LogoHbwTRU

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| **Course Outline**  **Department of Mathematics and Statistics**  **Faculty of Science** |

**DASC 5420-3**

**Theoretical Machine Learning (3,1,0)**

**Calendar Description**

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| This course will study the theory and applications of many foundational machine learning methods. Several supervised, semi-supervised and unsupervised learning approaches will be explored, including Bayesian methods, decision trees, kernel-based methods and neural networks methods, as well as areas of clustering and dimension reduction. We will also discuss how to model problems as machine learning problems. Methods discussed will be applicable to natural language processing, speech recognition, computer vision, data mining, adaptive computer systems and other areas. |

**Educational Objectives/Outcomes**

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| After completing this course, students should be able to:   1. Classify problems into different machine learning paradigms; 2. Design new (customized) learning methods using content in probability, statistics, calculus, linear algebra; 3. Evaluate models for their predictive or inferential abilities; 4. Draw conclusions in light of uncertainty or identify when uncertainty makes conclusions difficult with particular models; 5. Design standard unsupervised learning approaches including principal components, and clustering through hierarchical clustering and k-means clustering; 6. Create and train neural networks; understand how deep learning works; 7. Implement machine learning approaches in high-level computing language (e.g., R, Python). |

**Prerequisites**

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| • Successful completion of at least two university level computer programming courses  • Regression analysis (STAT 3060)  • Mathematical statistics/undergraduate inference (MATH 3050)  • Linear algebra (MATH 2120)  • Calculus 3 (MATH 2111) or equivalent  Strongly recommended: statistical design and inference (STAT 5310); graduate regression (STAT 5320); graduate databases (DASC 5410). |

**Co-requisites**

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| None |

**Texts/Materials**

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| Textbooks  Shai Shalev-Shwartz and Shai Ben-David, *Understanding Machine Learning*: *From Theory to Algorithms*, Cambridge Press, 2014.  Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press, 2016.  Tom Mitchell, *Machine Learning*, McGraw Hill, 1997. |

**Student Evaluation**

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| On-line Quizzes 5%  Assignments/Lab Work 30%  Mid-term Exam 25%  Final Project 40%  Students must pass the final exam with 70% or higher to pass the course. |

**Course Topics**

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| 1. Empirical risk minimization; 2. Learning Theory: PAC Learning; 3. Decision trees; 4. Clustering; 5. Perceptron; 6. Weak learnability and boosting; 7. Support vector machines; 8. Principal component analysis; 9. Graphical models and hidden Markov models; 10. Reinforcement learning; 11. Deep learning: neural networks, backpropagation. |

**Methods for Prior Learning Assessment and Recognition**

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| As per TRU policy. |

**Attendance Requirements – Include if different from TRU Policy**

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| As per TRU policy. |

**Special Course Activities – Optional**

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**Use of Technology – Optional**

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