Subject Description Form

Subject Code	DSAI4203
Subject Title	Machine Learning
Credit Value	3
Level	4
Pre-requisite / Co-requisite / Exclusion	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: 1. present the basic principles, concepts and models of modern machine learning; and 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: (a) understand the major concepts of machine learning models and algorithms; (b) critically evaluate the effectiveness of machine learning techniques; (c) gain knowledge and abilities to apply machine learning techniques to various cutting-edge applications; and (d) design machine learning solutions to solve new challenging problems in practice.
Subject Synopsis/ Indicative Syllabus	**Topic** **1. Part I: Machine Learning Fundamentals** • Linear algebra and probability • Numerical computation and optimisation • Learning tasks: Regression, classification, etc. • Performance issues: Cross-validation, Overfitting and curse of dimensionality, Bias-variance dilemma, etc.

Subject Synopsis/ Indicative Syllabus (Cont'd)

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			
		a	b	c	d
Continuous Assessment	**55%**				
1. Assignments		✓	✓	✓	
2. Tests/Quizzes		✓	✓	✓	
3. Project				✓	✓
Examination	**45%**	✓	✓	✓	✓
Total	100%				

<table>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes (Cont'd)</td><td colspan="2">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.

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.

Project: Assessment of problem solving ability in dealing with practical application problems by written reports and oral presentations.

End-of-term Assessment: Assessment of the overall performance by a written examination.</td></tr>
<tr><td rowspan="5">Student Study Effort Expected</td><td colspan="2">Class contact:</td></tr>
<tr><td>▪ Lecture/Tutorial/Lab</td><td>39 Hrs.</td></tr>
<tr><td colspan="2">Other student study effort:</td></tr>
<tr><td>▪ Self-study</td><td>83 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>122 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2">Reference Books:

1. Hastie, T., Tibshirani, R. and Friedman, J., The Elements of Statistical Learning, 2nd Edition, Springer, 2009.

2. Alpaydin, E., Intoduction to Machine Learning, 2nd Edition, MIT Press, 2010.

3. Shalev-Shwartz, S. and Ben-David, S., Understanding Machine Learning: From Theory to Algorithms, 2014.

4. Bousquet, O., Boucheron, S. and Lugosi, G., Introduction to Statistical Learning Theory, Advanced Lectures on Machine Learning.

5. Mohri, M., Rostamizadeh, A. and Talwalkar, A., Foundations of Machine Learning. USA, Massachusetts: MIT Press, 2012.

6. Vapnik, V. N., The Nature of Statistical Learning Theory. Springer, 2000.

7. Bishop, Christopher, Pattern Recognition and Machine Learning, Springer, 2006.

8. To be amended and updated at the beginning of the semester.</td></tr>
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