Appledore Island, Isle of Shoals, Kittery, Maine
t: 603.862.5346• shoals.lab@unh.edu • shoalsmarinelaboratory.org

Shoals Marine Laboratory
Introduction to Computer Vision for Field Biology
(BIOSM 2550/MEFB 585)
Summer 2027 (exact dates TBD)

Course Syllabus and Schedule

Faculty:
Dr. Andrew Hein (he/him)
Associate Prof. of Computational Biology
Cornell University
amh433@cornell.edu

Dr. Alexis Earl (she/her)
NSF Postdoctoral Fellow
Cornell University
ae74@cornell.edu

Teaching Assistant – to be named

Prerequisites: None

Course Credits: 3 Cornell credits / **4** UNH credits

Course Overview/Course Description:
This hands-on course introduces students to computer vision—using computer programs to identify, interpret, and extract information from images and video—as a tool for studying marine and coastal ecosystems. Students learn to design field studies, strategically deploy cameras and other imaging equipment across diverse habitats, and analyze visual data using Python with OpenCV. The course requires no prior programming experience and focuses on building an intuitive understanding of how computer vision works. Lectures cover the basics of computer vision and its growing role in ecology, behavior, and conservation research, including measuring predator-prey interactions, tracking collective movement in fish schools and bird flocks, counting individuals to estimate population size, and detecting behavioral shifts as early warning signs of ecological distress. Student-led projects focus on local biota, including nearshore fish, seabird residents of Appledore Island, intertidal plants, marine invertebrates, plankton, benthic cover, insects, and other coastal organisms.

Student Learning Outcomes
At the completion of this course, students will be able to:

1. Apply the fundamental principles of computer vision to field biology.
2. Design and execute field studies to address scientific questions and test hypotheses.
3. Deploy and recover camera/video equipment in terrestrial and aquatic habitats.
4. Use Python/OpenCV to perform basic image processing techniques, detect features and patterns in images, and apply basic machine learning models to visual tasks using data collected from the field.
5. Interpret and communicate research findings by connecting computer vision results to central concepts in ecology, animal behavior, and conservation biology.
6. Critically evaluate the strengths and limitations of automated/computational methods used in ecological field research, including the effects of data quality, collection conditions, and model assumptions on results.
7. Determine the ways that automated / computational methods can be misused or misinterpreted, including issues of bias, false detections, and overgeneralization of findings to broader ecological conclusions.

Course Materials/Learning Resources:
No primary textbook will be required for the course, and all readings and resources will be provided digitally. Peer-reviewed articles, book chapters, and tutorials will be provided to support each course topic.

Materials for students to bring:
1. A weatherproof field notebook (e.g., Rite in the Rain)
2. Your own laptop
3. Waterproof footwear, rain jackets, sunscreen,
4. Swimwear and snorkel gear recommended but not required. This course does not require students to swim or snorkel, however, having this gear may expand underwater hardware deployment opportunities for interested students.
5. Binoculars recommended but not required.

<u>Software & Python Packages:</u>
This is an introductory course, and students do not need prior programming experience. Instructors will provide all the guidance needed to use the following software.

To save time during the course, please download the following (free) software to your personal laptop that you will be bringing and install the following packages *before* you arrive at Shoals Marine Lab (following the instructions below):
1. **Anaconda (Python 3.x distribution)** — free from anaconda.com. This single installer bundles Python, Jupyter Notebooks, pandas, matplotlib, and NumPy, which covers the majority of the course's computing labs. *(Note: this is a ~1GB download — please install before arriving, as internet speed on the Island might be limited at times.)*
2. **VS Code** (optional but recommended) — free from code.visualstudio.com. A lightweight code editor that works well alongside Jupyter Notebooks; many students find it easier to use than the browser-based Jupyter interface. Not required if you prefer working in Jupyter directly.

Phones (helpful, not required):

1. **Merlin Bird ID** (Cornell Lab of Ornithology, free) — excellent for real-time identification of Appledore Island's seabird colonies during field sessions.
2. **iNaturalist** (free) — general species ID and logging, useful during intertidal and terrestrial field excursions.

Assessments/Assignments/Grading Overview:

- Field & Lab activities: 30%
- Final project oral presentation: 30%
- Final project written report: 30%
- Participation: 10%

Field & Lab Activities (30%)

Students will complete field and laboratory activities focused on study design, camera and imaging equipment deployment, data collection, and introductory image processing using Python/OpenCV. See daily schedule for additional details.

Final Project Oral Presentation (30%)

Students will present the results of a research project applying computer vision to a question in marine or coastal ecology. Presentations should describe the research question and methods, summarize key findings using appropriate visualizations, and discuss the ecological significance, limitations, and potential applications of the results. A grading rubric will be provided on the course Canvas site.

Final Project Written Report (30%)

Students will prepare a 5-page summary report that describes their research question and hypothesis(es), field and lab methods, computer vision workflow, results, including data visualizations, and interpretation. These reports should demonstrate a student's Reports should demonstrate critical evaluation of the methods used, acknowledge sources of uncertainty and potential bias, and connect findings to relevant ecological concepts and literature.

Participation (10%)

Participation reflects students' engagement in lectures, fieldwork, laboratory activities, and group discussions. Students are expected to contribute constructively to classroom activities, be engaged in field activities, and apply concepts learned during class to lab activities.

Late Assignments:

Assignments submitted after the deadline will incur a penalty of 10% of the total possible points per 24-hour period late, up to a maximum of 3 days. Assignments submitted more than 3 days late will not be accepted unless an extension has been approved by the faculty.

Grading Scale

UNH/other institution student grading Scale		Cornell student grading scale	
		100 – 98.00	A+
100 – 94.00	A	97.99 - 94.00	A
93.99 - 90.00	A-	93.99 - 90.00	A-
89.99 – 87.00	B+	89.99 – 87.00	B+
86.99 – 83.00	B	86.99 – 83.00	B
82.99 – 80.00	B-	82.99 – 80.00	B-
79.99 – 77.00	C+	79.99 – 77.00	C+
76.99 - 73.00	C	76.99 - 73.00	C
72.99 - 70.00	C-	72.99 - 70.00	C-
69.99 - 67.00	D+	69.99 - 67.00	D+
66.99 - 63.00	D	66.99 - 63.00	D
62.99 - 60.00	D-	62.99 - 60.00	D-
< 59.99	F	< 59.99	F

Expectations and Code of Conduct:

Students are responsible for fully understanding all the information presented in this syllabus and should discuss any questions with instructors as soon as possible. If there are any questions regarding this information, it is the student's responsibility to bring it to the instructor's attention. Students are responsible for attending all activities associated with this course and completing all assignments—your experience in the course will be most valuable and effective if you are present, enthusiastic, and prepared! Each student is responsible for their own behavior: always be respectful and collegial to other students, with instructors, SML staff, interns, visiting researchers, and other visitors. SML is a community, so please strive to be a positive member of that community. Students are responsible for fully understanding and adhering to all of the information presented in the *Appledore Island Handbook*. Safety training will take place on the day of students' arrival to Shoals Marine Lab. Students are expected to understand and adhere to all safety policies, including but not limited to boat safety, swimming and snorkeling, general and medical emergencies, fire safety, and field and lab guidelines specific to the work they will be performing in this course.

Students are *always* encouraged to ask questions, and to reach out to the instructor if they encounter difficulties with any of the activities or materials covered in this course. We will work with you to review material and skills and adapt as needed to ensure every student achieves all learning outcomes.

Attendance is expected for all class sessions. If you must miss class due to ill health or other personal emergencies, please let the instructor know as early as possible.

During class sessions (lectures and labs) you may use your laptop to take notes if you wish, but please turn off WiFi (unless required for accessing online materials specific to the class), close background apps, and silence cell phones to avoid creating distractions.

1. *Personal Technology / Electronic Devices.* Do not use cell phones, smart phones, iPads, headphones, or similar devices in the classroom or during course activities, unless approved by your faculty. Device use during lectures and activities is distracting, disrespectful, and detrimental to your learning.
2. *Transmission of Course Materials*. Students are not authorized to replicate, reproduce, copy or

transmit lectures and course materials presented, or derivative materials including class notes, for sale or free distribution to others without written consent of SML and the instructors who are the original source of the materials.

3. *Academic Integrity*. Any work submitted must be your own. Uncredited use of another person's words, data or images is considered plagiarism, a serious violation of UNH's or Cornell's academic integrity policies, whether the material comes from another student, a web site, or a published paper. It is your responsibility to properly cite any sources used in your work. Students must adhere to Cornell's and UNH's policies on academic integrity and discrimination:
    a. Cornell Code of Academic Integrity
    b. UNH Academic Integrity policy
4. *Use of Artificial Intelligence.* Unless otherwise specified, the **use of automated writing tools, including ChatGPT, ChatPDF, and similar artificial intelligence (AI) tools, is strictly prohibited** in this course, even when properly attributed. Such tools may not be used to generate responses toward any assessments in this course, including but not limited to written reports and presentations. The use of automated writing tools is considered plagiarism and will be handled in accordance with existing policy. If you find yourself stuck on how to approach an assignment, please reach out to your instructor and your peers for guidance. Any attempts to deviate from this principle by submitting work that is not independent and original will be construed as acts of academic misconduct.
5. *Collaboration:* Students are strongly encouraged to share ideas and feedback with one another (e.g., when designing experiments, analyzing and interpreting data, preparing written reports, practicing oral presentations). Under no circumstances are students allowed to work alone in the field (for safety reasons). Thus, during field work expect to work together in pairs, groups of three, and sometimes as a whole class.
6. *Disabilities & ADA Accommodation*: According to the Americans with Disabilities Act (as amended, 2008), each student with a disability has the right to request services from either Cornell University or UNH to accommodate their disability. If you are a student with a documented disability or believe you may have a disability that requires accommodations, please contact Cornell's Student Disability Services (SDS) or UNH's Student Accessibility Services (SAS). Accommodation letters are created by the student services office in consultation with the student. Students should follow-up with your instructor as soon as possible to ensure timely implementation of the identified accommodation in the letter. Faculty have an obligation to respond once they receive official notice of accommodations from SAS, but are under no obligation to provide retroactive accommodations.
7. Shoals Marine Lab and its faculty are committed to assuring a safe and productive educational environment for all students and for the university as a whole. To this end, SML faculty members will report to the appropriate Title IX offices (UNH - Title IX Coordinator, Bo Zaryckyj, Bo.Zaryckyj@unh.edu, 603-862-2930/1527 TTY); Cornell – Office of Civil Rights, titleix@cornell.edu, 607-255-2242) any incidents of sexual violence and harassment shared by students. If you wish to speak to a confidential support service provider who does not have this reporting responsibility because their discussions with clients are subject to legal privilege, you can contact the SHARPP Center for Interpersonal Violence Awareness, Prevention, and Advocacy at (603) 862-7233/TTY (800) 735-2964. SML also maintains an Anonymous Incident Reporting Page for students, staff and faculty to communicate incidences of bias and other feedback to SML leadership.
8. *Mental Health and Belonging*: Shoals Marine Laboratory cares about you and your well-being. If you experience unusual personal or academic stress during the course or need to talk to someone about a personal issue, seek support first from your TAs and faculty. SML staff are available

throughout the daytime, and at any time when there is an emergency. See the following resources for additional assistance:

a. UNH Mental Health Emergency Services
b. Cornell Mental Health care and emergency services
c. SML Supportive Community page, which includes a bias reporting and feedback form

Acknowledgement of Territory:

We would like to acknowledge that our class gathers the ancestral lands of the Wabanaki Nations. The people of the Wabanaki Nations include the Abenaki, Maliseet, Mi'kmaq, Passamaquoddy, and Penobscot are indigenous to the Acadia region which includes Maine, areas in New Hampshire, and the Canadian Maritime Provinces.

Course Schedule

Dining hall meal times:
Mon-Sat: Breakfast at 7:30am, Lunch at 12:30pm, Dinner at 6:00pm
Sun: Brunch at 10:00am, Dinner at 5:00pm
Island quiet hours:
10:00pm-7:00am

Day 1 Arrival Schedule

1:30 pm Arrive at the SML dock (315 Market Street, Portsmouth, NH).
Please note there is *NO* parking available at the SML dock; pick-up/drop-off only.
See email sent by SML for arrival and parking information.
Check-in with SML staff at the SML dock.
Unload luggage from vehicle(s) and load onto SML vessel.

2:45 pm Depart Portsmouth en route to Appledore Island (trip duration = ~90 minutes)

4:15 pm Approximate arrival to Appledore Island

4:30 pm Gather on Kiggins Commons deck for Island Welcome and Orientation led by SML Staff.
Luggage will be delivered to dorms by SML staff while students are in the Commons.

5:00 pm Participants shown to their dorm rooms

Class Schedule color code:
*Classroom
*Lab
*Field

Assignments/Deadlines

Tentative course calendar (subject to change based on weather, etc.):

Date	Morning (0900-1200)	Afternoon (1300-1700)	Evening (1900-2100)
Monday		Arrive at Appledore Island, campus tour, orientation	Course intro, overview of syllabus & expectations; **Lecture**: Intro to Computer Vision for Ecology (fundamentals, applications, scalability, best practices, potential challenges)

Tuesday	**Lec**: Digital images & cameras as ecological tools (pixels, color, resolution); **Field**: practice deploying cameras in different types of habitats around Appledore Island	**Computer Lab**: Intro to Python & Jupyter notebooks; load, display, and explore sample field images; intro to pandas & matplotlib for organizing counts and making simple plots	**Talk**: Case studies of camera-based ecology research; brainstorm research questions; reading time Tues Night: SML Rock Talk
Wednesday	**Lec** /**Lab**: Camera deployment strategies for terrestrial and aquatic habitats, including best practices for minimizing disturbance to wildlife **Panda and Matplotlib assignment DUE**	**Field**: deploy cameras around gull/seabird nesting areas and other terrestrial sites; Lab: troubleshoot camera setups, check footage, and practice file organization/naming conventions for field data; prepare underwater camera setups	**Lab**: Intro to OpenCV — images as data (pixels, color channels); load, display, and edit images (cropping, channels); reading time
Thursday	**Lec**: Intertidal zonation & invertebrate ID; Field: deploy cameras in tide pools (intertidal/inverts)	**Lab**: process morning's images using OpenCV	**Lec**: Study design — formulating ecological questions; reading time
Friday	**Lec**: Image processing for detection — thresholding, edge detection, background subtraction, and counting objects in images	**Field**/**Lab** Activity: class boat trip to retrieve RUV; sort underwater video footage	**Lab**: apply image-processing techniques to gull colony & tide pool footage to detect and count organisms; reading time

Saturday	**Lec**: Intro to machine learning & automated species detection; Lab: run a pre-trained model on seabird images to distinguish similar-looking species (e.g., Common vs. Arctic tern)	**Field**: recover terrestrial cameras; assemble & deploy underwater cameras at subtidal sites (subtidal/fish & inverts) Arrange times to meet with faculty/TA to discuss final research plan	**Lab**: review terrestrial camera footage **OpenCV image analysis lab assignment DUE**
Sunday	**Field**: recover/redeploy underwater cameras; conduct plankton tow from dock/boat	**Lab**: begin annotating footage — count individuals/species in underwater video and plankton microscope images	Fieldwork planning for student-led projects; write up project proposal/plans
Monday	**Lec**: Intro to tracking & automated counting methods, building on Friday's detection techniques; **Submit plan for final research project**	Review field plans; **Field**: students deploy cameras for research projects **Camera footage/annotation assignment DUE**	**Lec**: Troubleshooting common challenges in automated detection (lighting, occlusion, false detections); reading time
Tuesday	Computer lab: build a basic detection/counting pipeline using seal survey drone footage from Duck Island as practice data	**Field**: monitor project camera sites; continue data collection	Data analysis/writing; reading time Tues Night: SML Rock Talk
Wednesday	**Field**: recover project cameras; begin reviewing footage	**Lab**: apply detection/counting pipeline to project footage	Data analysis/writing

Thursday	**Field**: continue data collection / redeploy cameras as needed	**Field**/**Lab**: continue analysis of project footage **Counting pipeline assignment DUE**	Data analysis/writing
Friday	Field: retrieve cameras	prepare presentations	Independent work time
Saturday	Prepare presentations; writing time	Practice oral presentation session; writing check-ins	Independent work time
Sunday	Writing time; prepare presentations	**Final oral presentation session**; writing time	**Written research reports due**; Course debrief, self-assessments
Monday	Pack & cleanup, Departure		