

SYLLABUS

QM414E_0101_26

Introduction to Deep Learning

ACADEMIC AREA :	OPERATIONS AND ANALYTICS
PROGRAMME :	MASTER DAIS / PGE / UGTC LEVEL 4 PGE
PERIOD :	SPRING
COORDINATOR :	Dr. Ahmed ATIL
INSTRUCTOR(S) :	Dr. Ahmed ATIL
CONTACT HOURS :	24.0 hours
STUDY TIME :	null hours (Class preparation, homework and assessments)
CREDITS :	4.0 ECTS
AOL :	NO

PRE-REQUISITE MODULES :

Basic Programming in Python

Familiarity with Python programming, including basic syntax, functions, loops, and simple data structures. Prior exposure to scientific libraries such as NumPy is recommended, while experience with deep learning libraries (TensorFlow or PyTorch) is considered a plus but not mandatory.

Introductory Machine Learning Concepts

Basic understanding of machine learning principles, including the difference between supervised and unsupervised learning, common use cases, and simple models (e.g. linear models or basic classification).

Foundations of Mathematics for Data Science

Elementary knowledge of linear algebra (vectors, matrices, basic operations) and an intuitive understanding of how these concepts relate to data and models, without requiring advanced mathematical proofs.

Basic Probability and Statistics

Understanding of fundamental statistical notions such as mean, variance, probability distributions, and basic evaluation metrics, sufficient to interpret model results and performance.

Logical Thinking and Problem Solving

Ability to follow algorithmic logic, break down problems into steps, and reason about data and model behavior in a structured way.

MODULE DESCRIPTION :

Module Description

This course provides an introductory and practical overview of deep learning, a key subfield of machine learning based on neural networks for modeling complex data patterns.

Students progressively discover the core principles of deep learning, from basic neural networks to convolutional neural networks (CNNs), with a strong focus on intuition, real-world applications, and hands-on experimentation.

Throughout the course, students gain practical experience in building, training, and evaluating deep learning models using Python-based environments, while working on applied case studies and a group project.

By the end of the course, students will be able to understand the logic of deep learning models, implement simple neural network architectures, and interpret results for tasks such as classification and image analysis.

CONTRIBUTION TO PROGRAMME LEARNING OBJECTIVES :

- Build and cultivate relationships to Connect people in multicultural & multisituational contexts #ConnectPeople

MODULE INTENDED LEARNING OUTCOMES (ILOs) :

Upon successful completion of this module, students will be able to:

Understand the foundations of deep learning

Explain the core concepts of deep learning, including neural network architectures, activation functions, and the general training process.

Design and implement basic neural network models

Build and train simple deep learning models using Python-based tools and frameworks, following a structured and reproducible workflow.

Apply deep learning techniques to real-world datasets

Analyze real-world data and develop deep learning models to address common tasks such as classification and regression, with a particular focus on image-based problems.

Evaluate and improve model performance

Assess model performance using appropriate evaluation metrics and apply basic optimization and tuning techniques to improve results.

Recognize ethical and societal implications of deep learning

Identify ethical, social, and responsible AI considerations related to the use of deep learning technologies, including bias, transparency, and responsible deployment.

TOPICS COVERED :

Topics Covered

Foundations of Deep Learning

Introduction to deep learning, its place within artificial intelligence and machine learning, key concepts, and real-world use cases.

Neural Networks and Basic Architectures

Principles of artificial neural networks (ANNs), including feedforward networks, and an introduction to convolutional neural networks (CNNs) for image-based data.

Training Neural Networks

Core training mechanisms such as forward and backward propagation, gradient descent, and model optimization, presented with an intuitive and practical approach.

Model Performance and Regularization

Common issues such as overfitting and underfitting, and basic regularization techniques including dropout, normalization, and simple data augmentation strategies.

Applications and Case Studies in Deep Learning

Practical applications of deep learning in areas such as image classification, pattern recognition, and introductory computer vision tasks, supported by real-world datasets.

RESEARCH-LED TEACHING :

Research-Led Teaching

This course adopts a research-led teaching approach, introducing students to key ideas and recent developments in neural networks and deep learning through selected case studies and applied examples.

Students are exposed to simplified research insights and industry-driven applications, allowing them to understand how modern deep learning methods are used to solve real-world problems and how academic research contributes to ongoing technological advances.

The emphasis is on interpreting and applying research outcomes, rather than on mathematical formalism, enabling students to bridge foundational concepts with contemporary deep learning practices.

CSR AND SUSTAINABLE DEVELOPMENT GOALS :

Corporate Social Responsibility (CSR) and Sustainable Development Goals (SDGs)

Ethics and Bias in AI: Focus on the ethical considerations in deep learning, including data bias, model fairness, and privacy.

Hours concerning CSR and Sustainable Development: 3 hours dedicated to CSR, discussing the environmental impact of deep learning and responsible AI practices.

Sustainable Development Goals Covered:

SDG 9: Industry, Innovation, and Infrastructure.

SDG 10: Reduced Inequalities (with a focus on fairness in AI).

SDG 12: Responsible Consumption and Production (especially regarding the computational resources used in deep learning).

CSR NB HOURS :

3

SUSTAINABLE DEVELOPMENT GOALS COVERED :

- 09 - Industry, innovation and infrastructure
- 10 - Reduced inequalities
- 12 - Responsible consumption and production

TEACHING METHODS :

Teaching Methods

Conceptual Lectures

Lectures introduce the core concepts and principles of deep learning in a structured and progressive manner, supported by visualizations, intuitive explanations, and interactive discussions to facilitate understanding.

Hands-on Practical Sessions

Practical laboratory sessions allow students to design, train, and evaluate neural network models using Python and standard deep learning frameworks. Real-world datasets are used to reinforce learning through experimentation and case-based practice.

E-learning Platform and Continuous Learning

An online learning platform is used for assignments, quizzes, self-paced learning modules, and continuous assessment. This platform enables students to monitor their progress and engage with supplementary learning resources throughout the course.

METHODS OF ASSESSMENT :

Continuous/Final	Group/Individual	Assessment	Weight	Duration	ILOs assessed
Continuous	Individual	Multimedia production	10%		1 , 2 , 3 , 4 , 5
Continuous	Group	Written assessment at home	30%		1, 2 , 3, 4, 5

Final	Individual	Final written exam	60%	3 Heures	1,2, 3, 4 ,5
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Assessment 1 details:

Continuous Assessment via E-learning Platform (10%) over 6 sessions

Description:

Students will complete online quizzes, assignments, and interactive exercises through the E-learning platform to reinforce their understanding.

Objective:

Assess and reinforce understanding of foundational concepts and principles as they progress through the course.

Assessment 2 details:

Group Project Evaluation (30%) over 5 sessions

Description:

Students will work in groups to design and implement a deep learning model based on real-world data, with a presentation at the end of the course.

Objective:

Encourage collaboration, practical application of knowledge, and the integration of ethical considerations and sustainability in model development.

Assessment 3 details:

Final Individual Assessment (60%)

Description:

A final examination will assess students' comprehensive understanding of deep learning concepts, architecture, and practical applications.

Content:

Includes theoretical questions, case analysis, and problem-solving, with an emphasis on ethical implications and real-world applications.

Objective:

Measure students' ability to independently apply deep learning skills, demonstrate critical understanding, and engage with advanced deep learning topics.

ACADEMIC INTEGRITY :

Academic misconduct encompasses various behaviors or actions that violate the principles of academic integrity, fairness, and honesty, thereby undermining the credibility of academic work, assessments, or research. Examples of academic misconduct include:

- Cheating
- Plagiarism
- Fabrication
- Gaining an unfair advantage
- Assisting others in committing academic misconduct, such as by utilizing generative AI

- Falsification of records or official documents
- Unauthorized access to restricted information or data
- Unauthorized or unethical use of generative AIS

Academic misconduct is a serious offense and can result in consequences such as module failure, research project failure, or even expulsion from the school. To prevent unintentional academic misconduct, it is essential to consult with your instructor to understand the specific rules and instructions pertaining to the use of AI in learning and assessment.

For more comprehensive information on academic integrity rules, principles, and disciplinary procedures, please refer to the Academic Integrity section of the Student Handbook.

BIBLIOGRAPHY :

Recommended Bibliography

"Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

"Neural Networks and Deep Learning" by Michael Nielsen [free online book : <http://neuralnetworksanddeeplearning.com/index.html>]

Additional Reading

MODULE PLAN SESSIONS :

Plan Session 01 :

Session 1 — Introduction to Deep Learning & Environment Setup

Presentation of Deep Learning and real-world applications

Overview of the working environment (Google Colab, Jupyter, notebooks)

Introduction to basic concepts: data, tensors, simple operations

Group Project presentation: objectives, group formation, expectations, timeline

Plan Session 02 :

Session 2 — From Data to Neural Networks

From data to models: intuition of learning

Linear models, optimization, gradients (conceptual, no math)

Introduction to Neural Networks and learning logic

Plan Session 03 :

Session 3 — Artificial Neural Networks (ANN)

Structure of an ANN (layers, neurons, activations)

Training a simple ANN model

Case Study (ANN): classification problem (e.g. Kaggle tabular dataset)

Plan Session 04 :

Session 4 — Training Neural Networks

Forward and backward propagation (intuition-based)

Overfitting, underfitting, and model improvement

Case Study (ANN): improving model performance on real data

Plan Session 05 :

Session 5 — Introduction to Convolutional Neural Networks (CNN)

Why CNNs for images

Images, pixels, filters, and feature extraction

Case Study (CNN): image classification dataset (e.g. Kaggle images)

Plan Session 06 :

Session 6 — CNNs for Images and Visual Data

CNN architectures and interpretation

Model evaluation and results analysis

Case Study (CNN): advanced image dataset (images / basic video frames)

Plan Session 07 :

Session 7 — Review, Q&A and Mock Exam

Global review of key Deep Learning concepts

Questions & answers

Mock exam in class (concepts, interpretation, short exercises)

Plan Session 08 :

Session 8 — Group Project Presentation

Group project presentations

Explanation of data, model choice, and results

Feedback, discussion, and course wrap-up

