CSE 410/510
Introduction to Generative AI (Tentative Plan)

Lecture times: TR; 330pm-450pm
Classroom: Frnczk 454
Credits: 3

Dr. Sreyasee DAS BHATTACHARJEE
email: sreyasee@buffalo.edu
Office: Davis Hall 349
Office Hours: by appt.

TAs: Details in UBLearn Contact page
Office Hours/emails: In UBLearn

Course Description: This course is intended for Computer Science students who are interested in understanding the fundamental issues, challenges and techniques that are associated with recent advances in Generative Artificial Intelligence (Gen AI). The course will discuss the history and properties of basic Gen AI systems including foundational probabilistic principles of generative models, their learning algorithms, and several state-of-the-art model families, which include variational autoencoders, generative adversarial networks, autoregressive models, flow based models, energy based models, and diffusion models. The course will be a combination of lectures, discussions, hands-on activities and projects. During the entire course, students will also learn about different applications in domains like computer vision, natural language processing, healthcare, etc.

Learning Outcomes: (1)discuss the history, properties, and core modules of basic gen AI systems; (2) discuss the architectures of cutting edge gen AI models and study advanced techniques for combining different generative models including PixelVAE and FlowGAN; (3) Implement in code common algorithms following code standards and libraries used in Gen AI; (4) Development of multimodal generative models; (5) real-world applications; (6) Things to consider toward building an ethical Gen AI system; (6) Explore limitations of different Gen AI models

Course Prerequisites: CSE 574, or, CSE555, or equivalent graduate level courses on AI topics

Textbooks: We will refer research papers and book chapters, the details of which will be shared as the study materials during the entire course

Reference Texts:

- ***Deep Learning*** by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- ***Deep Generative Modeling***, 2024, Jakub M. Tomczak
- ***Generative Models: An Overview*** by Ian Goodfellow:
- ***Generative Deep Learning*** by David Foster

Other Supporting Materials (will continue to be extended later on):

Rough schedule

1. ***Introduction***: How did we get here? and where are we in reality?
2. ***Background*** (probabily, maximum likelihood, Neural network, Transformer model)
3. ***Probabilistic Models***: Mixture models to probabilistic circuits
4. ***Autoregressive models*** (link to Papers for presentations and report preparation: [redacted])
5. ***Latent Variable Models*** (Variational Auto Encoders (VAE), evidence lower bound (ELBO), hierarchical VAE)
6. ***Flow Based Models*** (Normalizing flows, Advanced flow based models, ResNet flows, DenseNet flows)
7. ***Generative Adversarial Networks***, Evaluating Generative Models
8. ***Energy Based Models***
9. ***Score Based Generative Models***
10. ***Diffusion Models*** (Score Based Diffusion Models, Discrete Latent Variable Models, DIffusion Models for Discrete Data)

Every enrolled student should possess a laptop with webcam that may be used for video monitoring in a remote testing situation.

Requirements: The course grade will be based on a midterm and final exam, regular homeworks, quizzes and three projects that will all be supported by the basic lecture material. Homework is due before class on the due date.

Grading Policy & Other Course Details: The following items are designed to make your life easier and to give you some flexibility for planning your work:

- Grades are NON-NEGOTIABLE per UB policy.
- You will have a semester project in the course.
- Every week (almost), a small quiz will be available in UBLearn at/after 500 pm Friday, which will be associated with our discussion during that week. The quiz will be open in UBLearn *for the next* 24 *hours NOT EOD of Saturday*. .
- You will need to submit your work in UBLearn.
- Every Thursday, we will have 2/3 student presentations. Students will select and present a paper from the list shared on the topic covered in the previous class. Each student should present at least 4 papers during the entire course.
- Reports on the paper list shared in a given week will be due on Monday EOD of the following week. Please follow the report template for preparing your report. Incomplete reports can be turned in for partial credit.
- Please check the QA and other past discussions in Piazza, before raising a question in Piazza. This helps TA, as they do not need to answer the same question multiple times and use their time on clarifying your doubts instead.
- **Students found involved in Academic Integrity related issues, will be getting 0 in the course.**

Grade Composition:

Semester Project	30%
Weekly Paper Study and Report Preparation:	25%
Paper Presentation:	25%
Class Participation:	10%
Weekly Quizzes	10%

Grading Scale:

A: 93-100	A-: 90-92	B+: 87-89	B: 83-86
C+: 77-79	C: 73-76	C-: 70-72	D: 67-60

To get a pass grade a student has to secure a score>= 60. Assignment of an incomplete grade will be considered in a case-specific manner and will follow UB's the university's Graduate Incomplete Policy:
https://www.buffalo.edu/grad/succeed/current-students/policy-library.htmli-grade

Academic Integrity:
(Short) Don't cheat! You will be caught and punished. Our department is serious about graduating ethical and upstanding computer scientists. The policy has recently been updated and will be enforced.
(Long) All academic work must be your own. Plagiarism, defined as copying or receiving materials from a source or sources and submitting this material as one's own without acknowledging the particular debts to the source (quotations, paraphrases, basic ideas), or otherwise representing the work of another as one's own, is never allowed. Collaboration, usually evidenced by unjustifiable similarity, is never permitted in individual assignments. Any submitted academic work may be subject to screening by software programs designed to detect evidence of plagiarism or collaboration. Also, do not post any of the course material outside of the Course piazza page. It will be interpreted as an attempt to get non-approved help. For the complete policy please see:
https://www.buffalo.edu/grad/succeed/current-students/policy-library.htmlacademic-integrity

Classroom Etiquette: For the complete policy please see:`https://catalog.buffalo.edu/policies/obstruction.html`

Violations of any of these, will fetch serious consequences.

- Paying attention in class
- Not coming to class late or leaving early
- Not talking with other classmates while the instructor or another student is speaking. If a student has a question or comment, he or she should raise a hand, NOT starting a conversation about it with a neighbor
- Turning off electronic devices including cell phones, pagers, and beeper watches
- Focusing on class material during class time. Sleeping, talking to others, doing work for another class, reading the newspaper, checking email, and exploring the Internet are unacceptable and can be disruptive
- Not packing book bags or backpacks to leave until the instructor has dismissed class.

Accessibility Resources: If you have any disability which requires reasonable accommodations to enable you to participate in this course, please contact the Office of Accessibility Resources, 25 Capen Hall, 645-2608, and also the instructor of this course .. The office will provide you with information and review appropriate arrangements for reasonable accommodations. http://www.student-affairs.buffalo.edu/ods/

Approved Resources:

1. Any material posted in the slides.
2. Material from the text-book (will copy relevant content to slides). Note, the code solutions from the book's website are NOT approved unless they are explicitly posted on the piazza page.

3. Sites (one click away) from the approved resources list on the Piazza page. I will add to them as appropriate for throughout the semester.

The use of gen AI (e.g., ChatGPT) is prohibited in this class and will be considered a violation of UB's academic integrity policy. Details of what resources are allowed will be provided for each assignment. If you are unsure if a resource or tool is allowable, be sure to ask.

Regarding Distribution of Course Materials: All materials prepared and/or assigned by me for this course are for the students' educational benefit. Other than for permitted collaborative work, students may not photograph, record, reproduce, transmit, distribute, upload, sell or exchange course materials, without my prior written permission. "Course materials" include, but are not limited to, all instructor-prepared and assigned materials, such as lectures; lecture notes; discussion prompts; study aids; tests and assignments; and presentation materials such as PowerPoint slides, or transparencies; and course packets or handouts. Public distribution of such materials may also constitute copyright infringement in violation of federal or state law. Students who violate this policy will be required to complete an educational sanction about the value of intellectual property. More serious and/or repeat violations of this policy may be treated as acts of "academic dishonesty" and/or subject a student to disciplinary charges under the Student Code of Conduct

Working with others: Please do help each other! This material is fun, but can be challenging. Discussing it with peers can deepen your understanding. You can talk *about* the homework problems and ways of approaching them, however, every person must write up solutions and code separately. We will compare all submissions with each other AND non-approved sources. If you can find something online, so we can we.

By signing the syllabus below, you certify that you have gone through it and agree to follow all the rules of the class.

(Student's Signature & Full name)