MANCHESTER 1824
The University of Manchester

# COMP24112: Machine Learning

## 2022/23 Examination Method and Content

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# Exam Information

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- 2-hour online exam.
- Exam questions include typical online question types, such as MCQ, calculated numeric, true/false, fill in the blank, short answer.
- Each question is worth 1 or 2 marks.
- Revision materials in Blackboard:
  - Lecture videos and notes
  - Supporting notes
  - Mentimeter and tutorial questions provided during lectures.
  - Revision practice questions
  - Past papers

# Chapter 1

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| Content |
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| Key definitions and concepts in machine learning. |
| Typical learning types (unsupervised, supervised, reinforcement learning). |
| Definition and examples of classification and regression tasks. |

# Chapter 2

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| Content |
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| K-NN rules for classification (core idea, pseudo code, usage). |
| K-NN rules for regression (core idea, pseudo code, usage). |
| Distance calculation between data points. |
| k-NN behaviour vs. neighbour number and training sample size. |

# Chapter 3

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| Content |
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| Classification performance measures (TP, FP, TN, FN, confusion matrix, specificity, sensitivity, precision, recall, $F_1$ score, ROC analysis). |
| Regression performance measures (RMSE, MAE, MAPE, $R^2$ score). |
| Concepts of sample error, true error, bias error, variance error, under-fitting, over-fitting. |
| Use given equations to compute confidence interval, and compare hypothesis via z-test. |
| Data splitting strategies and its usage in machine learning model training, hyper-parameter selection, and model testing. |

# Chapter 4

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| Content |
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| Basic machine learning ingredients (model, loss function, training). |
| Probabilistic and deterministic approaches for classification and regression. |
| Principle and usage of linear model, including single-output and multi-output. |
| Principle and usage of linear basis function model. |
| Core idea of kernel method, inner product in kernel space. |
| Principle and usage of logistic regression model, model output calculation given the input and weights. |

# Chapter 5

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| Content |
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| Calculation of sum of squares error, mean squared error, hinge loss, and cross entropy loss. |
| Basic idea of likelihood, log likelihood and maximum likelihood estimator. |
| Concept of regularisation and formulation of a regularisation term. |
| Principle and usage of (regularised) least squares model for classification and regression. |

# Chapter 6

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| Content |
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| Derive the least squares solution for simple classification and regression cases, where there are one or two input variables and one output variable. |
| Usage of normal equations (single-output and multi-output) for binary and multi-class classification. |
| Principles of gradient descent, stochastic gradient descent, and mini-batch gradient descent for optimization. |
| Derive the weight updating equations of least squares model for simple classification and regression cases, where there are one or two input variables and one output variable. |

# Chapter 7

| Content |
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| Single neuron model (adder and activation), and single layer perceptron. |
| Multi-layer perceptron/feed-forward artificial neural network, network output calculation given the weights and input. |
| Calculation of the number of neural network parameters to be trained, given the layer number and layer size. |
| Principle and usage of Perceptron algorithm. |
| Training methods for a neural network. |
| Basic idea of backpropagation. |
| Usage of artificial neural network (e.g., suitable for processing nonlinear data patterns, regression, two-class and multi-class classification). |

# Chapter 8

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| Content |
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| Key concepts and basic idea of SVM (separation margin, support vectors, slack variables). |
| Linear/nonlinear, separable/non-separable data patterns. |
| Usage of different types of SVM (hard-margin, soft-margin, linear and kernel SVM). |
| Pros and cons of different machine learning models |

# Chapter 9

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| Content |
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| Definition, key concepts and tasks in clustering. |
| Principle and usage of k-means algorithm. |
| Distance calculation between clusters (single-link, complete-link, average link). |
| Basic idea of hierarchical clustering. |
| Principle and usage of agglomerative algorithm. |
| Typical internal and external indexes for cluster validation. |

# Chapter 10

| Content |
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| Basic deep learning techniques. |
| Differences between deep learning and traditional machine learning strategies. |
| Convolutional neural network (architecture, convolutional, pooling, fully connected layers). |
| Compute the size of activation maps for CNN. |