Artificial Intelligence and Machine Learning: Theory and Practice

LMH Summer Programmes are provided by Lady Margaret Hall, a college in the University of Oxford

Course:	Artificial Intelligence and Machine Learning: Theory and Practice
Available:	Programme Session 1: 30th June 2025 to 18th July 2025 Programme Session 2: 21st July 2025 to 8th August 2025 Programme Session 3: 11th August 2025 to 29th August 2025
Lectures:	18 Hours
Seminars:	12 Hours
Tutorials:	3 Hours
Independent Study:	Approximately 120 Hours
Recommended Credit:	15 CATS / 7.5 ECTS / 4 US Credits

About this Course:	In our age of burgeoning smart technology and automation we are already seeing the transformative potential of Artificial Intelligence and Machine Learning in fields as diverse as finance, medicine, and manufacturing. This course offers a hands-on introduction to this future-focused area of research. You will begin with an introduction to the basics of programming in Python, in particular understanding object-oriented programming and its importance to deep learning. You will quickly proceed to an introduction to artificial intelligence, examining the fundamentals of supervised machine learning, including linear regression, logistic regression, neural networks, and gradient descent. In the second week of the course you will explore image processing, investigating transformations, convolutional filters, and edge detection, before an introduction to convolutional neural networks and some prominent CNN architectures such as VGG and ResNet. In the final part of the course, you will look at the core concepts of natural language processing, including sequence modeling, autoregressive models, and recurrent neural networks. This intensive course offers both a theoretical introduction to artificial intelligence and machine learning concepts, and an opportunity to put this knowledge into action in solving small-scale practical problems from diverse domains.

Lady Margaret Hall, University of Oxford
Norham Gardens, Oxford, OX2 6QA, United Kingdom
vacation.programmes@lmh.ox.ac.uk
+44 (0)1865 274295

Course Overview:	Week 1:
	• Introduction to Artificial Intelligence and Machine Learning
	  ○ Artificial Intelligence
	  ○ Machine Learning
	  ○ Deep Learning
	  ○ The history of the field
	• Introduction to Python Programming
	  ○ Simple Python programs
	  ○ Variable and Simple Data Types
	  ○ Basic Containers
	  ○ Loops
	  ○ Python Function
	• Object-Oriented Programming
	  ○ Objects and Classes
	  ○ Inheritance
	• Simple Linear Regression
	  ○ Functions and Basis
	  ○ Regression from Data
	  ○ Under-fitting, Over-fitting, and Regularisation
	Week 2:
	• Logistic Linear Regression
	  ○ Logistic Regression
	  ○ Kullback-Leibler Divergence and Cross-Entropy Loss
	• Optimisation Review
	  ○ Finding the Stationary Points of a Non-linear Function
	  ○ Gradient Descent
	  ○ Gradient Descent with Backtracking
	  ○ Stochastic Gradient Descent
	  ○ Second Order Methods: Newton Method
	• Neural Networks
	  ○ Basic Blocks of Neural Networks
	  ○ Activation Function
	  ○ Back-propagation and Weights Update in Neural Networks
	Week 3:
	• Convolutional Neural Networks
	  ○ Drawbacks of Neural Networks for Images
	• Advanced Topics
	  ○ Numpy
	  ○ Plotting in Python
	  ○ PyTorch Basics
	  ○ Data Loading and Transformation
	  ○ TensorFlow Basics
	  ○ MNIST Classification

Key Texts:	Bishop, C.M., *Pattern Recognition and Machine Learning*, New York, 2006. Goodfellow, I., Bengio, Y., and Courville, A., *Deep Learning*, Cambridge MA, 2016.
Learning Outcomes:	By the end of this course, you will: • Understand theoretical concepts of artificial intelligence and machine learning. • Know how basic artificial intelligence and machine learning tools are used in practice.

	• Know how to implement basic algorithms and train small networks for practical problems. • Be able to identify and use relevant artificial intelligence and machine learning tools in research. • Know how to implement and deploy artificial intelligence and machine learning algorithms on Google Cloud.
Admissions Requirements:	LMH Summer Programmes are designed for students who want to gain and develop knowledge in their chosen subject area. LMH Summer Programmes are intensive courses of study aimed at undergraduates who have completed one, two, or three years of their degree, or entry level postgraduate students. We will consider each applicant's academic ability and expect successful applicants to have a minimum grade point average equivalent to 2:1 level on the British grading scale. For example, this would mean at least a 3.2 GPA on the 4.0 grading scale in the United States, and 80% in China. **This course would suit STEM students in undergraduate or entry-level postgraduate study. Basic knowledge of calculus and linear algebra is required, and some experience of coding is recommended. Prior experience of artificial intelligence, machine learning, or the Python programming language is not required.** To participate fully in the programme all students will need to have proficiency in English. English language requirements for students who are not native English speakers: • TOEFL iBT score of 98 • IELTS score of 7.0 (no less than 6.5 in each component) • Duolingo English Test score of 125 (no less than 115 in each section) • Cambridge English Scale score of 185 If the language of instruction in your home institution is English you do not need to provide evidence of your English proficiency.
Teaching Methods:	Core syllabus material will be covered in lectures. Students attend four lectures each week and each lecture lasts 90 minutes. Seminars in smaller groups offer students space to discuss and debate, to dig deeper into difficult concepts, and to explore their own ideas. Student contribution to seminars is vital, and tutors will ensure everyone takes part in discussions. Seminars last 1 hour and students will take part in four seminars each week. Independent study is a crucial part of an LMH Summer Programme and of the Oxford teaching model. Tutors will recommend important reading to do between lectures and seminars that will enable students to come to class equipped to understand the information presented and prepared to take part in discussion and debate. Each week students will have an assignment of independent work to complete and submit in advance of the tutorial. There is an appropriate amount of space in the timetable to complete the necessary reading, preparation, and assignments. Students should expect to do around 40 hours of independent study each week. The final class each week is a tutorial, a very small class typically including only 2-4 students and central to the teaching methods used by the University of Oxford and on LMH Summer Programmes. Guided by their tutor, students will receive feedback on their assignments and be challenged to defend, justify, or even rethink their work and ideas. These rigorous academic discussions help develop and facilitate learning in a way that cannot be done with lectures and seminars alone.

Assessment:	On a three-week LMH Summer Programme students produce one piece of assessed work every week, which is submitted to the tutor and then discussed in a tutorial. At the end of each week students will receive a percentage grade for their submitted work. Each week's work counts for a third of the final percentage grade, so the final grade is an average of the mark received for each piece of work. Students who stay for six or nine weeks will receive a separate grade for each 3-week course.
Academic Credit:	Lady Margaret Hall will provide a transcript of students' assessed work, and can send this directly to your home institution if required. LMH Summer Programmes are designed to be eligible for academic credit, and we will communicate with home institution to facilitate this as needed. As a guide, we recommend the award of 15 CATS / 7.5 ECTS / 4 US Credits for each 3-week course.

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