



**Computer Science EN.601.482/682
Machine Learning: Deep Learning
Spring, 2022 (4 credits, E)**

Instructor

Mathias Unberath, <https://arcade.cs.jhu.edu/>

Office hours: TBD

Office hours Zoom link: TBD

Teaching Assistants

Catalina Gomez Caballero

Office hours: TBD

Office hour Zoom link: TBD

Weiyao Wang

Office hours: TBD

Office hours Zoom link: TBD

Sihan Wei

Office hours: TBD

Office hours Zoom link: TBD

Meetings

Asynchronous consumption of lecture recordings (required)

Synchronous, virtual recitation and flipped classroom session (required)

All sections Mondays 8.30 to 9.45 am

Class Zoom link

Synchronous, virtual homework review and Q/A (voluntary)

All sections Fridays 9.00 to 9.50 am

Class Zoom link:

Textbook

This course does not explicitly follow a specific textbook, though many good textbooks on the topic are available. A fairly exhaustive list of additional reading material (including textbooks, blog articles, tutorials, and scientific articles) will be made available in the “Resource” section of Piazza.

Online Resources

Please log in to Piazza for all materials related to this course.

Course Information

Synopsis: Deep learning (DL) has emerged as a powerful tool for solving data-intensive learning problems such as supervised learning for classification or regression, dimensionality reduction, and control. As such, it has a broad range of applications including language processing, computer vision, medical imaging, and perception-based robotics. The goal of this course is to introduce the basic concepts of DL. The course will include a brief introduction to the basic theoretical and methodological underpinnings of machine learning, commonly used architectures for DL, current challenges including ethics and fairness, and specialized applications with a particular focus on computer vision. Students will be expected to solve several DL problems on standardized data sets and will be given the opportunity to pursue team projects on topics of their own interest.

Prerequisites: (AS.110.201 or AS.110.212 or EN.553.291) and (EN.553.310 EN.553.311 or EN.553.420 or EN.560.348) and (EN.601.475 or equivalent); Calc III and numerical optimization recommended. Recommended co-req: EN.601.382.

Communication Plan: In Spring 2022, this course will be held in a hybrid model consisting of synchronous remote and asynchronous elements. This format enables remote learning that is compatible with individual learning styles and schedules while preserving some of the valuable synchronous and personalized interactions that distinguish this course from other online material. We will use multiple channels to communicate as effectively as possible.

How does this work? You will find below a list of lectures and/or other material for you to consume during the specified week of the semester. Consuming this material is asynchronous and you can decide your schedule as long as you finish it in the week leading up to the next synchronous session. Questions that arise during self-study of the material can be posted on Piazza (ideally as public post, so that everyone can benefit from our answers, though private posts are enabled). During our synchronous sessions, we will then review, emphasize, and expand on the most important learning points and/or discuss flipped classroom tasks.

Where do I find the material? The course's home is on Piazza and you should sign up as soon as possible using this link: [dummy link](#). On **Piazza** you will find links to recorded lectures, slides, assignments, and other relevant course material and resources. You are encouraged to post any questions and discussions on Piazza and contribute to answering questions your peers have posted. Please note that, while you can remain anonymous to peers, posting anonymously to instructors is disabled.

What about homework assignments? We will offer "homework orientation and Q/A sessions" during the Friday slot. Attending these sessions is voluntary but highly recommended. Questions about homework assignments should be posted to Piazza (again, ideally as public post so that everyone can benefit from our answers) and can also be

discussed in greater detail during office hours. Homework assignments are submitted through **Gradescope** with course code **DUMMY CODE**.

Any other communication platforms? Yes – We will use **Google Forms** for quizzes. Links to Quizzes will be shared during the synchronous sessions.

Course Goals

Specific Outcomes for this course are that

- Students will learn fundamental concepts of machine learning
- Students will learn the theoretical underpinnings of deep learning
- Students will learn contemporary architectures, applications, and challenges of deep learning
- Students will learn to design, implement, and validate deep learning-based solutions to machine learning problems

This course will address the following CSAB ABET Criterion 3 Student Outcomes

Graduates of the program will have an ability to:

1. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
2. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
3. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
4. Apply computer science theory and software development fundamentals to produce computing-based solutions.

Course Topics

Homework assignments **are released / are due** Wednesdays (latest submission 11.59pm).

Week 1 (Jan 24): Introduction and Basics

Synchronous: Welcome and Course Logistics

Asynchronous: Please review the following material

L-1) Overview

L-2) Basics Part I: Image Features, Regression, and Classification

Wednesday, Jan 26: Homework 1 released

Week 2 (Jan 31): Basics

Synchronous: Recitation Week 1

Asynchronous: Please review the following material

L-3) Basics Part II: Regularization and Optimization

L-4) Computational Graphs and Backpropagation Part I

Voluntary review: Intro to Python video

Wednesday, Feb 2: Homework 1 due, Homework 2 released

Week 3 (Feb 07): Convolutional Neural Networks

Synchronous: Q/A Week 2

Asynchronous: Please review the following material

- L-5) History of and Introduction to Neural Networks
- L-6) Convolutional Neural Networks

Week 4 (Feb 14): Training Neural Networks

Synchronous: Q/A Week 3

Asynchronous: Please review the following material

- L-7) Training Part I: Activation, Initialization, Preproc., Dropout, Batch norm
- L-8) Training Part II: Updates & Momentum, Augmentation, Transfer Learning

Wednesday, Feb 16: Homework 2 due, Homework 3 released

Week 5 (Feb 21): Architectures

Synchronous: Q/A Week 4

Asynchronous: Please review the following material

- L-9) **Inverse Classroom:** It's not working! Help!
- L-10) Network Architectures: AlexNet, VGG, ResNet, U-Net, ...

Wednesday, Feb 23: Homework 3 due, Homework 4 released

Week 6 (Feb 28): Architectures continued – **Form project groups**

Synchronous: Q/A Week 5 and **Inverse Classroom Discussion**

Asynchronous: Please review the following material

- L-11) **Inverse Classroom:** What does this network do?

Week 7 (Mar 07): Sequence Modeling

Synchronous: Q/A Week 6 and **Inverse Classroom Discussion**

Asynchronous: Please review the following material

- L-12) RNNs and LSTM

Wednesday, Mar 09: Homework 4 due, Homework 5 released

Week 8 (Mar 14): Unsupervised Learning

Synchronous: Q/A Week 7

Asynchronous: Please review the following material

- L-13) Unsupervised and Self-supervised Learning
- L-14) Autoencoders, Variational Autoencoders, and Disentanglement

Wednesday, Mar 16: Homework 5 due, Homework 6 released

Week 9 (Mar 21): Spring Break

The week of Monday Mar 21 is designated as spring break

Week 10 (Mar 28): Generative Models

Synchronous: Q/A Week 8

Asynchronous: Please review the following material

- L-15) Generative Adversarial Networks
- L-16) **Inverse Classroom:** Labeling? Ain't nobody got time for that.

Week 11 (Apr 04): Current Topics— **Start project work**

Synchronous: Q/A Week 10 and **Inverse Classroom Discussion**

Asynchronous: Please review the following material

L-17) Generalization, domain gaps, and explainable AI

L-18) Domain gaps and black boxes

Wednesday, Apr 06: **Project proposals due, Homework 6 due, Homework 7 released**

Week 12 (Apr 11): Current Topics

Synchronous: Q/A Week 11

Asynchronous: Please review the following material

L-19) DL4Health

L-20) Character and word embedding

Week 13 (Apr 18): Current Topics

Synchronous: Q/A Week 12

Asynchronous: Please review the following material

L-21) Natural Language Processing and Transformers

L-22) Deep Reinforcement Learning

Week 14 (Apr 25): Wrap up

Synchronous: Q/A Week 13

Asynchronous: Please review the following material

L-23) Human-centered AI, ethics, etc.

L-24) Wrap Up

Wednesday, Apr 27: **Homework 7 due**

Wednesday, May 04: **Final project reports due**

TBD Between May 9th and 17th (final exam slot, we will address time zone concerns):

Synchronous project pitch and breakout rooms

Course Expectations & Grading

We will have short weekly quizzes to test your comprehension and recollection of the course material you prepared asynchronously. The link to participate in quizzes will be shared during the respective synchronous session. Further, the course has 7 assignments: 3 are written and the remaining 4 focus on programming. The bulk of the homework assignment workload (1 to 6) is condensed into the first three quarters of the semester to free up time for the final project. Starting in Week 11, most time will be spent on the final project that will be completed in groups of four. Individual grades will be computed as a weighted combination of these factors:

- 1) Quizzes: 10%
- 2) Homework Assignments: 50%
- 3) Final Project: 40%

There is opportunity for bonus points. Bonus points are earned by completing additional assignments that will be described in homework assignment 7.

All quizzes after the “course add” deadline will count towards the grade. The **worst quiz score** of every student will be automatically **dropped** from scoring.

For late assignment submissions, you have a total of **5 late days** that you can use at your discretion. However, no smaller quantity than “day” can be used but you can use multiple days for the same homework. You do not need to request late days but will have to keep track of your remaining quota yourself. Once you run out of late days but submit late anyway, the submission will not award any points.

Assignments & Readings

See above schedule for assigned lectures and materials in every week.

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful, abiding by the *Computer Science Academic Integrity Policy*:

Cheating is wrong. Cheating hurts our community by undermining academic integrity, creating mistrust, and fostering unfair competition. The university will punish cheaters with failure on an assignment, failure in a course, permanent transcript notation, suspension, and/or expulsion. Offenses may be reported to medical, law or other professional or graduate schools when a cheater applies.

Violations can include cheating on exams, plagiarism, reuse of assignments without permission, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Ignorance of these rules is not an excuse.

Academic honesty is required in all work you submit to be graded. Except where the instructor specifies group work, you must solve all homework and programming assignments without the help of others. For example, you must not look at anyone else’s solutions (including program code) to your homework problems. However, you may discuss assignment specifications (not solutions) with others to be sure you understand what is required by the assignment.

If your instructor permits using fragments of source code from outside sources, such as your textbook or on-line resources, you must properly cite the source. Not citing it constitutes plagiarism. Similarly, your group projects must list everyone who participated.

Falsifying program output or results is prohibited.

Your instructor is free to override parts of this policy for particular assignments. To protect yourself: (1) Ask the instructor if you are not sure what is permissible. (2) Seek help from the instructor, TA or CAs, as you are always encouraged to do, rather than from other students. (3) Cite any questionable sources of help you may have received.

On every exam, you will sign the following pledge: "I agree to complete this exam without unauthorized assistance from any person, materials or device. [Signed and dated]". Your course instructors will let you know where to find copies of old exams, if they are available.

Report any violations you witness to the instructor.

You can find more information about university misconduct policies at these sites:

- For undergraduates: <http://e-catalog.jhu.edu/undergrad-students/student-life-policies/>
- For graduate students: <http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/>

Personal Wellbeing

- If you are sick please notify me by email so that we can make appropriate accommodations should this affect your ability to attend class, complete assignments, or participate in assessments. The [Student Health and Wellness Center](#) is open and operational for primary care needs. If you would like to speak with a medical provider, please call 410-516-8270, and staff will determine an appropriate course of action based on your geographic location, presenting symptoms, and insurance needs. Telemedicine visits are available only to people currently in Maryland. See also <https://studentaffairs.jhu.edu/student-life/student-outreach-support/absences-from-class/illness-note-policy/>
- The Johns Hopkins COVID-19 Call Center (JHCCC), which can be reached at 833-546-7546 seven days a week from 7 a.m. to 7 p.m., supports all JHU students, faculty, and staff experiencing COVID-19 symptoms. Primarily intended for those currently within driving distance of Baltimore, the JHCCC will evaluate your symptoms, order testing if needed, and conduct contact investigation for those affiliates who test positive. More information on the JHCCC and testing is on the [coronavirus information website](#).
- All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (385 Garland Hall; 410-516-4720; <http://web.jhu.edu/disabilities/>) to receive accommodations.
- Students who are struggling with anxiety, stress, depression or other mental health related concerns, please consider connecting with resources through the JHU Counseling Center. The Counseling Center will be providing services remotely to protect the health of students, staff, and communities. Please reach out to get connected and learn about service options based on where you are living this fall at 410-516-8278 and online at <http://studentaffairs.jhu.edu/counselingcenter/>.

- Student Outreach & Support will be fully operational (virtually) to help support students. Students can self-refer or refer a friend who may need extra support or help getting connected to resources. To connect with SOS, please email deanofstudents@jhu.edu, call 410-516-7857, or students can schedule to meet with a Case Manager by visiting the Student Outreach & Support website and follow “Schedule an Appointment”.

Classroom Climate

As your instructor, I am committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me or the TAs. I promise that we will take your communication seriously and to seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the Department Head (Randal Burns, randal@cs.jhu.edu), the Director of Undergraduate Studies (Joanne Selinski, joanne@cs.jhu.edu), the Assistant Dean for Diversity and Inclusion (Darlene Saporu, dsaporu@jhu.edu), or the Office of Institutional Equity (oiie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g. sexual harassment).

Family Accommodations Policy

You are welcome to bring a family member to class on occasional days when your responsibilities require it (for example, if emergency childcare is unavailable, or for health needs of a relative). In fact, you may see my children in class on days when no other accommodations are possible. Please be sensitive to the classroom environment, and if your family member becomes uncomfortably disruptive, you may leave the classroom and return as needed.

University Policy on Incompletes

The university recognizes that the Spring 2021 semester is surrounded with uncertainty and many students may find themselves in unexpected situations where study is difficult if not impossible. Students who are confronted with extraordinary circumstances that interfere with their ability perform their academic work may request an incomplete grade from the instructor. While approval of such a request is not automatic, it is expected that faculty will make every effort to accommodate students dealing with illness in the family and other pandemic-related hardships. The instructor and student must establish a timetable

for submitting the unfinished work with a final deadline no later than the end of the third week of the Fall 2021 semester. Exceptions to this deadline require a petition from the instructor to the student's academic advising office by the deadline. When entering an Incomplete grade in SIS, faculty must include a reversion grade which represents the grade the student will receive if s/he does not complete the missing work by the agreed-upon deadline.

Deadlines for Adding, Dropping and Withdrawing from Courses

Students may add a course up to **February 5, 2021**. They may drop courses up to **March 7, 2021** provided they remain registered for a minimum of 12 credits. Between **March 7 and April 16, 2021**, a student may withdraw from a course with a W on their academic record. A record of the course will remain on the academic record with a W appearing in the grade column to indicate that the student registered and then withdrew from the course.

For more information on these and other academic policies, see <https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/grading-policies/>

The Office of Academic Support at JHU

All programs are free to students, please see below for specifics:

- **PILOT Learning** – Peer-Led Team Learning
 - Students are organized into small study teams who meet weekly to collaborate on faculty-developed problems-sets. Students work together as a team to solve problems.
 - A trained student leader acts as captain and facilitates the weekly meetings using various strategies to foster a collaborative learning environment.
 - Registration opens on August 31st at 9pm EST; registration will remain open throughout the semester if space allows.
 - Contact: Ariane Kelly - ariane.kelly@jhu.edu
 - Instagram: @jhupilot
- **Learning Den Tutoring Program** - Small Group Tutoring
 - Small group, tailored tutoring of 4 students or less which is headed by one tutor. Visit the website (above) to access zoom links for drop-in sessions
 - Tutors can assist with but are not limited to:
 - Review and strengthening of subject-specific material knowledge
 - Assist with homework-like problems
 - Course-specific study skills and exam preparation
 - Contact: Kaitlin Quigley – quigley@jhu.edu
 - Instagram: @jhulearningden
- **The Study Consulting Program**
 - Students work one-on-one with a study consultant to set academic goals and develop customized strategies for success. Areas addressed include but are not limited to:
 - Time management
 - Note taking and test preparation

- Mastering large amounts of information
 - Contact: Dr. Sharleen Argamaso – sharleen.argamaso@jhu.edu
 - Instagram: @jhustudyconsulting
- **The Writing Center**
 - Undergraduate and graduate students in KSAS/Whiting School of Engineering can schedule 50-min sessions with a Writing Center tutor to look over a draft of written work (up to 10 pages) or a personal statement for graduate study
 - Contact: Robert Tinkle – rtinkle1@jhu.edu
 - Web Address: <https://krieger.jhu.edu/writingcenter/>