# MODULE DESCRIPTION FORM

| Module Information | | | | | |
|---|---|---|---|---|---|
| **Module Title** | **Machine Learning** | | | **Module Delivery** | |
| **Module Type** | **Basic** | | | ☑ Theory<br>☑ Lecture<br>☑ Lab<br>☑ Tutorial<br>☑ Practical<br>☐ Seminar | |
| **Module Code** | **AIE313** | | | | |
| **ECTS Credits** | **6** | | | | |
| **SWL (hr/sem)** | **150 H/Sem.** | | | | |
| **Module Level** | 3 | | **Semester of Delivery** | 5 | |
| **Administering Department** | Artificial Intelligence Eng. | | **College** | College of Engineering | |
| **Module Leader** | Sarmad Kadhim Alkhfaji | | **e-mail** | sarmad.kazem@alayen.edu.iq | |
| **Module Leader's Acad. Title** | Assistant Prof. | | **Module Leader's Qualification** | Ph.D. | |
| **Module Tutor** | Firas Sabar Miftan | | **e-mail** | firas@utq.edu.iq | |
| **Peer Reviewer Name** | | | **e-mail** | Hasnaa.Mohammed@alayen.edu.iq | |
| **Scientific Committee Approval Date** | 27/9/2021 | | **Version Number** | 1.0 | |

| Relation with other Modules | | | |
|---|---|---|---|
| **Prerequisite module** | **NONE** | **Semester** | |
| **Co-requisites module** | **NONE** | **Semester** | |

| Module Aims, Learning Outcomes and Indicative Contents | |
|---|---|
| **Module Objectives** | **Introduction in Machine Learning, Deaf Learning, Learning by Instruction, Example-based learning, Learning by Analogy, Modeling and Simulation, Learning Theory, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Applications of Supervised Learning, Linear Regression, Gradient Descent, Stochastic Gradient Descent, Ensembling and Overfitting, Parametric and Non-parametric Algorithms, Locally Weighted Regression, inductive Bias of Linear Regression, Motivations for Logistic Regression, Logistic Regression, Perceptron and Newton's Method, Intelligent Modeling.** |

| | | | |
|---|---|---|---|
| **Module Learning Outcomes** | Knowledge | A1 | A1.1 Define the fundamental concepts of Introduction in Machine Learning and the main paradigms of learning, including Deaf Learning, Learning by Instruction, Example-based Learning, and Learning by Analogy.<br>A1.2 Explain key principles from Learning Theory and their role in Modeling and Simulation for real-world applications.<br>A1.3 Choose appropriate learning methods, distinguishing between Supervised Learning, Unsupervised Learning, and Reinforcement Learning.<br>A1.4 Illustrate practical Applications of Supervised Learning such as Linear Regression, and the optimization techniques of Gradient Descent and Stochastic Gradient Descent.<br>A1.5 Differentiate between Ensembling techniques and Overfitting, and distinguish Parametric and Non-parametric Algorithms.<br>A1.6 Distinguish advanced techniques like Locally Weighted Regression and understand the Inductive Bias of Linear Regression.<br>A1.7 Propose motivations for Logistic Regression and explore its implementation along with Perceptron and Newton's Method.<br>A1.8 Select Intelligent Modeling approaches and their effectiveness in solving real-world Machine Learning problems. |
| | | A4 | A4.1 Recognize the paradigms of Supervised Learning, Unsupervised Learning, and Reinforcement Learning.<br>A4.2 Identify common Applications of Supervised Learning.<br>A4.3 Apply Linear Regression using Gradient Descent and Stochastic Gradient Descent.<br>A4.4 Compare Parametric and Non-parametric Algorithms and their performance on real datasets.<br>A4.5 Create predictive and classification models, including Logistic Regression, to address real-world problems.<br>A4.6 Develop strategies to prevent Overfitting and apply Ensembling methods for more robust models.<br>A4.7 Predicate the selection of algorithms based on data characteristics, performance, and model interpretability.<br>A4.8 Evaluate intelligent modeling approaches, including the Perceptron, Newton's Method, and integrated frameworks for solving complex tasks. |

| | | | |
|---|---|---|---|
| | Skills | B1 | B.1.1 Function efficiently as an individual<br>B.1.2 Function as a member of multidisciplinary and multicultural teams. |
| | | B3 | B.3.1 Acquire and apply new knowledge.<br>B.3.2 Practice the strategies of searching for information in life – long self-learning |
| | Ethics | C3 | C.3.1 Utilize contemporary technologies<br>C.3.2 Make use of codes of practice and standards, quality guidelines. |

| | |
|---|---|
| **Indicative Contents** | Indicative content includes the following.<br>Unit 1: Introduction to the history of Machine Learning evolution , Deaf Learning, Learning by Instruction, Example-based learning, Learning by Analogy, Modeling and Simulation, Learning Theory. [6 hours]<br>Unit 2: Supervised Learning, Unsupervised Learning. [8 hours]<br>Unit 3: Reinforcement Learning, Applications of Supervised Learning, Linear Regression. [4 hours]<br>Unit 4: Gradient Descent, Stochastic Gradient Descent, Ensembling and Overfitting, Parametric and Non-parametric Algorithms. [6]<br>Unit 5: Locally Weighted Regression, inductive Bias of Linear Regression, Motivations for Logistic Regression, Logistic Regression, Perceptron and Newton's Method, Intelligent Modeling. [6 hours] |

## Learning and Teaching Strategies

| | |
|---|---|
| **Strategies** | • Presentation<br>• Interactive learning<br>• Discussions<br>• Brainstorming<br>• Group Solving Problems<br>• Problem-Based Learning<br>• Self-learning |

## Student Workload (SWL) for 15 weeks

| | | | |
|---|---|---|---|
| **Structured SWL (h/sem)** | 78 | **Structured SWL (h/w)** | 5.2 |
| **Unstructured SWL (h/sem)** | 72 | **Unstructured SWL (h/w)** | 4.8 |
| **Total SWL (h/sem)** | 150 | | |

| Module Evaluation<br>تقييم المادة الدراسية | | | | | |
|---|---|---|---|---|---|
| | | **Time/Number** | **Weight (Marks)** | **Week Due** | **Relevant Learning Outcome** |
| **Formative assessment** | **Quizzes** | 2 | 10% (10) | 5 and 10 | A1, A4 |
| | **Assignments** | 2 | 10% (10) | 2, 4,6,8,10,12 and 14 | A1, A4 |
| | **Projects / Lab.** | | | | A1, A4, B1, B3, C3 |
| | **Report** | 1 | 10% (10) | 13 | A1, A4, B1, B3 |
| **Summative assessment** | **Midterm Exam** | 1hr | 10% (10) | 7 | A2 |
| | **Final Exam** | 3hr | 50% (50) | 15 | A2, A5 |
| **Total assessment** | | | 100% (100 Marks) | | |

| Delivery Plan (Weekly Syllabus)<br>المنهاج الاسبوعي النظري | | |
|---|---|---|
| | **Material Covered** | **Los** |
| **Week 1** | Introduction in Machine Learning | A1.1 |
| **Week 2** | Deaf Learning, , Learning by Instruction, Example-based learning, Learning by Analogy, Modeling and Simulation, Learning Theory | A1.1, A1.2 |
| **Week 3** | Supervised Learning | A1.3, A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |
| **Week 6** | Unsupervised Learning | A1.3, A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |
| **Week 7** | Reinforcement Learning, | A1.3, A4,1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |
| **Week 8** | Applications of Supervised Learning | A1.4, A4.2, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |
| **Week 9** | Linear Regression, Gradient Descent, Stochastic Gradient Descent | A1.4, A4.3, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 10** | Mid -term EXAM | A1, A4 |

| | | |
|---|---|---|
| **Week 11** | Ensembling and Overfitting | A1.5, A4.6, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 12** | Parametric and Non-parametric Algorithms | A1.5, A4.4, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 13** | Locally Weighted Regression, inductive Bias of Linear Regression | A1.6, A4,7, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 14** | Motivations for Logistic Regression, Logistic Regression | A1.7, A4.5, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 15** | Perceptron and Newton's Method, Intelligent Modeling | A1.8, A4.8, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 16** | Rubric Exam<br>Preparatory week before the final Exam | A1,A2 , A3 , A4, A5 |

| **Delivery Plan (Weekly Lab. Syllabus)**<br>المنهاج الاسبوعي للمختبر | | |
|---|---|---|
| | **Material Covered** | **Los** |
| **Week 1** | Introduction to Machine Learning Environment: Setup Python, Jupyter Notebook, and essential ML libraries (NumPy, Pandas, scikit-learn, Matplotlib). | |
| **Week 2** | supervised Learning Practice: Implement simple supervised learning algorithms (KNN ) | A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |
| **Week 4** | Model Evaluation Metrics: Train/test split, accuracy, precision, recall, F1-score, confusion matrix. | A4.4, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 5** | Unsupervised Learning Practice: Implement clustering algorithms | A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |
| **Week 6** | Applications of Supervised Learning: Practice real datasets (e.g., regression and classification tasks). | A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2 |

| | | |
|---|---|---|
| **Week 7** | Regression Algorithms: Implement Linear Regression, Gradient Descent, Stochastic Gradient Descent on sample datasets. | A4.3, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 8** | Ensembling Techniques & Overfitting: Implement Bagging, Random Forests, and Boosting. Explore overfitting and regularization. | A4.6, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 9** | Parametric vs Non-parametric Algorithms: Implement algorithms (e.g., Linear Regression vs k-NN) and compare performance. | A4.4, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 10** | Mid -term EXAM | A1, A4 |
| **Week 11** | Logistic Regression: Implement logistic regression; compare with other classification methods. | A4.5, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 12** | Hands-on review of key algorithms and techniques | A4, B1.1, B1.2, B3.1, B3.2, C3.1 |
| **Week 13** | Implement a mini ML project | A1, A4,B1, B3, C3 |
| **Week 14** | Rubric Exam<br>Preparatory week before the final Exam | A1, A4 |

| Learning and Teaching Resources<br>مصادر التعلم والتدريس | | |
|---|---|---|
| | **Text** | **Available in the Library?** |
| **Required Texts** | **Andreas C. Müller & Sarah Guido**, *Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly Media, 2016. | NO |
| **Recommended Texts** | **Aurélien Géron**, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 3rd Edition, O'Reilly Media, 2022. | NO |
| **Websites** | https://eng.alayen.edu.iq//colleges/e/42 | |

| Grading Scheme<br>مخطط الدرجات | | | | |
|---|---|---|---|---|
| **Group** | **Grade** | التقدير | **Marks (%)** | **Definition** |
| **Success Group (50 - 100)** | **A** - Excellent | امتياز | 90 - 100 | Outstanding Performance |
| | **B** - Very Good | جيد جدا | 80 - 89 | Above average with some errors |
| | **C** - Good | جيد | 70 - 79 | Sound work with notable errors |
| | **D** - Satisfactory | متوسط | 60 - 69 | Fair but with major shortcomings |
| | **E** - Sufficient | مقبول | 50 - 59 | Work meets minimum criteria |
| **Fail Group (0 – 49)** | **FX** – Fail | راسب (قيد المعالجة) | (45-49) | More work required but credit awarded |
| | **F** – Fail | راسب | (0-44) | Considerable amount of work required |
| | | | | |

**Note:** Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.