# Subject Description Form

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| **Subject Code** | COMP4432 |
| **Subject Title** | Machine Learning |
| **Credit Value** | 3 |
| **Level** | 4 |
| **Pre-requisite / Co-requisite / Exclusion** | Nil (but students are preferred to have some previous exposure to introductory Artificial Intelligence/Data Analytics concepts and be familiar with basic notions in linear algebra and probability) |
| **Objectives** | The objectives of this subject are to:<br>1. present the basic principles, concepts and models of modern machine learning; and<br>2. introduce recent advances of machine learning technology with impactful applications in pattern recognition, computer vision and other areas. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br>(a) understand the major concepts of machine learning models and algorithms;<br>(b) critically evaluate the effectiveness of machine learning techniques;<br>(c) gain knowledge and abilities to apply machine learning techniques to various cutting-edge applications; and<br>(d) design machine learning solutions to solve new challenging problems in practice. |
| **Subject Synopsis/ Indicative Syllabus** | **Topic**<br>**1. Part I: Machine Learning Fundamentals**<br>• Linear algebra and probability<br>• Numerical computation and optimisation<br>• Learning tasks: Regression, classification, etc.<br>• Performance issues: Cross-validation, Overfitting and curse of dimensionality, Bias-variance dilemma, etc. |

**2. Part II: Models and Techniques**

- Supervised learning:
  - Parametric vs non-parametric methods
  - Decision tree based methods
  - Bayesian models
  - Neural networks and support vector machines
  - Advanced models: CNN
- Unsupervised learning:
  - k-means and hierarchical clustering
  - Spectral clustering and density-based clustering
  - Advanced models: autoencoder, embedding techniques, etc.
- Regression and boosting
- Feature selection and dimensionality reduction

**3. Part III: Applications**

- Handwriting recognition challenge, e.g. MNIST
- Object detection, recognition and tracking
  - Object feature descriptions: Engineering approach vs feature learning approach
  - Object detection examples, e.g. pixel clustering for face detection, etc.
  - Object recognition examples, e.g. face recognition via eigenface features
  - Object tracking examples, e.g. human motion tracking

**Teaching/ Learning Methodology**

39 hours of class activities including lectures on the main concepts and models, together with applicational case studies, tutorials and class/group discussions, laboratory works and student presentations. Additional reading of research papers will be assigned, whenever appropriate.

**Assessment Methods in Alignment with Intended Learning Outcomes**

| Specific assessment methods/tasks | % weighting | Intended subject learning outcomes to be assessed | | | |
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| | | a | b | c | d |
| **Continuous Assessment** | **55%** | | | | |
| 1. Assignments | | ✓ | ✓ | ✓ | |
| 2. Tests/Quizzes | | ✓ | ✓ | ✓ | |
| 3. Project | | | | ✓ | ✓ |
| **Examination** | **45%** | ✓ | ✓ | ✓ | ✓ |
| Total | 100% | | | | |

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignment: After-class assessment of the continuous understanding of the concepts, issues, models and applications of machine learning techniques by providing answers to given questions.

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| | Test/Quiz: In-class assessment of the understanding of the concept, issues, models and applications of machine learning techniques by providing answers to given questions.<br><br>Project: Assessment of problem solving ability in dealing with practical application problems by written reports and oral presentations.<br><br>End-of-term Assessment: Assessment of the overall performance by a written examination. | |
| **Student Study Effort Expected** | Class contact: | |
| | ▪ Lecture/Tutorial/Lab | 39 Hrs. |
| | Other student study effort: | |
| | ▪ Self-study | 83 Hrs. |
| | Total student study effort | 122 Hrs. |
| **Reading List and References** | **Reference Books:**<br><br>1. Hastie, T., Tibshirani, R. and Friedman, J., T*he Elements of Statistical Learning*, 2nd Edition, Springer, 2009.<br><br>2. Alpaydin, E., Intoduction to Machine Learning, 2nd Edition, MIT Press, 2010.<br><br>3. Shalev-Shwartz, S. and Ben-David, S., *Understanding Machine Learning: From Theory to Algorithms,* 2014.<br><br>4. Bousquet, O., Boucheron, S. and Lugosi, G., I*ntroduction to Statistical Learning Theory,* Advanced Lectures on Machine Learning.<br><br>5. Mohri, M., Rostamizadeh, A. and Talwalkar, A., *Foundations of Machine Learning*. USA, Massachusetts: MIT Press, 2012.<br><br>6. Vapnik, V. N., *The Nature of Statistical Learning Theory*. Springer, 2000.<br><br>7. Bishop, Christopher, *Pattern Recognition and Machine Learning,* Springer, 2006.<br><br>8. To be amended and updated at the beginning of the semester. | |