University of Georgia
College of Engineering

ENGR 8990 – Deep Learning & Engineering Applications
(3 Credits)

Instructor:	**Jidong J. Yang, Ph.D., P.E.** 708D Boyd Graduate Studies Building Phone: (706) 542-5669 Email: Jidong.Yang@uga.edu

Office Hours:	Wednesday, 10:00 am – 12:00 pm; 1:00 pm –3:00 pm Other times by appointment
Course Date/Time:	Wednesday, 5:30 pm - 8:00 pm
Room Location:	Driftmier Engineering Center, Room 1355
Pre-requisites / Co-requisites:	Fundamental machine/statistical learning courses or equivalent approved by the instructor.

Textbooks/References:

(1) Dive into Deep Learning (https://d2l.ai/; https://d2l.ai/d2l-en-pytorch.pdf)
(2) Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (https://www.deeplearningbook.org/)
(3) Anaconda: https://www.anaconda.com/
(4) Python: https://www.python.org/
(5) Jupyter Notebook: https://jupyter.org/
(6) PyTorch: https://pytorch.org/
(7) Tensorflow: https://www.tensorflow.org/
(8) Matrix math for deep learning: https://explained.ai/matrix-calculus/index.html
(9) A number of reference papers to be discussed in class.

Course Description:

This course explores modern deep learning techniques and architectures with an emphasis on their engineering applications. The focuses of the course will be on major advancements in deep learning in recent years. The core ideas and principles of deep learning will be discussed. Both supervised and self-supervised learning will be covered with an emphasis on vision applications, including image classification, object detection, and image segmentation. Besides convolutional neural networks (CNNs), recurrent neural networks (RNNs), transformers, energy-based models will be introduced as well. Students are expected to apply the knowledge and skills learned from this course to the research problems of their interests. An individual class project is required, which can be based on a research project or a self-motivated study initiated from the course. The delivery of the project includes a technical paper and an oral presentation.

Course Objective:

Upon the completion of this course, the students should be able to:

- Understand fundamental concepts and principles of deep learning.
- Explain various modern deep learning architectures.
- Choose and compose proper architectures for specific engineering applications.

- Build, train and test models using commonly used machine learning frameworks (e.g., PyTorch or TensorFlow).
- Interpret the results in specific engineering settings.

Course Outline: The following is a tentative outline of the topics to be covered. The course syllabus is a general plan for the course; any deviations, if necessary, will be announced by the instructor.

Week No.	Topic	Assignment*
1	Introduction to Deep Learning	
2	Neural Networks & Training	Assignment 1
3	***Convolutional Neural Networks (CNNs)***	
4	Modern CNNs (e.g., AlexNet, VGG, GoogLeNet, ResNet, and DenseNet)	
5	Image Classification	Assignment 2
6	Object Detection I	
7	Object Detection II	
8	Image Segmentation	Assignment 3
9	***Recurrent Neural Networks (RNNs)***	
10	Modern RNNs (GRU & LSTM)	Project Proposal Due
11	***Attention Mechanisms***	Assignment 4
12	Transformer & Vision Transformer	
13	***Energy-Based Models***	
14	Autoencoder & Variational Autoencoders	
15	Generative Adversarial Networks (GAN)	
16	Self-Supervised Learning	
17	Project Presentation	
18	***Final Paper Due***	

Letter Grades: Course grades will be calculated in accordance with the following:

100 – 90	A
89 – 80	B
79 – 70	C
69 – 60	D
Below 60	F

Grading System: The grading system includes four assignments and a class project (a paper and an oral presentation).

Assignment1	15%
Assignment2	15%
Assignment3	15%
Assignment4	15%
Class Project (paper & presentation)	40%
Total	**100 %**

Class Setup: The course consists of weekly meetings between the students and the instructor.

Assignments: Assignments will be assigned via eLC. Assignments must be turned in to the instructor by the designated date and time (typically in one week after the assignment). **Late assignments will not be accepted.**

Final Comprehensive Project: Students must choose the project topic related to their ongoing research or approved by the instructor. The deliverables of the project will include an oral presentation to the class and a technical paper following the format of a professional journal.

Professionalism: Engineering faculty at UGA expect students to act in a professional manner at all times, develop the work ethic required for a successful engineering career and follow the Engineering Code of Ethics. Engineering students at UGA are responsible for maintaining the highest standards of professionalism and professional practice.

Inclement Weather: Class will be held at its regularly scheduled time unless the University is shut down or we (instructor) make a personal decision to cancel class. In the event that we cancel class, we will post an e-mail message.

Cheating: Every student must agree to abide by UGA's academic honesty policy and procedures known as *A Culture of Honesty*, when applying for admission to the University of Georgia. *A Culture of Honesty* and the University of Georgia Student Honor Code work together to define a climate of academic honor and integrity at the University. All members of the University Community have a responsibility to uphold and maintain an honest academic environment and to report when dishonesty occurs. Where suspected violations of the academic honesty policy occur, appropriate procedures are designed to protect the academic process and integrity while ensuring due process. The University's academic honesty system is an academic process founded on educational opportunities.

As a University of Georgia student, you have agreed to abide by the University's academic honesty policy, "A Culture of Honesty," and the Student Honor Code. All academic work must meet the standards described in "A Culture of Honesty" found at: www.uga.edu/honesty. Lack of

knowledge of the academic honesty policy is not a reasonable explanation for a violation. Questions related to course assignments and the academic honesty policy should be directed to the instructor. The link to more detailed information about academic honesty can be found at: http://www.uga.edu/ovpi/honesty/acadhon.htm

All cases of suspected violation of the UGA Academic Honesty Policy will be reported. Cheating of any kind will not be tolerated. Plagiarism and cheating will not be tolerated and may lead to failure on an assignment, in the class, and dismissal from the university. To learn more about what plagiarism is, please review the website: http://www.plagiarism.org/learning_center/printable_docs.html.

Policy: Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact us personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities. Students with disabilities who want academic accommodations must register with Disability Recourses Center, Division of Student Affairs, 114 Clark Howell Hall (706) 542-8719.

UGA Engineering Printing Policy: Each engineering student will be allowed to print up to 100 pages free on printers managed by Engineering. In addition, each student enrolled in an engineering class receives 100 free prints per engineering class. So if you are an engineering student enrolled in one engineering class, you will receive 200 free prints.

Course Communication: Typically, we will send out class e-mails with supplemental materials used for the course, quiz/exam reminders, and general course information. Students must provide the instructor with a current e-mail address in which the student can receive class e-mails. It is the student's responsibility for messages sent via email. Students are encouraged to send the instructor e-mails if assignments are unclear or would like to schedule an office visit.

Registration and Academic Deadlines: Deadlines outlined by the College of Engineering and the University of Georgia will be strictly enforced.

Students Called for Military Duty: If you are a student in the military with the potential of being called to military service and/or training during the course of the semester, you are encouraged to contact the College of Engineering Office immediately.

Engineering Professionalism Policy
Engineers make great contributions to society. Engineering is a very satisfying profession that provides many rewards but is demanding and requires hard work. The engineering profession is governed by a code of ethics. The following link will take you to the National Society of Professional Engineers, Engineering Code of Ethics website. http://www.nspe.org/resources/ethics/code-ethics. Engineering faculty at UGA expect students to act in a professional manner at all times and develop the work ethic required for a successful engineering career. Engineering students at UGA are responsible for maintaining the highest standards of professionalism and professional practice.

UGA College of Engineering Accreditation
The programs in the UGA College of Engineering are accredited through ABET, a nonprofit, non-governmental organization that accredits college and university programs in the disciplines of applied science, computing, engineering, and engineering technology. ABET accredits over 3,100 programs at more than 670 colleges and universities in 24 countries. *

Earning a degree from an ABET-accredited program:*

- Verifies that the quality of the educational experience you've received meets the standards of the profession.
- Increases and enhances employment opportunities.
- Permits and eases entry to a technical profession through licensure, registration, and certification.
- Establishes eligibility for many federal student loans, grants, and/or scholarships.

An ABET-accredited program assures students that:*

- the institution is committed to improving their educational experience
- the program is committed to using best practices and innovation in education
- the program is guided by its industry, government, and academic constituents through formal feedback
- the program considers the students' perspective as part of its continuous quality improvement process

See more at http://abet.org/why-accreditation-matters/

*from abet.org

As part of the accreditation process, you will be asked for your assessment of UGA's Engineering Programs via an online survey. Your responses are much appreciated and will contribute toward the continuous improvement process.

Engineering Calendar: The College of Engineering maintains an online calendar that includes information regarding academic deadlines, student engagement and success activities, student club and organization meetings, and career preparedness and employer events. The calendar is accessible at https://www.engineering.uga.edu/calendar. Students are encouraged to visit the calendar each week to view upcoming events.

Students may also access the Engineering Calendar using the QR code below:

Coronavirus Information for Students

Face coverings:
Following guidance from the University System of Georgia, face coverings are recommended for all individuals while inside campus facilities.

How can I obtain the COVID-19 vaccine?
University Health Center is scheduling appointments for students through the UHC Patient Portal (https://patientportal.uhs.uga.edu/login_dualauthentication.aspx). Learn more here – https://www.uhs.uga.edu/healthtopics/covid-vaccine.
The Georgia Department of Health, pharmacy chains and local providers also offer the COVID-19 vaccine at no cost to you. To find a COVID-19 vaccination location near you, please go to: https://georgia.gov/covid-vaccine.
In addition, the University System of Georgia has made COVID-19 vaccines available at 15 campuses statewide and you can locate one here: https://www.usg.edu/vaccination

What do I do if I have COVID-19 symptoms?
Students showing COVID-19 symptoms should self-isolate and schedule an appointment with the University Health Center by calling 706-542-1162 (Monday-Friday, 8 a.m.-5p.m.). Please DO NOT walk-in. For emergencies and after-hours care, see, https://www.uhs.uga.edu/info/emergencies.

What do I do if I test positive for COVID-19?
If you test positive for COVID-19 at any time, you are **required to report it** through the DawgCheck Test Reporting Survey. We encourage you to stay at home if you become ill or until you have excluded COVID-19 as the cause of your symptoms. UGA adheres to current Georgia Department of Public Health (DPH) quarantine and isolation guidance and requires that it be followed. Follow the instructions provided to you when you report your positive test result in DawgCheck.

Guidelines for COVID-19 Quarantine Period (As of 8/1/21; follow DawgCheck or see DPH website for most up-to-date recommendations)
Students who are fully vaccinated **do not** need to quarantine upon exposure unless they have symptoms of COVID-19 themselves. All others should follow the Georgia Department of Public Health (DPH) recommendations:
Students who are not fully vaccinated and have been directly exposed to COVID-19 but are not showing symptoms **should self-quarantine for 10 days**. Those quarantining for 10 days must have been symptom-free throughout the monitoring period and continue self-monitoring for COVID-19 symptoms for a total of 14 days. You should report the need to quarantine on DawgCheck (https://dawgcheck.uga.edu/), and communicate directly with your faculty to coordinate your coursework while in quarantine. If you need additional help, reach out to Student Care and Outreach (sco@uga.edu) for assistance.
Students, faculty and staff who have been in close contact with someone who has COVID-19 are no longer required to quarantine if they have been fully vaccinated against the disease and show no symptoms.

Well-being, Mental Health, and Student Support
If you or someone you know needs assistance, you are encouraged to contact Student Care & Outreach in the Division of Student Affairs at 706-542-7774 or visit https://sco.uga.edu/. They will help you navigate any difficult circumstances you may be facing by connecting you with the appropriate resources or services.

UGA has several resources to support your well-being and mental health: https://wellbeing.uga.edu/
Counseling and Psychiatric Services (CAPS) is your go-to, on-campus resource for emotional, social and behavioral-health support: https://caps.uga.edu/, TAO Online Support (https://caps.uga.edu/tao/), 24/7 support at 706-542-2273. For crisis support: https://healthcenter.uga.edu/emergencies/.
The University Health Center offers FREE workshops, classes, mentoring and health coaching led by licensed clinicians or health educators: https://healthcenter.uga.edu/bewelluga/

Monitoring conditions:
Note that the guidance referenced in this syllabus is subject to change based on recommendations from the Georgia Department of Public Health, the University System of Georgia, or the Governor's Office or. For the latest on UGA policy, you can visit coronavirus.uga.edu