USC IOVINE AND YOUNG ACADEMY

IDSN 543 Augmented Intelligence
Units: 4, Term—Day—Time: Spring 2025 MW 10-12

Location: USC Iovine and Young Hall (IYH) 3780 Watt Way, LA, 90089
Instructor: Thanassis Rikakis and Tamim Ahmed
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IT Help: https://uscedu.sharepoint.com/sites/IYAStudent/SitePages/IT-Resources.aspx
Hours of Service: 8:30 a.m. – 6:30 p.m. **Contact Info:** iyahelp@usc.edu

Course Description

Activity systems that successfully combine embodied human intelligence with interactive machine intelligence can promote augmented intelligence. Augmented intelligence requires a deep understanding of expert human performance within a complex challenge (e.g .surgery or product design) and the potential for expanding that performance through custom applications of machine intelligence.

The course aims to prepare students for developing augmented intelligence systems. The course
- introduces current machine learning techniques and analyzes the processes that each of the techniques uses for codifying and classifying human embodied activity.
- explores how each type of computational codification can synergize with the human intelligence involved in a human embodied activity within a complex challenge so as to generate augmented intelligence for societal impact
- groups students in teams to develop an augmented intelligence prototype related to a complex societal challenge

Learning Objectives
- working familiarity with key machine learning techniques
- ability to apply key machine learning techniques to the codification, segmentation and classification of structured and semi-structured embodied daily human activity (walking, seating, grasping, transporting, task performance) as well as expert human performance (e.g. education, rehabilitation, dancing)
- use such codifications to prototype machine and human intelligence interactions within daily activity and expert performance contexts so as to advance augmented intelligence

Recommended Preparation
This is a 500-level course that assumes students already have basic abilities for programming in Python, some familiarity with machine intelligence and some preparation in interaction design or interactive computing interfaces. Students can gain these abilities through taking ACAD 274 Designing Interactive Data Systems, ACAD 222 Introduction to Machine Intelligence, ACAD 280 Information Design, or similar courses.

Technological Proficiency and Hardware/Software Required
All necessary software and hardware will be available to the students through the IYA computing and data lab. Most technical assignments of the course will require the use of the lab in person.

Required Readings and Supplementary Materials
Excerpts from three books that can be found online (see syllabus outline for specific excerpts)
"Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
"Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili.
"Probabilistic Graphical Model: Principles and Techniques" by Daphne Koller and Nir Friedman

AND: Approximately **20 relevant papers** listed in the course schedule and available through the course BrightSpace portal.

Optional Readings and Supplementary Materials
Code examples and datasets will be made available to the students in the course and will be available on the lab machines.

Description and Assessment of Assignments
- Students are given individual technical assignments that advance working knowledge of machine learning techniques
- There are weekly reading assignments that are assessed through individual reading summary presentations
- There are regular quizzes to test the developing knowledge of the students in the readings and technical tools
- Student teams will be created in the first week of class (any may be tweaked). The student teams will be asked to integrate knowledge from the readings and machine learning techniques/exercises into an iterative representation of a Design Strategy for Augmented Intelligence
- In the middle of the semester new teams will be formed by the students based on their augmented intelligence areas of interest and application areas of interest. The teams will be asked to
  - Define an Augmented Intelligence Project within a Complex Challenge Space
  - Select and Organizing and Annotate Training Data for the Project
  - Develop and train machine intelligence prototypes for the chosen Project using the selected data
  - Building and demonstrate machine-human intelligence interaction prototypes for the Project
- Team Projects receive both a team grade and individual grade. Each student needs to record individual contributions to the team project and write a reflection on these contributions.

Assignment Submission Policy: No late assignments accepted.

Grading Scale: Course final grades will be determined using the following scale:
A 100-94; A- 94-90
B+ 90-87; B 87-83; B- 83-80
C+ 80-77; C 77-73; C- 73-70
D+ 70-67; D 67-64; F 64 or below

Grading Breakdown

Assessment Tool (assignments)	Points	% of Grade
Reading Presentation assignments - summary slide	2.5 points per assignment X 4 10 total	10%
Quizzes on readings and terminology	5 points per Quiz X 3 15 total	15%
Design Strategy for AI team Assignments	7 points per assignment X 3 21 total	21 %
Individual technical assignments	2 points per assignment X 2 4 total	4%
Participation and Attendance	10 points	10%
Final Student projects	20 points for team performance, 20 points for individual performance and reflection 40 total	40%
TOTAL	100	100

Course Attendance Policy

The Academy maintains rigorous academic standards for its students and on-time attendance at all class meetings is expected. Each student will be allowed two absences over the course of the semester for which no explanation is required. Students are admonished to not waste excused absences on non-critical issues, and to use them carefully for illness or other issues that may arise unexpectedly. Except in the case of prolonged illness or other serious issue (see below), no additional absences will be excused. Each unexcused absence will result in the lowering of the final grade by ⅓ of a grade (e.g., an A will be lowered to A-, and A- will be lowered to a B+, etc.). In addition, being tardy to class will count as one-third of an absence. Three tardies will equal a full course absence.

Students remain responsible for any missed work from excused or unexcused absences. Immediately following an absence, students should contact the instructor to obtain missed assignments or lecture notes and to confirm new deadlines or due dates. Extensions or other accommodations are at the discretion of the instructor. Automatically excused absences normally may not be used for quiz, exam or presentation days. Using an excused absence for a quiz, exam or presentation, such as in the case of sudden illness or other emergency, is at the discretion of the instructor.

In the case of prolonged illness, family emergencies, or other unforeseen serious issues, the student should contact the instructor to arrange for accommodation. Accommodation may also be made for essential professional or career-related events or opportunities. Additionally, students who need accommodations for religious observations should provide advanced notice to instructors and student athletes should provide Travel Request Letters. All accommodations remain at the discretion of the instructor, and appropriate documentation may be required.

Unless students provide an accommodation letter from USC's Office of Student Accessibility Services (OSAS) or a letter from IYA Student Services detailing visa or travel restrictions, attendance and active participation is expected in the classroom. Any student with such accommodations should submit their accommodation document to the instructor as soon as possible to discuss appropriate accommodations.

Students who are experiencing illness should not attend class in person. Please inform the instructor in advance of any class sessions that you can't attend for medical reasons, and accommodations will be arranged to view recorded lectures and submit alternatives to any missed class participation. Students will not be penalized for not attending class in person under these circumstances.

COURSE SCHEDULE

Date	Subject	Readings Due	Outcomes Due
January 13	Introduction to augmented intelligence, creation of augmented intelligence teams, discussion of design strategy for augmented intelligence, discussion of syllabus and course policies, review of prior technical knowledge needed	Book: Python Machine Learning ch-2-3	
January 15	Review of Python and Matlab knowledge needed, Review of prior MI Knowledge needed. Establish accounts on lab computers. Exercise in class: https://machinelearningmastery.com/machine-learning-in-python-step-by-step/	Excerpt: Hutchins reading from Cognition in the Wild Excerpt: Tacit Knowledge from How Facts Travel (LSE)	Team assignment prep: start work on systems diagram for Augmented intelligence (integrate readings)
January 20	NO CLASS MLK DAY		
January 22	Design strategy for augmented Intelligence, session 1	Paper: Integrating Machine Learning with Human knowledge	Team assignment 1: First systems diagram of Augmented intelligence; integrate readings
January 27	Basics of machine learning: supervised, unsupervised, and reinforcement learning. Understanding neural networks: architecture, layers, and activation functions; Deep learning frameworks: PyTorch basics;	Book: Python Machine Learning ch-2-3 Book: ``Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville. ch-6-8	Technical exercise 1: finish python exercise
January 29	Capturing, Modeling, Analyzing and Recognizing structured and semi-structured embodied human activity. Modeling structured and semi-structured human activity with neural networks. RGB Image segmentation and classification using Convolutional Neural Networks (CNN) using Coco dataset. Demos and exercises in class.	Paper: Sensor-based and vision-based human activity recognition: A comprehensive survey Paper: A survey on Deep Learning for Human Activity Recognition	Reading presentation 1: Present slides on readings and discuss
February 3	Modeling structured and semi-structured human activity with neural network – continued. RGB Image Segmentation and Classification using Faster RCNN; using Coco dataset. Demo and use of Yolo. Demos in class and exercises in class.	Paper: Detecting and Recognizing Human-Object Interactions Paper: Real-Time Flying Object Detection with YOLOv8 Web source: https://docs.ultralytics.com/tasks/segment/#models	Quiz 1 on machine intelligence terms, tools and functions
February 5	Design strategy for augmented Intelligence, session 2; how does human intelligence interact with convolutional networks and automated segmentation and classification of 2D image space		Team assignment 2: Second systems diagram for Augmented intelligence that includes capturing and analysis techniques
February 10	Modeling structured and semi-structured human activity continued - feature engineering that leverages human expertise. Feature extraction using open pose and faster RCNN.	Guide to OpenPose: Viso.ai Paper: OpenPose: Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields	

February 12	Temporal human activity video segmentation and classification using RNN, LSTM while also leveraging human domain expertise Introduction of clinical practice data set with time series data Complete LSTM assignment in class	Start LSTM assignment: Machine learning mastery	Technical assignment 2: Show current state of LSTM assignment
February 17	NO CLASS President's day		
February 19	Temporal human activity video segmentation and classification using Transformers while leveraging human domain expertise	Paper: Transformers in Time Series: A Survey	Quiz 2 on machine intelligence terms, tools and functions
February 24	Design strategy for augmented Intelligence, session 3 Creation of Project Teams		Team assignment 3: Third systems diagram of Augmented intelligence that integrates all readings and techniques covered up to this point as well as pertinent human interaction and augmentation
February 26	Characterizing and modeling probabilistic embodied human activity that has partly observable characteristics. Application of HMM: Time series human activity video segmentation with transition matrices from human expertise	Book: "Probabilistic Graphical Models: Principles and Techniques" by Daphne Koller and Nir Friedman. Ch- 6.2.3 Article: Hidden Markov models for time series classification	
March 3	Early take on Student Challenge Based Innovation Projects that leverage Augmented Intelligence		Project team assignment: Present your Challenges, your Augmented Intelligence approach and your capture, analysis and interaction techniques
March 5	Hierarchical representation of complex human learning in action. Hierarchical Bayesian modeling for human and machine learning. Dimensionality reduction using HBM generated weights	Book: "Probabilistic Graphical Models: Principles and Techniques" by Daphne Koller and Nir Friedman. Chapters 3.1 and 3.2 Paper: A Hierarchical Bayesian Model for Cyber-Human Assessment of Movement in Upper Extremity Stroke Rehabilitation	Quiz 3 on AI terms and literature
March 10	Design Strategy and Augmented Intelligence Student Projects	Project Presentations	Present your project proposal and the data set(s) to be used along with the Machine Intelligence and Augmented Intelligence Strategies to be used

March 12	Ensuring quality annotation for model training; How to design data annotation tools and related databases that are compatible with expert knowledge and machine intelligence Data dimensionality reduction -continued	Paper: Towards Standardized Processes for Physical Therapists to Quantify Patient Rehabilitation Book: Python Machine Learning ch-5 (not required but recommended)	Start Collecting and Organizing you Project Data
March 16-March 23	SPRING BREAK		
March 24	Challenges of missing data/noisy data in datasets for training machine intelligence. Methods for data imputation: statistical approaches and deep learning techniques. Improving computational performance with noisy data by leveraging expert knowledge and labels	Paper: SAITS: Self-Attention-based Imputation for Time Series Article: Simple techniques for missing data imputation Book: Python Machine Learning ch-4 (not required but recommended)	Continue developing your project
March 26	Ensemble models for Augmented Intelligence	Paper: Automated Movement Assessment in Stroke Rehabilitation	Reading presentation 2: Present reading slides for March 24 and 26 and discuss
March 31	Present updates of student projects		Present updates of student projects with examples of functioning prototypes
April 2	Large Language Models and Augmented Intelligence	Paper: LLMs and Collective Intelligence Paper: A new sociology of humans and machines	Continue the development and training of your Augmented Intelligence projects
April 7	Large Language Models and Augmented Intelligence - Transformers and LLMs	Paper: Augmenting human innovation teams with artificial intelligence: Exploring transformer-based language models	Reading presentation 3: Present slides on LLM readings for discussion, cover April 2 and 7 readings
April 9	Small Language Models and Structured Human Activity	Article: How Small Language Models Outperform LLMs for Less Paper: Scaling Laws for Neural Language Models	Reading presentation 4: Present slides on readings for discussion Continue the development of your projects
April 14	Present Current State of Projects in class and receive feedback		Present Projects
April 16	Structured Human Expression and SLMs	Paper: Information Lattice Learning	
April 21 and April 23	Collaboration time in class for student projects		
April 28 and April 30	Final Project Student Presentations		Final Presentations
FINAL	**Individual Contribution Reflection Due**		Discussion of Reflections and Course

Statement on Academic Conduct and Support Systems

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - *(213) 740-9355 – 24/7 on call*
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - *988 for both calls and text messages – 24/7 on call*
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining

custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - *(213) 740-9355(WELL) – 24/7 on call*
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - *(213) 740-5086*
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - *(213) 740-5086 or (213) 821-8298*
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - *(213) 740-0776*
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - *(213) 740-0411*
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - *(213) 740-2101*
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - *UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - *UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call*
Non-emergency assistance or information.

Office of the Ombuds - *(213) 821-9556 (UPC) / (323-442-0382 (HSC)*
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - *(323) 442-2850 or* otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.