Syllabus: Digital Entomology, Ecology, and Agriculture (ENTOM 799)

Course:	DigEnt**,** ENTOM 799, 3 credits, Fall 2024
Meeting time:	Tuesday & Thursday 11:30 AM – 12:45 PM
Location:	124A Waters Hall
Instructor:	Dr. Brian Spiesman
	Email: bspiesman@ksu.edu
	Office: 234 Waters Hall
	Office hours: By appointment

Course Description

AI and computer vision are rapidly transforming entomology and other fields in the natural sciences, while the open-source and maker communities are making tools to apply AI increasingly accessible for non-experts. In this project-based course, we will take a practical, hands-on approach to learning cutting-edge skills in computer vision and automation for applications in entomology, ecology, and agriculture (or anything else!). Students will learn the basics of computer vision, taking projects from data collection to annotation, model training, evaluation, and deployment. We will build custom devices using open-source hardware (including Raspberry Pis) and learn some basic fabrication skills (e.g., 3D printing). The course will cover applied programming (primarily using the web-based Google Colab) for model development, hardware design, data analysis, and visualization. Guided in-class exercises mini projects will be paired with group discussions of recent research papers exploring cutting edge applications for science. Students will also develop an independent project on a subject of their choice. No experience with programming or open-source hardware required!

Note: while no experience or coursework is required, during the course we will be programming in multiple programming languages: primarily Python but also some R. If you do not have prior experience with these languages, it would be beneficial to work through brief online courses providing an overview of these languages to gain some general familiarity. Many are available, but here are some examples:

Python: https://www.youtube.com/watch?v=rfscVS0vtbw or https://python.land/python-tutorial

R: https://www.youtube.com/watch?v=_V8eKsto3Ug or https://www.datacamp.com/courses/free-introduction-to-r

Other resources: https://www.w3schools.com/

Student learning objectives

The goal of this course is to demystify and provide an overview of some of the current technology in AI and computer vision. The course will begin to equip you with the some of the technical abilities, critical thinking, and problem-solving skills necessary to address cutting-edge research problems. At the end of this course, you will be able to:

1. Identify key, cutting-edge technological advances relevant for the study of biological systems
2. Critically evaluate the role of technological advances for designing and carrying out scientific research – what the tech can and cannot do
3. Develop custom datasets and computer vision models
4. Develop custom hardware for integrating AI models into experimental designs and data collection deploying AI models and integrating into experiments

Textbooks and course materials

There is no required textbook. Readings will be provided and posted on Canvas in advance.

Computers and project materials

You will have access to all necessary programs and materials for in-class activities and mini projects. ***However, you will need to bring your own laptop or tablet capable of running the necessary programs.*** Please speak to Dr. Spiesman if you have concerns about this. Most programs will be run on web-based platforms, which reduces OS compatibility issues. But be aware that Dr. Spiesman designs course activities using Windows devices and may not be able to help troubleshoot Mac/Windows (or Linux for real nerds) compatibility issues. All hardware (e.g., microcontrollers, cameras, etc.) will be provided on loan for use during the semester and must be returned before grades are due. Students are welcome, however, to purchase and use their own devices, particularly for independent projects, but I suggest checking with me before purchasing. Check with your major advisor for funding if the device factors into your undergrad or graduate research program. **Note:* There may be (*very*) limited funds available to purchase loanable components or sensors for class projects, depending on price, availability, and the likelihood they can be repurposed in the future.

Attendance Policy

Students are expected to attend all classes. However, if you are ill, please stay at home and contact Dr. Spiesman once you are feeling better. Make-up work will be discussed on a case-by-case basis. However, given the nature of the in-class and group work, make-up work for unexcused absences is generally not allowed. Students who may need special accommodations for coursework and/or known absences will need to speak with Dr. Spiesman by the end of the second week of class to make certain that these accommodations are met.

Expectations for a 3 credit-hour course

This class meets for 75 minutes twice a week and carries the expectation that students will work on course learning activities (reading, writing, project work, etc.) for about 3 hours out of classroom for every class period.

Course Grading
Letter grades will be assigned based on the total number of points earned by the end of the semester in the class. The final score will be based on:

Participation	10 pts
Mini-review	20 pts
Class discussions	40 pts
Mini projects	90 pts
Final project	100 pts
TOTAL	**240 pts**

Grade	**Point range**
A	240 - 216
B	215 - 192
C	191 - 168
D	167 - 144
F	< 144

<u>Summary of class activities</u>:

Participation
Your score for class participation will be based on attendance and engagement in lectures and in-class activities. Asking and answering questions, engaging with your peers on group problems is noticed and encouraged.

Mini-review
Each student will give one 5-minute presentation in which they provide a summary of a topic related to the course (20 pts). Students should choose 3 or more related papers from the literature and provide a brief synthesis for the class. Each student should schedule their mini review with Dr. Spiesman, which will be presented at the beginning of that class.

Discussions
There will be 4 in-class discussions (10 points each). We will use papers from the scientific literature to help you explore concepts and applications in deep learning and related technology. In each of 4 discussion sessions during the semester, you will be asked to read papers for discussion in small groups of 2 or 3 and all together as a class. Students will take turns being discussion leaders to help facilitate discussions. All students will need to carefully read the assigned papers and be prepared so they can participate in thoughtful discussions.

In-class mini projects
We will have 3 in-class mini projects (30 points each). Mini projects will mimic the general structure of your final project (e.g., collect, visualize, and analyze a data set from a custom hardware device). Projects will integrate a range of hardware, sensors, and software. For example, we will build a robotic car and program it to perform automated tasks, which will incorporate Raspberry Pi microcontrollers, cameras, audio systems, and deep learning algorithms.

Final Research Project
To evaluate your ability to synthesize and apply course concepts you will design, conduct, and present a technology-based research project (100 pts).

The project will have three components:

(1) *Proposal*: Designing and writing up, in outline form, a proposal for your project (20 pts)
(2) *R & D*: This component may involve collecting data, training deep learning algorithms, building hardware, and testing your novel application (40 pts)
(3) *Presentation*: Presenting your project to the class with a 10-minute PowerPoint presentation (40 pts)

More details will be given later in the semester, but briefly, you will design a project to apply the concepts we have learned in class. Essentially, you will design and carry out your own mini project. Research projects can be conducted independently or in teams of 2. Team projects should be larger in scope than solo projects. You will submit an outline of your project plan that must be approved by Dr. Spiesman before you can begin. Start thinking about project ideas early so you have time to collect the necessary data, troubleshoot, test, and implement your project. I encourage you to develop your project based on your own interests, but I am happy to suggest projects and point you to datasets, etc. After approval, you may begin work based on your proposed methodology. You will have some in-class time to work on your project, but it is expected that you will also work on your project outside of class. Contact Dr. Spiesman if you have any questions or problems along the way. Your project results will be presented to the class at the end of the semester.

Technology in class
Please silence devices before the start of class. Laptops are usually required. Careful use of generative AI (e.g., ChatGPT, Copilot, etc.) **is allowed** for help with coding and troubleshooting. However, it is to your great advantage to begin learning the concepts and coding skills to develop a deeper understanding of the issues but also so you can interact productively with AI assistants. They can't (yet) do it all for you. Generative AI **is <u>not</u> allowed** for written work or presentations. Audio or video recording in class is prohibited without prior permission.

Office hours and communication
Office hours will be by appointment. I am flexible with scheduling so please contact me with any questions or concerns.

***_Tentative_* schedule for course activities**

Week	Day	Date	Topics	Notes
1	T	8/20	Course intro	
	Th	8/22	Neural networks and AI	
2	T	8/27	Class discussion: Deep learning in Entomology	**Discussion 1: Høye, Sittinger,**
	Th	8/29	Data/model resources - e.g., GBIF, Roboflow, Huggingface	
3	T	9/3	Let's annotate some data with Roboflow	
	Th	9/5	Data management - GitHub	
4	T	9/10	Class discussion: Multi modal environmental monitoring	**Discussion 2: Besson, Tuia**
	Th	9/12	Training and evaluating AI models 1	
5	T	9/17	Training and evaluating AI models 2	
	Th	9/19	Training and evaluating AI models 3	
6	T	9/24	Deploying models - demo sites, Shiny, Gradio, Roboflow, etc	
	Th	9/26	Class discussion: Raspberry Pi applications	**Discussion 3: Jolles, TBD**
7	T	10/1	Edge devices and microcontrollers	
	Th	10/3	Mini Project 1: Let's build an autonomous car	
8	T	10/8	PiCar part II	
	Th	10/10	PiCar part III	
9	T	10/15	Innovation lab - tour and 3D printing	
	Th	10/17	Mini Project 2: Let's build a smart bird feeder	
10	T	10/22	Bird feeder cont.	**Proposal due**
	Th	10/24	Bird feeder cont.	
11	T	10/29	Class discussion 4 Citizen Science	**Discussion 4: Suzuki-Ohno, TBD**
	Th	10/31	Mini Project 3: TBD	
12	T	11/5	MP3 cont.	
	Th	11/7	MP3 cont.	
13	T	11/12	***No class: EntSoc Meeting***	
	Th	11/14	Final project Hackathon	
14	T	11/19	Final project Hackathon	
	Th	11/21	Final project Hackathon	
15	T	11/26	***No class: Thanksgiving Break***	
	Th	11/28	***No class: Thanksgiving Break***	
16	T	12/3	Final project Hackathon	
	Th	12/5	Final project presentations	**Final presentation**
17		12/9-13	***No class: Finals week***	

1. Statement Regarding Academic Honesty
Kansas State University has an Honor and Integrity System based on personal integrity, which is presumed to be sufficient assurance that, in academic matters, one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor and Integrity System. The policies and procedures of the Honor and Integrity System apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. A component vital to the Honor and Integrity System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation.

2. Statement Regarding Students with Disabilities
Students with disabilities who need classroom accommodations, access to technology, or information about emergency building/campus evacuation processes should contact the Student Access Center and/or their instructor. Services are available to students with a wide range of disabilities including, but not limited to, physical disabilities, medical conditions, learning disabilities, attention deficit disorder, depression, and anxiety. If you are a student enrolled in campus/online courses through the Manhattan or Olathe campuses, contact the Student Access Center at accesscenter@k-state.edu, 785-532-6441; for K-State Polytechnic campus, contact Julie Rowe, Diversity, Inclusion and Access Coordinator, at jarowe@ksu.edu or call 785-826-2971.

3. Statement Defining Expectations for Classroom Conduct
All student activities in the University, including this course, are governed by the Student Judicial Conduct Code as outlined in the Student Governing Association By Laws, Article V, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.

4. Statement on Mutual Respect and Inclusion in K-State Teaching and Learning Spaces
At K-State, faculty and staff are committed to creating and maintaining an inclusive and supportive learning environment for students from diverse backgrounds and perspectives. K-State courses, labs, and other virtual and physical learning spaces promote equitable opportunity to learn, participate, contribute, and succeed, regardless of age, race, color, ethnicity, nationality, genetic information, ancestry, disability, socioeconomic status, military or veteran status, immigration status, Indigenous identity, gender identity, gender expression, sexuality, religion, culture, as well as other social identities.

Faculty and staff are committed to promoting equity and believe the success of an inclusive learning environment relies on the participation, support, and understanding of all students. Students are encouraged to share their views and lived experiences as they relate to the course or their course experience, while recognizing they are doing so in a learning environment in

which all are expected to engage with respect to honor the rights, safety, and dignity of others in keeping with the K-State Principles of Community https://www.k-state.edu/about/values/community/.

If you feel uncomfortable because of comments or behavior encountered in this class, you may bring it to the attention of your instructor, advisors, and/or mentors. If you have questions about how to proceed with a confidential process to resolve concerns, please contact the Student Ombudsperson Office. Violations of the student code of conduct can be reported here https://www.k-state.edu/sga/judicial/student-code-of-conduct.html. If you experience bias or discrimination, it can be reported here https://www.k-state.edu/report/discrimination/.

5. Statement for Copyright Notification