



湖北工業大學  
HUBEI UNIVERSITY OF TECHNOLOGY

<b>Course Title</b>	Foundations of Machine Learning
<b>Course Code</b>	CMPT 4131
<b>Semester</b>	Summer 2026
<b>Course Length</b>	4 Weeks, 60 Contact Hours
<b>Credits</b>	4
<b>Instructor</b>	TBA
<b>Office</b>	TBA
<b>Email</b>	TBA
<b>Prerequisite</b>	MATH 2151 Linear Algebra I MATH 2231 Multivariable Calculus STAT 2851 Probability and Statistics CMPT 2141 Data Structures and Algorithms Proficiency in Python.

### Course Description:

This course provides a comprehensive introduction to the fundamental principles, algorithms, and applications of machine learning. The curriculum focuses on the mathematical foundations of learning from data, covering supervised learning (regression and classification), unsupervised learning (clustering and dimensionality reduction), and an introduction to deep learning architectures. Students will explore theoretical concepts such as the bias-variance tradeoff and generalization, alongside practical implementation using modern computational tools.

### Course Goals:

Students who successfully complete this course will demonstrate competency in the following general education core goals:

- **Critical Thinking Skills** – Students will engage in analytical thinking, demonstrating the ability to critically evaluate, synthesize, and apply knowledge to complex problems, and construct well-reasoned solutions and arguments.
- **Independent Research and Inquiry** – Students will conduct independent research, utilizing academic resources to explore relevant topics, formulating research questions, analyzing data, and presenting findings in a coherent, scholarly manner.
- **Problem-Solving and Application** – Students will apply theoretical concepts and methodologies learned in the course to real-world problems, demonstrating the ability to develop practical solutions informed by academic inquiry.
- **Global and Cultural Awareness** – Students will gain awareness of the global and cultural contexts relevant to the course, appreciating diverse perspectives

and considering the implications of their studies in a broader, international context.

### Student Learning Outcomes:

Upon completion of this course, students will be able to:

- Contrast different learning frameworks (supervised, unsupervised, and reinforcement) and identify their appropriate application domains;
- Mathematically derive updates for learning algorithms and implement them from first principles using numerical computing libraries;
- Formalize real-world problems into appropriate machine learning frameworks;
- Implement and tune classical learning algorithms from scratch and using libraries;
- Critically evaluate model performance using standard metrics and cross-validation;
- Understand the theoretical conditions under which learning is feasible and robust.

### Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

#### Textbooks:

- *Pattern Recognition and Machine Learning* by Christopher Bishop. Springer, 2016.
- *Machine Learning* by Zhou Zhihua. Springer, 2021.
- *The Elements of Statistical Learning (2nd Edition)* by Hastie, Tibshirani, and Friedman. Springer, 2009.

#### Software/Technology Requirements

- Language: Python 3.10+
- Environment: Jupyter Notebooks
- Key Libraries: PyTorch, Scikit-learn, Matplotlib.

### Course Requirements:

#### Algorithmic Implementation Assignments (30%)

These assignments focus on coding from scratch. Students are required to implement core algorithms (e.g., Gradient Descent, SVM, etc.) using only NumPy to ensure a deep understanding of the underlying mechanics rather than just calling library functions. Assessment focuses on implementation accuracy, code efficiency, and the ability to reproduce theoretical results on benchmark datasets.

#### Theoretical Problem Sets (20%)

These sets bridge the gap between abstract mathematics and algorithmic application. Students are tasked with proving properties of loss functions, deriving posterior distributions for Bayesian models, and calculating the VC-dimension of various hypothesis spaces.

#### Midterm Exam (20%)

A closed-book exam covering the first half of the semester (Foundations through Linear Models). It assesses the student's ability to recall definitions, perform manual calculations on toy datasets, and select appropriate models for specific scenarios.

#### Research-Oriented Term Project (30%)

This capstone experience challenges students to apply the course's methodologies to an open-ended research problem. Working in small teams of 2-3, students must perform data preprocessing, select and tune multiple models, and provide a rigorous comparative analysis. The final deliverable includes a research-style technical report and a code repository, evaluated on scientific rigor, innovation, and the clarity of the experimental design.

<b>Assessments: Activity</b>	<b>Percent Contribution</b>
Algorithmic Implementation Assignments	30%
Theoretical Problem Sets	20%
Midterm Exam	20%
Research-Oriented Term Project	30%

### Grading:

Final grades will be based on the sum of all possible course points as noted above.

<b>Grade</b>	<b>Percentage of available points</b>
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D	64-69
D-	60-63
F	0-59

### Course Schedule:

*The schedule of activities is subject to change at the reasonable discretion of the instructor. Minor changes will be announced in class, major ones provided in writing.*

<b>CMPT 4131 Schedule</b>		
<b>Lecture</b>	<b>Topic</b>	<b>Readings</b>
L1	Introduction: Experience & Inductive Bias	<i>Bishop</i> Ch 1
L2	Supervised Learning: Terminology & KNN	<i>Bishop</i> Ch 1.1
L3	Linear Regression & Least Squares	<i>Bishop</i> Ch 3.1
L4	Shrinkage Methods: Ridge & Lasso	<i>Bishop</i> Ch 3.3
L5	Complexity & Bias-Variance Tradeoff	<i>Bishop</i> Ch 3.2
L6	Linear Discriminant Analysis (LDA)	<i>Bishop</i> Ch 4.1
	*Problem Set 1 Due	
L7	Logistic Regression & Indicators	<i>Bishop</i> Ch 4.3
	*Assignment 1 Due	
L8	Probabilistic Generative Models	<i>Bishop</i> Ch 4.2
L9	Optimization: Gradient Descent & Newton	<i>Bishop</i> Ch 3.1.3
L10	Decision Trees: ID3, C4.5, CART	<i>Bishop</i> Ch 14.4
L11	Midterm Review & Discussion	Lectures 1-10
L12	<b>Midterm Theoretical Examination</b>	-
L13	Neural Networks: Basis Functions	<i>Bishop</i> Ch 5.1

L14	Error Backpropagation & Training *Problem Set 2 Due	<i>Bishop</i> Ch 5.2-5.3
L15	Regularization in Deep Networks *Assignment 2 Due	<i>Bishop</i> Ch 5.5
L16	Kernel Methods: Dual Representations	<i>Bishop</i> Ch 6.1
L17	Support Vector Machines: Max Margin	<i>Bishop</i> Ch 7.1
L18	SVM: Soft Margin & Robustness *Problem Set 3 Due	<i>Bishop</i> Ch 7.1.1
L19	Graphical Models: Directed & Undirected	<i>Bishop</i> Ch 8.1
L20	EM Algorithm & Mixture Models	<i>Bishop</i> Ch 9.2-9.4
L21	Unsupervised: K-Means & Clustering	<i>Bishop</i> Ch 9.1
L22	Dimensionality Reduction: PCA & SVD *Problem Set 4 Due	<i>Bishop</i> Ch 12.1
L23	Ensemble Learning: Bagging & Boosting *Assignment 3 Due	<i>Bishop</i> Ch 14.2
L24	Computational Learning Theory & PAC *Final Report Due	<i>Zhou</i> Ch 12
L25	Final Project Presentation & Review	-

### **Accommodation Statement:**

Academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow.

### **Academic Integrity Statement**

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in coursework may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

### **Other Items:**

#### **Attendance and Expectations**

All students are required to attend every class, except in cases of illness, serious family concerns, or other major problems. We expect that students will arrive on time, be prepared to listen and participate as appropriate, and stay for the duration of a meeting rather than drift in or out casually. In short, we anticipate that students will show professors and fellow students maximum consideration by minimizing the disturbances that cause interruptions in the learning process. This means that punctuality is a must, that cellular phones be turned off, and that courtesy is the

guiding principle in all exchanges among students and faculty. You will be responsible for the materials and ideas presented in the lecture.

**Assignment Due Dates**

All written assignments must be turned in at the time specified. Late assignments will not be accepted unless prior information has been obtained from the instructor. If you believe you have extenuating circumstances, please contact the instructor as soon as possible.

**Make-Up Work**

The instructor will not provide students with class information or make-up assignments/quizzes/exams missed due to an unexcused absence. Absences will be excused and assignments/quizzes/exams may be made up only with written documentation of an authorized absence. Every effort should be made to avoid scheduling appointments during class. An excused student is responsible for requesting any missed information from the instructor and setting up any necessary appointments outside of class.

**Access, Special Needs, and Disabilities**

Please notify the instructor at the start of the semester if you have any documented disabilities, a medical issue, or any special circumstances that require attention, and the school will be happy to assist.