# **Introduction to Machine Learning**

# **Spring 2021**

# Department of Computer Science and Engineering, CPSC5440 (CRN:21427) / CPSC 4430 (CRN:21424), Online, 3 credit hours

**Instructor:** Yu Liang

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**Teaching Assistants:**

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**Office Hours and Location:** Available through video conferences and emails.

**Course Meeting Days, Times, and Location:** Asynchronous Online

**Course Catalog Description:** This course (Introduction to Machine Learning) covers the development of machine learning models on exploit the data. Topics include: (1) Fundamentals: mathematics essentials (linear algebra, probability and statistics, optimization, vector calculus), Python programming, information theory (entropy and information gain); (2) basis of machine learning: data preparation, regression, supervised and unsupervised learning, clustering, decision tree and random forest, Bayesian network and hidden Markov model (HMM), dimensionality reduction, entropy, gini-index and decision tree, Bayesian network; (3) neural network: multiple-layer perceptron, convolutional neural network (CNN), recurrent neural network (RNN); and (4) advanced neural network: generative adversarial network (GAN), reinforcement learning.

**Course Prerequisites:** CPSC 5000 or department head approval.

**Restrictions:** NA.

**Mutually Exclusive:** Student receiving credit in CPSC 5195 may not receive credit in CPSC 5440

**Course Student Learning Outcomes:** Upon completion of the required credit hours in this subcategory, students will be able to: (1) Understand the paradigms of supervised and unsupervised machine learning. (2) Explain the fundamental issues and challenges of machine learning. (3) Identify the strengths and weaknesses of multiple machine learning approaches. (4) Formalize a task as a machine learning problem. (5) Identify suitable algorithms to tackle different machine learning problems. (6) Develop models and apply machine learning frameworks to solve practical problems.

**Course Fees:** Differential course fee will be assessed.

**Required Course Materials:** Textbook:Title: Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, 1st Edition, MIT Press (2016). ISBN-13: 978-0262035613 ISBN-10: 0262035618.

**Supplemental/Optional Course Materials:** Online materials will be provided by the instructor.

**Technology Requirements for Course:** In this class, you will need to use Python 3.6 or above, and Tensorflow 2.0.

**Technology Skills Required for Course:** Students are expected to have the knowledge of computer usage, internet search engines, Microsoft Word, Microsoft PowerPoint, and YouTube to complete course requirements. Students are expected to learn to take screenshots and/or screen-cast of your activities on your computer. Students are expected to check course pages at UTCLearn regularly for course information, assignment and exams. Students need access to a computer with a reliable internet connection to complete online assignments and exams. Test your computer set up and browser for compatibility with UTC Learn at http://www.utc.edu/learn/getting-help/system-requirements.php. Students will need to install Respondus Lockdown browser on their own computers in order to take online exams. Instructions to install and use Respondus Lockdown Brower can be bound at https://www.utc.edu/walker-center-teaching-learning/classroom-technology/respondus-lockdown-browser.php. Computers in the UTC library are installed with Respondus Lockdown Broswers. Students are encouraged to use the library computers if they do not have their own computers.

**Campus Safety Policy:** Due to COVID-19, there is a [campus safety policy](https://www.utc.edu/walker-center-teaching-learning/covid-19-safety-policy.php) (<https://www.utc.edu/walker-center-teaching-learning/covid-19-safety-policy.php>) for classes that meet on campus; please review this policy.

**COVID-19 Absence Policy:** Due to COVID-19, there is an [absence policy](https://www.utc.edu/walker-center-teaching-learning/covid-19-absence-policy.php) (<https://www.utc.edu/walker-center-teaching-learning/covid-19-absence-policy.php>) for Fall 2020.

**COVID Absences**

Prior to arriving on campus each day or attending a face-to-face class, students are to complete the daily self-check through the university approved application. Students who are instructed to stay home due to their responses are not to come to campus or attend face to face classes and instead follow up as directed through the self-check instructions.

Students **must notify the instructor of their absence by email within 48 hours, if possible.** Students are not required to provide the instructor with documentation of COVID-19 symptoms. Students will not be penalized for absences or late course assessments unless they are unable to complete course learning outcomes. Faculty will work with students to identify ways to complete course requirements.

Students must, if they are asymptomatic or if their symptoms do not interfere with their ability to participate in the course, **continue to participate in the course using the online assets and tools that the instructor makes available through UTCLearn including**: follow weekly guideline, finish assignments, and finish the final project.

If COVID-19 related illness results in any missed course work (face-to-face or online), students should **proactively work with the instructor to plan make-up work.**  It remains the student’s responsibility to complete any missed work such as assignments, tests, quizzes, labs, or projects outside of scheduled class time. But please realize that class will continue, and students may find themselves in the situation where they are unable to complete all work by the end of the semester. In such a case, students should consider a late withdrawal or an incomplete grade. Please contact the Records Office (423-425-4416) to learn more about the late withdrawal process.

If students have COVID-19 disability related risk factors that may affect attendance, students are strongly encouraged to register with the Disability Resource Center (423-425-4006) in order to receive necessary accommodations.

If students believe the instructor has not made reasonable and appropriate accommodations for absences, or makeup assignments, projects, labs, or exams due to COVID-19, students have the right to appeal according to UTC’s [Policies and Procedures for Student Complaints](https://www.utc.edu/dean-students/complaint.php) by filling out the [Student Complaint Form](https://cm.maxient.com/reportingform.php?UTChattanooga&layout_id=70) and submitting to the Office of the Dean of Students.

**Technology Support****:** If you have problems with your UTC email account or with UTC Learn (Canvas), contact IT Help Desk at 423-425-4000 or email [helpdesk@utc.edu](mailto:helpdesk@utc.edu).

**Student Technology:** If you have technology needs to access your courses and/or complete course requirements in Canvas, [submit a request](https://new.utc.edu/information-technology/learning-from-home) (<https://new.utc.edu/information-technology/learning-from-home>) with Information Technology.

**Student Accommodations:** If you have accessibility and accommodation requests, contact the [Disability Resource Center](https://www.utc.edu/disability-resource-center/index.php) (<https://www.utc.edu/disability-resource-center/index.php>) at 423-425-4006 or email [DRC@utc.edu](mailto:DRC@utc.edu).

**Course Assessments and Requirements:** Homework assignments and final project will be used to assess student learning outcomes. Students are expected to check UTC Learn regularly for due dates of assignments and final project and complete them on-time. Scores of assignments will contribute 70% to the final grade, while the score of the final project will contribute 30%.

**Course Grading**

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| --- | --- | --- |
| **Activities/**  **Evaluation Methods** | **Number** | **Percentages**  **(or Points)** |
| Term Exams | 2 | 36 % |
| Quizzes | TBD | 12 % |
| Homework (x5) | 5 | 42 % |
| Final Project (YouTube Presentation and Seven-pages technical report in IEEE format) in teamwork | 1 | 10 % |
| **Total** |  | **100%** |

**Course Grading Policy:** The letter grades will be assigned as follows: A: 90---100; B: 80---89; C: 70---79; D: 60---69; F: Below 60

**Instructor Grading and Feedback Response Time:** Instructors and TAs will respond within one-week after the deadline.

**Course and Institutional Policies**

**Late/Missing Work Policy:** To receive full credit for assignments and final project, students are expected to submit their work by the deadline. Assignments and final project submitted after the due date will receive a 20% reduction in score if submitted within 48 hours of the due date and will be assessed a grade of 0 after 48 hours of the due date. There are NO EXCEPTIONS, so plan accordingly. **If you don’t finish your assignment or final project independently unless otherwise instructed, you will receive a grade of zero for the assignment or final project, and you may receive further sanctions decided by the institution. Every student must submit the final project.** We will drop the lowest grade of the assignments. The final project grade will be used to calculate the course grade for every student.

**Student Conduct Policy:** UTC’s Student Code of Conduct and Honor Code (Academic Integrity Policy) can be found on the [Student Conduct Policy page](https://www.utc.edu/student-conduct/codes.php) (<https://www.utc.edu/student-conduct/codes.php>).

**Honor Code Pledge:** As a student of the University of Tennessee at Chattanooga, I pledge that I will not give or receive any unauthorized assistance with academic work or engage in any academic dishonesty in order to gain an academic advantage. I will exert every effort to insure that the Honor Code is upheld by myself and others, affirming my commitment to a campus-wide climate of honesty and integrity

**Course Attendance Policy:** *Attendance and participation are required.*

**Course Participation/Contribution:** Students are responsible for all material covered and homework assignments during their absence. Students are responsible for obtaining all handouts, assignments, etc. distributed during their absence. 0-tolerance about disruptive behavior (i.e., texting, chatting, cell phone, web-surfing) 0-tolerance about copy-and-paste of lab and homework assignment.

**Course Learning Evaluation:** Course evaluations are an important part of our efforts to continuously improve learning experiences at UTC. Toward the end of the semester, you will be emailed links to course evaluations and you are expected to complete them. We value your feedback and appreciate you taking time to complete the anonymous evaluations.

**UTC Bookstore:** The UTC Bookstore will price match Amazon and Barnes and Noble (<https://www.barnesandnoble.com/>) prices of the exact textbook - same edition, ISBN, new to new format, used to used format, and used rental to used rental format, with the same rental term.   For more information, go to the [Bookstore Price Match Program](https://bnc.pgtb.me/MMt77F) (<https://bnc.pgtb.me/MMt77F>), visit the bookstore, email [sm430@bncollege.com](mailto:sm430@bncollege.com) or call 423-425-2184.

**Course Calendar/Schedule:**

The schedule below contains class activities, assignments, and the final project. Note that the course schedule is “tentative” and subject to change based on student and/or pedagogical needs. All changes will be announced and posted on the course website.

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| ***Class/Date*** | ***Activities*** | ***Notes*** |
| Week 1 | * Orientation: Roadmap, classroom policy, and grading policy of 5440, and overview of Machine Learning theories and applications * Probability and Statistics |  |
| Week 2 | * Linear algebra: vector, matrix, tensor, space * Partial derivation and multi-variate calculus |  |
| Week 3 | * Optimization: gradient descent and Newton-Raphson * Decision tree based on Gini-index and entropy; random forest |  |
| Week 4 | * Supervised vs. Unsupervised Learning; classification vs. clustering. * Regression and Logistic regression * K-Means, K-Nearest Neighbor, Hierarchical Clustering | HW1 |
| Week 5 | * Dimensionality Reduction -- PCA * Association Rule Learning: Apriori algorithm and Eclat algorithm |  |
| Week 6 | * Bayesian Network (BN) * Hidden Markov Method (HMM) |  |
| Week 7 | * Computational Graph and Data-flow graph * Backward propagation – forward pass | Exam 1 |
| Week 8 | * Backward propagation – backward pass |  |
| Week 9 | * Multiple-Layer Perceptron Neural Network (MLP) | HW2 |
| Week 10 | * Convolutional Neural Network * AutoEncoder | HW3 |
| Week 11 | * Recurrent Neural Network and LSTM | HW4 |
| Week 12 | * Generative Adversarial Network (GAN): constructor and discriminator | HW5 |
| Week 13 | * Reinforcement Learning   + Value-based: DQN   + policy-based: A3C |  |
| Week 14 | * Summary of neural network architecture |  |
| Week 15 | Review of CPSC5440 | Exam 2 |
| Week 16 | Final project presentation and technical report |  |

**This syllabus is subject to change with notification on UTC Learn, email, or other written notification.**