Missouri University of Science and Technology — Department of Computer Science
**Spring 2023** — **CS 6406: Machine Learning for Computer Vision**

# SYLLABUS

**Instructor:** *Sid Nadendla* — **Email:** *nadendla@mst.edu*

## 1 Course Information

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|---|---|
| **Course Website:** | https://sid-nadendla.github.io/teaching/SP2023_MLCV/index.html |
| **Lecture Venue and Time:** | 207 Comp Sci Building, T/Th 11:00AM - 12:15AM |
| **Instructor's Office Hours:** | Friday 3:00PM - 4:00PM, or by appointment |
| **Instructor's Contact Details:** | nadendla@mst.edu, (573) 341-4090 |
| **Grader's Name and Email:** | Mukund Telukunta, mt3qb@mst.edu |
| **Recitation Venue and Time:** | 220 Comp Sci Building, W 3:00PM - 4:00PM (biweekly) |
| **Grader's Office Hours:** | 220 Comp Sci Building, W 3:00PM - 4:00PM, or by appointment |

## 2 Intended Audience & Prerequisites

Students are expected to have a strong background in introductory machine learning and/or data mining ('C' or better in Comp Sci 5402), or introductory computer vision ('C' or better in Comp Sci 5404). Exposure to deep learning ('C' or better in Comp Sci 5001 – Introduction to Deep Learning) will greatly benefit students.

## 3 Textbook

In this course, we will **not** be following any one textbook. However, students are encouraged to refer the following reference books[1] from the following (non-exhaustive) list:

- Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning," The MIT Press, Cambridge, MA, 2016. URL: https://www.deeplearningbook.org/
- Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "Dive into Deep Learning," Release 0.17.0, Available on ArXiv: 2106.11342, URL: https://d2l.ai
- Aurlien Gron, "Hands-on machine learning with Scikit-Learn and TensorFlow : Concepts, Tools, and Techniques to Build Intelligent Systems," O'Reilly Media, Sebastopol, CA, 2017
  (Online copy available through S&T library).
- Bruce Hajek, Maxim Raginsky, "Statistical Learning Theory," Lecture Notes for ECE 543, University of Illinois, Urbana-Champaign, IL, USA, 2021, URL: http://maxim.ece.illinois.edu/teaching/SLT/.
- Matus J. Telgarsky, "Deep Learning Theory," Lecture Notes for CS 540, Version: 2021-10-27 v0.0-e7150f2d (alpha), University of Illinois, Urbana-Champaign, IL, USA, 2021.
  URL: https://mjt.cs.illinois.edu/dlt/
- Kush R. Varshney, "Trustworthy Machine Learning," Chappaqua, NY, USA, 2021.
  URL: http://trustworthymachinelearning.com/

[1] Links to free electronic copies of the books will be provided on the course website, if they are available.

The instructor will provide relevant articles/papers and open-source chapters as reading assignments on topics that are not covered in any of the reference books.

## 4 Description

Machine Learning for Computer Vision (MLCV) is a course that focuses on the fundamentals of deep learning (DL) and its application to solving computer vision (CV) problems. Fundamentals of learning are reintroduced from a PAC learning perspective (with special focus on neural networks), in addition to covering computationally efficient learning algorithms (including state-of-the-art software) to training/implementing deep neural networks. The course also covers the application of DL to a few well-known CV problems such as object detection. Finally, the course also introduces various techniques that address trust concerns (e.g. discrimination and lack of transparency) when DL based solutions are deployed in real-world applications.

## 5 Course Objectives

- Develop a deep understanding of the fundamental limits, design and analysis of neural networks.
- Gain mastery in computing gradients and necessary optimization-based training algorithms.
- Become proficient in solving well-known computer vision problems using deep learning.
- Cultivate the ability to reason how/why machine learning algorithms can lead to distrust upon deployment, either due to discrimination, lack of transparency, or adversarial threats.

## 6 Tentative Schedule & Prospective List of Topics

| **Topic** | **Subtopics** | **# Lectures** |
|---|---|---|
| Basics of Learning | Learning with Neural Networks, Optimization Algorithms | 7-8 |
| Efficient Computation | Computational Graphs, Computing on GPUs, Software | 4 |
| Deep Learning for CV | Advanced Architectures, Object Detection, Generative Models | 10 |
| Trustworthy Vision | Fairness, Explainability, Adversarial Machine Learning | 5-6 |

## 7 Grading Information

Students' grades will be calculated based on 4 topic-wise assignments[2], as shown below:

| | |
|---|---|
| **Assignment 1:** | 25% of total grade |
| **Assignment 2:** | 25% of total grade |
| **Assignment 3:** | 25% of total grade |
| **Assignment 4:** | 25% of total grade |
| **Final Grade:** | $[85-100]$: A, $[70-85)$: B, $[55-70)$: C, $<55$: F |

All the grades will be posted and maintained on Canvas.

[2]These topic-wise assignments could be further split into sub-assignments, if it helps students to better learn concepts.

# 8 Course Policies & Requirements

## 8.1 Required Materials and Homework Submissions

Students will submit all of their homework assignments via Gitlab, regarding which the instructor will discuss in the first class. Feedback will be uploaded back into the respective Gitlab folders privately, and the grades will be maintained on CANVAS. Late submissions will only be considered at the discretion of the instructor and the responsible teaching assistant/grader, only under valid circumstances. All other submissions will be disregarded and will be treated as a no submission.

In order for this plan to work successfully, students are mandated to have laptops, web cams, scanners[3] (if submitting a hand-written assignment), headsets, microphones, or other resources to learn in an online synchronous setting. Most of these items are available for checkout from the Service Desk in the library.

## 8.2 Lecture Format and Contingency Plans

This course will be offered in-person only. However, all lectures will be recorded in SP'23 via Zoom, which will be available to all students through CANVAS after the class. If the instructor has to travel for conferences or workshops during the semester, alternative lecture arrangements (if any) will be communicated with the students well in advance. If any class is cancelled, the updates will be reported through the schedule maintained on the course website.

All students are strongly encouraged to get vaccinated (and with a booster shot) against COVID-19 and Flu. If a student is unable to attend class in-person due to any illness, they should immediately contact the instructor so that appropriate arrangements can be made for the student to attend the class remotely.

# 9 Campus Policies and Resources

## 9.1 Accessibility and Accommodations

It is the university's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on a disability, please contact Student Accessibility and Testing at (573) 341-6655, email dss@mst.edu, or visit https://saat.mst.edu/ for information.

## 9.2 Writing Center

**Link:** https://writingcenter.mst.edu/

The Writing Center's mission is to assist **all students** in their efforts to become better writers, communicators, and critical thinkers. The Writing Center's peer consultants provide free individualized one-on-one and small-group conversations to offer meaningful feedback and guidance to students across all disciplines. More information can be found on their website and through email: writing@mst.edu.

## 9.3 S&Tconnect

**Link:** https://canvas.mst.edu/ ("Starfish" icon on left toolbar)

S&Tconnect enables students to request appointments with their instructors and advisors via the S&Tconnect

[3]There are several mobile applications available in different platforms that can use the camera in smart devices to scan documents.

calendar, which syncs with the Outlook Exchange calendar. S&Tconnect tracks each student's performance across all courses. S&Tconnect Early Alert enables students to be provided with services as need arises.

### 9.4 Student Success Center

**Link:** https://studentsuccess.mst.edu/

The Student Success Center (SSC) provides additional assistance for students academically and helps bolster non-academic life skills, such as goal setting and time-management. The SCC offers individualized tutoring, peer-to-peer life skill coaching, and campus programming while providing free coffee and hot beverages! All student Miners are encouraged to utilize the SSC's free services to get timely support and to enhance their S&T Miner Experience. Visit the SSC at 198 Toomey Hall, contact us at success@mst.edu, or join us on social media @sandtssc. To see the course offerings and times for SSC Tutoring, visit studentsuccess.mst.edu/tutoring/.

### 9.5 Statement about Copyright, FERPA, and Use of Video

It is vitally important that our classroom environment promote the respectful exchange of ideas. This entails being sensitive to the views and beliefs expressed during discussions, whether in class or online. Please obtain instructor permission before recording any class activity. It is a violation of University of Missouri policy to distribute such recordings without authorization and the permission of all who are recorded. More information is provided online at this link: https://www.umsystem.edu/ums/elearning/policies

### 9.6 Student Well-Being

**Link:** https://wellbeing.mst.edu/

Student Well-Being provides counseling services, health promotion initiatives, and prevention programs to empower the S&T community to thrive and enhance personal, academic, and professional success. Department office hours are Monday-Friday, 8 a.m. – 5:00 p.m. On the website, you can find information related to individual and group counseling, wellness consultations and trainings, resources for many health and wellness topics, and help for mental health crisis situations.

### 9.7 UCARE

**Link:** https://studentsupport.mst.edu/ucarereferrals/

UCARE is the central point of contact to connect a student who may be experiencing a personal, academic, financial, wellbeing, and/or other concern to support and resources. Sharing your concern with UCARE helps connect a student with solution-focused assistance to support their holistic well-being, success, and academic progress. A referral can be submitted at https://go.mst.edu/ucare-refer or by emailing ucare@mst.edu. For urgent matters, check out the after-hour and urgent resources here in this link: https://studentsupport.mst.edu/supportresources/afterhoursresources/.

### 9.8 Miner Well-Being Certification Program

**Link:** https://minerlink.mst.edu/student_checklists

The Miner Well-Being Certification Program is a semester-long certification where students can engage

with campus-wide services and initiatives that help develop skills that contribute to personal well-being and success. Housed in MinerLink, students can start the certification at any time in the spring or fall semesters, but it must be completed before the end of the semester in which they started it. Participants who finish the program will receive a certification of completion signed by the director of the Student Well-Being department, a letter of recommendation, and a badge in MinerLink.

### 9.9 Student Support and Community Standards

**Link:** https://studentsupport.mst.edu/

Student Support and Community Standards knows student life can be difficult. During your time at Missouri ST, you may have a friend or peer who needs help navigating their student experience, facing a challenge, or experiencing distress and could benefit from support and connection to resources. You are not alone. We have a dedicated team of Care Managers, numerous resources, and services to support you or your student, friend, or peer. This includes emergency funding support for unexpected emergency expenses. To learn more visit or apply online.

### 9.10 Student Veterans Resource Center

**Link:** https://svrc.mst.edu/

The Student Veterans Resource Center (SVRC) is the nexus of resources and support for student veterans at S&T. The SVRC provides student veterans with a "safe space" and a familiar atmosphere. The center's Veteran Consuls provide one-on-one consultations to guide students to various resources on campus, while its advisor provides students with VA health and benefits resources. Visit the SVRC at Harris Hall, Suite G10, and contact us at svrc@mst.edu.

### 9.11 Student Honor Code and Academic Integrity

- All students are expected to follow the Honor Code, which can be found at this link: http://stuco.mst.edu/honor-code/
- Student Academic Regulations handbook (ref. https://registrar.mst.edu/academicregs/conductofstudents/) describes the student standard of conduct relative to the University of Missouri System's Collected Rules and Regulations section 200.010, and offers descriptions of academic dishonesty including cheating, plagiarism and sabotage, any of which will be reported to the Vice Provost for Undergraduate Education.
- Other resources for students regarding academic integrity can be found at https://undergrad.mst.edu/academicintegrity/studentresources-ai/

### 9.12 Health and Well-Being CANVAS Course

**Link:** https://umsystem.instructure.com/enroll/G3LY3G

The Health and Well-Being Canvas Course features trainings, presentations, and other health and well-being resources for students. The course is free for all students, is non-credit, and students can enroll at any point in the semester.

## 9.13 Nondiscrimination, Equity, and Title IX

Missouri S&T is committed to the safety and well-being of our campus community, and to creating an environment free from discrimination and harassment.

The University does not discriminate on the basis of race, color, national origin, ancestry, religion, sex, pregnancy, sexual orientation, gender identity, gender expression, age, disability, protected veteran status, and any other status protected by applicable state or federal law. As used in this policy, the word "sex" is also inclusive of the term "gender."

Additionally, US Federal Law Title IX states that no member of the university community shall, on the basis of sex, be excluded from participation in, or be denied benefits of, or be subjected to discrimination under any education program or activity. Sexual harassment violations of this law include quid pro quo, hostile environment, sexual assault, dating/domestic violence, and stalking. The U.S. Department of Education has stated the prohibition on discrimination on the basis of sex includes sexual orientation and gender identity.

Students who are experiencing pregnancy or pregnancy-related conditions, including the birthing parent and non-birthing parent, have rights protected under Title IX. Students should contact the Office of Equity and Title IX to learn more about their rights and pregnancy-related assistance/accommodations provided by the University to ensure equitable access to University educational programs and activities.

In accordance with the University of Missouri's Collected Rules and Regulations, all faculty and staff are required to report any information concerning discrimination disclosed through communication including, but not limited to, direct conversation, email, social media, classroom papers and homework exercises to the Equity Officer/Title IX Coordinator.

**Office of Equity and Title IX:**

Equity Officer and Title IX Coordinator: Dr. Paul Hirtz
Phone: (573) 341-7734
Location: 900 Innovation Drive, Suite 500
E-mail: equity@mst.edu

## 9.14 Classroom Egress Maps

For all in-person instruction, faculty should explain where the classroom emergency exits are located. Classroom egress maps are posted at http://designconstruction.mst.edu/floorplan/.