THE GEORGE WASHINGTON UNIVERSITY

School of Engineering and Applied Science

Online Programs Office

Syllabus for

SEAS 8525-DA2

Computer Vision & Generative AI

Fall-1 2024

**Instructor:** Vijay Raghavan

**eMail**: vijayrag@gwu.edu  
**Credit Hours**: 3 credit hours   
**Course Website**: On Blackboard   
**Class Time and Dates:**

* Day and Time: Saturday 9-12.10 PM (Eastern)
* All Class Meeting Dates: Aug 31; Sept. 7, 14, 21, 28; Oct 5, 12, 19, 26; Nov. 2
* Attendance is normally expected at all sessions. If an absence from a class meeting is needed (due to family/medical or work-related emergency) students must contact the instructor in advance.
* Online classes are conducted via Zoom; Links are provided in Blackboard.
* Zoom link for Office Hours: https://gwu-edu.zoom.us/my/gwuvijayrag

**Office Hours:** For 3 hours every week I will be available for drop-in office hours, as follows:

* Every Monday 8-9.30 PM
* Every Friday 8-9.30 PM

**Bulletin Description of the Course:**Explore Gen AI’s visual realm. Learn image processing and generative models with Deep neural networks. Master tools for creative AI applications in art, design. Ethical considerations and societal impacts of generative AI technology

**Course Learning Objectives**:

Upon completing the course, students will know how to:

1. Understand the fundamentals of Generative AI.
2. Explore Latent space from an Encoder and Decoder perspective.
3. Learn the theory and the practical aspects of generative AI

**Required Textbook and Other Materials:**

* Textbook: : Generative Deep Learning: Teaching Machines To Paint, Write, Compose, and Play 2nd Edition

The textbook is available at https://wrlc-gwu.primo.exlibrisgroup.com/permalink/01WRLC\_GWA/15suu1b/cdi\_safari\_books\_v2\_9781098134174

* Other Material: Readings as assigned

## Average Amount of Out-of-Class or Independent Learning Expected per Week:

Over 10 weeks, there will be 10 sessions of 3 hours and 10 min each, and 2 sessions of 3 hours each, which are devoted to exams, for a total of 37.5 hours direct instruction. Homework and out-of-class reading is estimated to be 7.5 hours per week. This is a total of 112.5 hours.

## Class Schedule and Assignments

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| **Class** | **Topic/Activity** | **Assignment Due** |
| 1 | Aug 31st : Introduction to Generative AI – Chapter 1 | None |
| 2 | Sept 7th: Deep Learning – Vision to NLP, Foundational Models in Vision, Convergence of Vision and NLP, and Constrastive Learning – Chapter 2 | HW1: 1) Run Class-1-LatentSpace-PyTorch.ipynb on colab 2) Pick a Generative AI use case for your organization and explain the pros and cons. Due Septh 7th 9 am |
| 3 | Sept 14th: Autoencoders, Architecture, Variational Autoencoders (VAE), Building VAE, and Latent space – Chapter 3 | HW2: 1) Read the SimCLR paper and discuss at least one-use case where you would need to generate such data to train your model. And comment about the organization of the paper in few lines. 2) Pick 2 Class-2-CL-\* notebooks, change one of the hyperparameters (e.g. num of epochs) and note the changes in the results. Due Sept 14th 9 am |
| 4 | Sept 21st: Transformers, Attention, Layernorm, Residual connections, Causal Mediatiion Analysis, and Memory in Transformers – Chapter 9 | HW 3: 1) Run [https://github.com/vijaygwu/SEAS8525/blob/main/Class\_4\_Transformer\_Visualizations.ipynb 2](https://github.com/vijaygwu/SEAS8525/blob/main/Class_4_Transformer_Visualizations.ipynb%202)) Explain what you see in Model view in few sentences. Feel free to comment on anything interesting that you see as well. Due Sept 21st 9 am |
| 5 | Sept 28th Positional embeddings, RNN and Backpropagation through time (BPTT), RNN for NLP and PixelCNN - Chapter 5, 9 | HW4: 1) Read the notebook and try running it for a limited number of epochs.  2) In a few lines, please explain why a PixelCNN might need a high number of epochs (and compute) to converge to an acceptable result. Note - there is no right or wrong answer here. Due Sep 28th 9 am  Midterm Exam |
| 6 | Oct 5th Multimodel Large Language Models, Contrastive Language – Image Pretraining (CLIP), and Bootstrapping Language Image Pre-training – Chapter 13 | None |
| 7 | Oct 12th: Diffusion Models, and Video Generation Models – Chapter 8 | HW5: Explain [this](https://colab.research.google.com/drive/1zsK1yA5WBv158cQ3fCDvGkW15sSIAN2J?usp=drive_link) code in few paragraphs. Due 9 am Oct 12th |
| 8 | Oct 19th : Generative Adversarial Networks (GAN), Wasserstein GAN, Optimizations for WGAN and Conditional GANs - Chapter 4, 10 | HW6: Please run these two notebooks and explain the results in your own words   1. <https://github.com/vijaygwu/SEAS8525/blob/main/Class_8_CGAN_MINST.ipynb> 2. <https://github.com/vijaygwu/SEAS8525/blob/main/Class_8_WGAN_GP.ipynb>   Due 9 am Oct 19th |
| 9 | Oct 26th : Normalizing Flow Models, Jacobian Determinent, Change of Variables and Real-Valued non-volume preserving Transofrmations – Chapter 6 | HW7: Run [this](https://github.com/vijaygwu/SEAS8525/blob/main/Class_6_MultiModalLLMs.ipynb) notebook. Please write a summary (in a paragraph or two) of how the code in the notebook works. Due 9 am Oct 26th |
| 10 | Nov 2nd: Energy Based Models, Small Language Models, Flash Attention, and Compiler Optimizations – Chapter 7 | HW8: Run [this](file:///Users/vraghavan/Desktop/LLMs/Run%20this%20notebook.%20Please%20discuss%20the%20positives/negatives%20of%20the%20Hugging%20Face%20workflow) notebook. Please discuss the positives/negatives of the Hugging Face workflow Due 9 am Nov 2nd |

**Course recordings**: Downloadable recordings of each class session will be available within about 2 hours of the conclusion of class meetings and will be available for the duration of the course. These recordings are to be used exclusively by registered students in that class for their own private use. *Releasing these recordings is strictly prohibited.*

**Exams:**

* There will be a mid-term and a final exam, both closed book, administered on Blackboard outside the class meeting time.
* You may only use calculators native to the PC or Mac as well as Excel.
* Each exam is designed to be completed in 2.5 hours, with a 3-hour window to take it in.
* You are permitted to bring a single, 8.5”x11”, reference sheet (front and back) to each exam, any format.
* **The mid-term will be released at 8 pm Eastern on Saturday, Sept 28th and must be started no later than the following Monday, 5 pm Eastern. The final exam will be available at 8 pm eastern on Saturday, Nov 2nd , the last week of classes and must be started no later than 5 pm Eastern on the following Monday.**
  + Students are highly encouraged to take the exam early during the exam period
  + Exams are proctored by Honorlock, which records the examinee’s webcam, audio, and desktop. Certified reviewers confirm that the student adheres to the institution’s and the faculty member’s policies. Information about Honorlock can be found at the following link: [https://online.engineering.gwu.edu/student-resources/](https://seasonline.gwu.edu/useful_links/)
  + Contact Mark Griffith at [seasonline@gwu.edu](mailto:seasonline@gwu.edu) (202-422-2806) and copy instructor email regarding issues related to the exam in Honorlock and/or Blackboard

**Online Engineering Programs Labs:** Students can remotely access most computer labs of the School of Engineering and Applied Science and work with a variety of engineering design and analysis software packages. See <https://www.seas.gwu.edu/remote-access-labs>

**Grading:**

GW’s grading system for graduate students is: ***A****,* Excellent; ***B****,* Good; ***C****,* Satisfactory; ***F****,* Fail; other grades that may be assigned are ***A*−***,* ***B*+***,* ***B*−***,* ***C*+, C-***.* In this course, grades are determined by weighted average values and based on a standard curve relative to the class average:

Homework, totaling: 30%

Exam 1 35%

Exam 2 35%

Written work must comply with the Academic Integrity Policy of the George Washington University policy. Any plagiarized material will receive a grade of 0. No late submission of homework or discussion board will be accepted.

**Withdrawals:**

* Students may drop from courses through the day after the second class meeting without any academic or financial penalty. After that time, students may withdraw through the day after the eighth class meeting and will receive a designation of “W” and are responsible for full tuition.

**Incomplete**

* Students who cannot complete a course due to deployment overseas/called to active military duty/death in the immediate family/debilitating illness may seek an incomplete with proper documentation.

**University Policies**

**University Policy on Observance of Religious Holidays:** Students should notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. See <https://registrar.gwu.edu/university-policies#holidays>

**Student Disability Support Services (DSS) 202-994-8250:** Students needing an accommodation based on the potential impact of a disability should contact Disability Support Services. See https://[disabilitysupport.gwu.edu/](https://disabilitysupport.gwu.edu/).

**Student Mental Health Services 202-994-5300:** GW offers 24/7 assistance and referral for students needing crisis and emergency mental consultations, confidential assessment, and counseling services. See https://[counselingcenter.gwu.edu/](http://counselingcenter.gwu.edu/).

**Online Engineering Programs Office Policies:** <https://online.engineering.gwu.edu/policies-procedures-doctoral>

**Emergencies:** In case of emergency, students will be notified on Blackboard.

**Academic Integrity Code:** Academic dishonesty is defined as cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and fabricating information. All academic work is subject to GW University and SEAS Online Programs policy and may be scrutinized electronically. For more information, see https://[studentconduct.gwu.edu/](http://studentconduct.gwu.edu/code-academic-integrity).

**Student Guidelines for “Honorlock”, our exam proctoring software**

Honorlock is used with all online exams:

* Students must establish identity following the procedures outlined in the [Honorlock User Guide](https://seasonline.gwu.edu/useful_links/).
* Students are responsible for testing the functionality of the system well in advance of the remote-proctored exams in their courses so that any troubleshooting required can be accomplished. Check with your exam sponsor/faculty member for practice exams.

Review the Honorlock video tutorial streaming recording link at:

<https://honorlock.kb.help/how-to-use-honorlock-student/>

**Test Environment Requirements**The online test environment should mimic the in-class test environment, and conform to the following:

**Test Area**

* Sit at a clean desk or table (not on a bed or couch).
* Ensure that lighting in the room is bright enough to be considered "daylight" quality. Overhead lighting is preferred; however, if overhead is not possible, the source of light should not be behind you.
* Clear the desk or table of all materials: Students can have a single sheet of 8.5 x 11 inch paper with handwritten or typed notes on the front and back only
* Use one computer monitor only; dual monitors are not permitted.
* Have no writing on desk or walls or any notes or writing saved as your computer desktop background.
* No software other than Honorlock and Blackboard should be open unless permitted by the instructor.
* Close all other programs and/or windows on the testing computer before logging in to the proctored test environment.
* Do not have a radio or television playing in the background.
* Do not talk to anyone else—you may not communicate with others by any means.
* No other persons except the test-taker is permitted in the room during testing.
* If a calculator is required, you may use the calculator that comes with the Mac or the Windows operating system only. No physical calculators will be allowed in the testing area.

**Behavior**

* Dress as if in a public setting
* You will be allowed to take a brief bathroom break during the exam. You should not leave the room for any other reason during the exam. Do not take the computer into another room to finish testing (exam must be completed in the same room as the “Exam Environment View”).
* No headsets, ear plugs, or similar audio devices are permitted
* Cell phones are not permitted in the exam room.
* Your entire face must be visible throughout the exam. Being out of camera view is considered an exam violation. You should check the thumbnail at the top of the screen to confirm.
* Your ID photo ID must be readable

**Policy Violation Consequences**

* Exams
  + **Minor Violations** – radio/TV in the background, someone enters the room, sitting on a couch, any part of face out of camera view briefly (less than 5 minutes in total), second monitor (off) on the desk, improper lighting, using headphones, wearing hats, sunglasses, etc.
    - If you are flagged for a minor violation, you will receive a warning for the first offense. Students who commit minor violations after being warned will be penalized 10% on the exam. Subsequent minor violations could result in referral to the office of academic integrity. Minor violations will be counted cumulatively across the entire program.
  + **Major Violations** - browsing the web, using the phone or other devices, using additional screens, any part of face out of camera view (more than 5 min), communicating with another individual by any means.
    - If you are flagged for a major violation you will receive a 20% reduction on the exam and may be referred to the office of academic integrity.
* Homework and other written material
  + Written work must comply with the Academic Integrity Policy of the George Washington University policy. Any plagiarized material will receive a grade of 0.