

## COURSE SPECIFICATION DOCUMENT

<b>Academic School/Department:</b>	Science, Innovation & Technology
<b>Programme:</b>	Math & Data Science
<b>FHEQ Level:</b>	6
<b>Course Title:</b>	Machine Learning for Predictive Analytics
<b>Course Code:</b>	MATH 6102
<b>Total Hours</b>	160
Timetabled Hours:	45
Guided Learning Hours:	15
Independent Learning Hours:	100
<b>Credits:</b>	16 UK CATS credits 8 ECTS credits 4 US credits

### **Course Description:**

This course provides an in-depth understanding of Machine Learning (ML) and Predictive Analytics, focusing on algorithms, methodologies, and applications. Students will explore fundamental ML models, from supervised and unsupervised learning to more advanced topics such as deep learning and ensemble methods. The course emphasizes both theoretical understanding and practical implementation using real-world datasets. Students will be taught to use ML to build predictive models, evaluate their performance, and apply them to solve complex problems in various fields, including finance, healthcare, and technology.

### **Prerequisites:**

70 credits + MATH 5104 Linear Algebra and Multivariable Calculus or  
COMP 5102 Cyber Security or SENG 5101 Intermediate Software development with AI.

## **Aims and Objectives:**

### **Aims:**

- To introduce students to the principles and techniques of Machine Learning and Predictive Analytics.
- To provide hands-on experience with modern tools and frameworks for implementing machine learning models.
- To enable students to critically evaluate and select appropriate models and techniques based on problem context.
- To explore the ethical considerations and challenges associated with data-driven predictions and decision-making.

### **Objectives:**

- Develop an understanding of the core concepts and algorithms used in Machine Learning.
- Build and evaluate predictive models using real-world datasets.
- Gain proficiency in applying data pre-processing, feature engineering, and model selection techniques.
- Analyze the performance of models and understand limitations and overfitting challenges.
- Understand the ethical and practical implications of using Machine Learning for decision-making.

## **Programme Outcomes**

L6 AI, AII, AIII, BIII, CII, DIII

A detailed list of the programme outcomes is found in the Programme Specification. This is maintained by Registry and located at: <https://www.richmond.ac.uk/programme-and-course-specifications/>

## **Learning Outcomes:**

By the end of this course, successful students should be able to:

1. Demonstrate knowledge of key Machine Learning algorithms and their applications.
2. Apply various Machine Learning techniques, including supervised and unsupervised learning, to real-world datasets.
3. Implement and tune machine learning models using appropriate programming languages and tools (e.g., Python, R).
4. Evaluate model performance using statistical and machine learning metrics such as accuracy, precision, recall, F1-score, and ROC curves.
5. Critically assess the ethical considerations of deploying predictive analytics in practice, including biases in datasets and fairness.
6. Work collaboratively in teams to solve complex predictive analytics problems, presenting solutions and insights effectively.

## **Indicative Content:**

- Overview of Machine Learning paradigms (supervised, unsupervised, reinforcement learning) Predictive Analytics and its applications
- Data Preprocessing and Feature Engineering
- Supervised Learning - Regression (Linear, Ridge, Lasso) Classification (Logistic Regression, Decision Trees, k-Nearest Neighbours, Support Vector Machines)
- Unsupervised Learning - Clustering techniques (k-Means, Hierarchical Clustering, DBSCAN) Dimensionality reduction (PCA, t-SNE)
- Ensemble Methods - Bagging, Boosting (AdaBoost, Gradient Boosting), Random Forests. Stacking and Blending models.
- Model Evaluation and Hyperparameter Tuning
- Deep Learning Basics - Introduction to Neural Networks and Deep Learning
- Predictive Analytics in Practice - Real-world case studies in healthcare, finance, marketing, etc.
- Ethical issues in machine learning, including bias, fairness, and accountability
- Tools and Frameworks - Introduction to Python libraries and practical implementation through Jupyter Notebooks

**Assessment:**

This course conforms to the University Assessment Norms approved at Academic Board and located at: <https://www.richmond.ac.uk/university-policies/>

**Teaching Methodology:**

This course will be delivered face to face through a combination of lectures and interactive sessions. In addition to classroom activities, there are guided learning elements that are tutor led and arranged through Blackboard. These activities can be asynchronous online sessions, flipped classrooms, set readings with discussion boards or set guest lectures for example. Set activities are monitored by the instructor to ascertain student engagement. Students are encouraged to prepare for class and to play an active part, to raise questions, following-up ideas and interact with a wide range of provided material.

**Indicative Text(s):**

Géron, A. (2019) *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*. 2nd edn. Sebastopol, CA: O'Reilly Media.

James, G., Witten, D., Hastie, T. and Tibshirani, R. (2013) *An Introduction to Statistical Learning*. (with Applications in R). New York: Springer.

James G, A. and Witten, D. (2024) *An Introduction to Statistical Learning: with Applications in Python*. New York: Springer.

Kulkarni A. and Shivananda A. (2019) *Natural language processing recipes [electronic resource]: unlocking text data with machine learning and deep learning using Python* New York: Apress.

Murphy, K. P. (2012) *Machine Learning: A Probabilistic Perspective*. USA: MIT Press.

**Journals and websites**

*Journal of Analysis & Applications*.

*Journal of computational and graphical statistics: joint publication of American Statistical Association, Institute of Mathematical Statistics, Interface Foundation of North America*.

See syllabus for complete reading list.

**Change Log for this CSD:**

Nature of Change	Date Approved & Approval Body (School or LTPC)	Change Actioned by Academic Registry
First Edition	Nov 2024	