New York University
Tandon School of Engineering

Computer Science and Engineering
CS-GY 6643 I Computer Vision
Fall 2026

Professor Erdem Varol
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Time: 11:00 AM - 1:30 PM Thursdays;
Classroom: Room 475, 6 Metrotech
Office hours: TBA (via Zoom)
TA's: Anushk Pandey, Akshat Mishra, Dipesh Kumar, Srirupa Dutta, Thiago Viegas

Course Pre-requisites: CS 5403 (Data Structures) or equivalent, proficiency in programming, particularly Python, and familiarity with matrix arithmetic and linear algebra.

Course Description: A central goal of signal processing and artificial intelligence (AI) is to enable computers to understand and interpret visual information. Computer vision focuses on extracting meaningful measurements and representations of physical objects from images using techniques from image processing, pattern recognition, geometric modeling, cognitive processing, and machine and deep learning. This course covers the fundamental concepts and techniques of image processing and computer vision at an intermediate level, combining theoretical understanding with practical application. Students will also participate in Kaggle competitions to apply course concepts to real datasets, along with a midterm examination to evaluate their understanding of the material.

Please note that this is NOT a Machine/Deep Learning course, but rather a focused study of image processing and computer vision methods beyond the basic introductory stage.

Capstone Course: This course counts as a capstone course and includes comprehensive programming projects in addition to theoretical assignments. Strong emphasis will be placed on rigorous assignments and competitive programming challenges designed to test **creativity, critical thinking,** and application of concepts. These projects will serve as a way to benchmark performance, encourage collaboration, and foster innovation in applying image processing and computer vision techniques. Course materials such as slides, written handouts, and solutions to quizzes, assignments, and homeworks will be distributed via Brightspace and Slack. We will not record classes, and students are strongly encouraged to attend in person to actively participate in discussions.

Readings:

Reference material for the course comes from the following books:

- **Primary Book:** Richard Szeliski, Computer Vision: Algorithms and Applications.
  (available online: https://szeliski.org/Book/download.php)
- Milan Sonka, Vaclav Hlavac, and Roger Boyle, Image Processing, Analysis, and Machine Vision, 4th Ed, 2015
- David A. Forsyth and J Ponce, Computer Vision: A Modern Approach, 2012
- Simon J. D. Prince, *Understanding Deep Learning*, 2023.
- *Dive into Deep Learning*, available online, as a supplementary practical reference for modern deep learning methods.

Course Load: The course will primarily consist of **5 programming projects and one midterm exam**. The programming projects will be competition-based and will require students to implement, evaluate, and report on computer vision methods and models. Projects will have fixed deadlines and will build progressively on the concepts and techniques covered throughout the course. Students may use any high-level programming language, although **Python is strongly recommended** and will be the language supported by the CAs.

Grade Calculation:

Midterm Exam (scheduled *October 15*, subject to change)	25%
Programming Projects & Competitions(5 team projects)	75%

Note: *~60% of the Programming Project Grade will be competition based. Further breakdown will be provided in the class and brightspace.*

Programming Projects: The programming projects in this course will primarily take the form of competitions designed to assess students' ability to apply computer vision techniques to challenging, practical problems. Each project will be graded according to three components: **40%** for meeting or exceeding the specified baseline performance, **50%** based on comparative performance in a **Kaggle-style competition**, and **10%** for a written project report describing the student's approach, experiments, results, and analysis.

The competitive component will reward students for improving upon the baseline and achieving strong results relative to their peers. **Project grades will be curved at the end of the course** based on overall performance across the competitions.

Further details on deliverables will be provided.

Topics (subject to change):

Part I

- Image Representation and Properties (Connectivity, Histograms) Image Preprocessing, Image Formation, Filtering and Edge Detection
- Feature Detection & matching
- Image alignment
- Segmentation
- Machine Learning ,Backprop with MLP, Neural Networks, CNNs
- Convolutional Neural Networks; YOLO

Part II

- Motion models, Depth estimation and Optical flow
- Self Supervised Learning, CLIP Embeddings
- Attention Mechanism, Vision Transformer
- Structure from Motion
- Gaussian Splatting
- Additional Topics

Code Lab: Each lecture will be accompanied by a code lab session led by the course assistants. These labs will demonstrate essential coding practices and techniques, while also highlighting relevant recent models, tools, and developments in the field.

Inclusion, Diversity, Belonging, Equity and Accessibility (IDBE)

NYU is committed to creating an inclusive and equitable environment for all students. In this class, I aim to cultivate a strong sense of community, emphasizing that it is a space where individuals of diverse backgrounds—spanning beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities—are treated with respect. All members of the class are expected to contribute to an inclusive atmosphere for each other. While disagreement and differing ideas are welcome, the expectation is that we respect perspectives beyond our own, even when they diverge from our personal beliefs or

experiences. If you encounter disrespect or discrimination in the class or feel that the outlined standards are not being upheld, please report your experiences to me.

Moses Center Statement of Disability

If you are student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities (CSD) at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 3rd floor.

NYU School of Engineering Policies and Procedures on Academic Misconduct – complete Student Code of Conduct here

Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.

Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:

Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.

Fabrication: including but not limited to, falsifying experimental data and/or citations.

Plagiarism: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.

Unauthorized collaboration: working together on work meant to be done individually.

Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.

Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

NYU School of Engineering Policies and Procedures on Excused Absences – complete policy here

Introduction: An absence can be excused if you have missed no more than **10 days of school**. If an illness or special circumstance has caused you to miss more than two weeks of school, please refer to the section labeled Medical Leave of Absence.

Students may request special accommodations for an absence to be excused in the following cases: Medical reasons, Death in immediate family, Personal qualified emergencies (documentation must be provided), Religious Expression or Practice

Deanna Rayment, deanna.rayment@nyu.edu, is the Coordinator of Student Advocacy, Compliance and Student Affairs and handles excused absences. She is located in 5 MTC, LC240C and can assist you should it become necessary.

NYU School of Engineering Academic Calendar – complete list here.

Please pay attention to notable dates such as Add/Drop, Withdrawal, etc. For confirmation of dates or further information, please contact Susana Garcia: sgarcia@nyu.edu