** This is a group project course; your active participation is required throughout all stages of the project development. Vocal as well as written reports will be required periodically throughout the semester, and all members of each group will be expected to take turns presenting ideas and conclusions.

**Rescheduling work, exams:** Quizzes will not be rescheduled, and you will not be able to retake exams without prior approval and authorization. For additional information, see the section below on Campus Policies.

**Classroom deportment:** This is a graduate computer science class. Group discussion and exchange of ideas is expected, and interactions can become heated and passionate. Civil behavior and professional courtesy are expected at all times. Repeated outbursts or class disruption can lead to an adjustment of an individual's grade or other disciplinary action. Inclusive, non-racist, non-sexist language is expected in class. For additional information, see the section below on Campus Policies.

## Campus Policies

**Academic Honesty Statement:** Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be

given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University.

**Students with disabilities statement:** If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, 581.2319, as early as possible in the term. Students who have already been approved for accommodations by SAS and have a current accommodation letter should meet with me, Terry Yoo, privately as soon as possible.

**Course Schedule Disclaimer (Disruption Clause):** In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

**Observance of Religious Holidays/Events:** The University of Maine recognizes that when students are observing significant religious holidays, some may be unable to attend classes or labs, study, take tests, or work on other assignments. If they provide adequate notice (at least one week and longer if at all possible), these students are allowed to make up course requirements as long as this effort does not create an unreasonable burden upon the instructor, department or University. At the discretion of the instructor, such coursework could be due before or after the examination or assignment. No adverse or prejudicial effects shall result to a student's grade for the examination, study, or course requirement on the day of religious observance. The student shall not be marked absent from the class due to observing a significant religious holiday. In the case of an internship or clinical, students should refer to the applicable policy in place by the employer or site.

**Sexual Violence Policy**

**Sexual Discrimination Reporting**
The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell any of your teachers about sexual discrimination involving members of the campus, **your teacher is required to report** this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

Behaviors that can be "sexual discrimination" include sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct, and gender discrimination. Therefore, all of these behaviors must be reported.

**Why do teachers have to report sexual discrimination?**
The university can better support students in trouble if we know about what is happening. Reporting also helps us to identify patterns that might arise – for example, if more than one victim reports having been assaulted or harassed by the same individual.

**What will happen to a student if a teacher reports?**
An employee from the Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity will reach out to you and offer support, resources, and information. You will be invited to meet with the employee to discuss the situation and the various options available to you.

If you have requested confidentiality, the University will weigh your request that no action be taken against the institution's obligation to provide a safe, nondiscriminatory environment for all students. If the University determines that it can maintain confidentiality, you must understand that the institution's ability to meaningfully investigate the incident and pursue disciplinary action, if warranted, may be limited. There are times when the University may not be able to honor a request for confidentiality because doing so would pose a risk to its ability to provide a safe, nondiscriminatory environment for everyone. If the University determines that it cannot maintain confidentiality, the University will advise you, prior to starting an investigation and, to the extent possible, will share information only with those responsible for handling the institution's response

The University is committed to the well-being of all students and will take steps to protect all involved from retaliation or harm.

**If you want to talk in confidence** to someone about an experience of sexual discrimination, please contact these resources:

> For *confidential resources on campus*: **Counseling Center: 207-581-1392** or **Cutler Health Center: at 207-581-4000.** For *confidential resources off campus*: **Rape Response Services:** 1-800-310-0000 **or Spruce Run:** 1-800-863-9909**.**

**Other resources:** The resources listed below can offer support but may have to report the incident to others who can help:

> For *support services on campus*: **Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911.** Or see the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/