Knight Foundation School of Computing and Information Sciences

Course Title: Introduction to Machine Learning **Date:** 11/3/2015

Course Number: CAP 4612

Number of Credits: 3

Subject Area: Foundations	**Subject Area Coordinator:** Leonardo Bobadilla **email:** bobadilla@cs.fiu.edu
Catalog Description: Topics will include concepts, principles, and approaches of machine learning, including classification, clustering, structured models and recommendation system.	
Textbook: "Machine Learning" by Tom Mitchell, McGraw Hill Education, 1997 (ISBN: 978-0070428072)	
References: "Pattern Recognition and Machine Learning" by Christopher M. Bishop. Springer. (ISBN: 9780387310732)	
Prerequisites Courses: COP 3530 and STA 3033	
Corequisites Courses: None	

Type: Elective for CS (Applications group).

Prerequisites Topics:

- Basic techniques of algorithm runtime analysis
- Knowledge of a standard data structure library of a major programming language
- Familiarity with basic probability concepts
- Familiarity with discrete and continuous probability functions

Course Outcomes:

1. Explain the differences among the three main styles of learning: supervised, reinforcement, and unsupervised. [Familiarity]
2. Implement simple algorithms for supervised learning and unsupervised learning. [Usage]
3. Determine which of the three learning styles is appropriate to a particular problem domain. [Usage]
4. Compare and contrast each of the following techniques, providing examples of when each strategy is superior: K-nearest-neighbors, decision trees, neural networks, and support vector machines. [Assessment]
5. Evaluate the performance of a simple learning system on a real-world dataset. [Assessment]
6. Characterize the state of the art in learning theory, including its achievements and its shortcomings. [Familiarity]
7. Explain the problem of overfitting, along with techniques for detecting and managing the problem. [Usage]

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Relationship between Course Outcomes and Program Outcomes

BS in CS: Program Outcomes	Course Outcomes
a) Demonstrate proficiency in the foundation areas of Computer Science including mathematics, discrete structures, logic and the theory of algorithms	1, 6, 7
b) Demonstrate proficiency in various areas of Computer Science including data structures and algorithms, concepts of programming languages and computer systems.	2, 3
c) Demonstrate proficiency in problem solving and application of software engineering techniques	2, 3, 4, 5
d) Demonstrate mastery of at least one modern programming language and proficiency in at least one other.	
e) Demonstrate understanding of the social and ethical concerns of the practicing computer scientist.	
f) Demonstrate the ability to work cooperatively in teams.	
g) Demonstrate effective communication skills.	1, 3, 7

Assessment Plan for the Course & how Data in the Course are used to assess Program Outcomes

Student and Instructor Course Outcome Surveys are administered at the conclusion of each offering, and are evaluated as described in the School's Assessment Plan: https://abet.cs.fiu.edu/csassessment/

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Outline

Topic	Lecture Hours	Outcome

• Machine Learning Introduction
  • Concepts
  • Applications
	2	1

• Supervised Learning – Discriminative Methods
  • Instance-Based Learning
  • Decision Tree Learning
  • Linear Classifiers
  • Neural Networks
  • Support Vector Machines
  • Kernels
	12	2, 3, 4, 5

• Supervised Learning – Generative Methods
  • Naïve Bayes Classifier
  • Markov Models
  • Hidden Markov Models and Viterbi
	10	2, 3, 4, 5

• Unsupervised Learning
  • K-Means Clustering
  • Mixture of Gaussians
  • Hierarchical Clustering
  • Hidden Markov Models
	8	2, 3, 4, 5

• Learning Theory
  • Error bounds
  • PAC Learning
	2	6

• Model Evaluation and Selection
  • Prediction and over-fitting
  • Train, validation, test split
  • Model Assessment
	2	3, 5, 7

Total	36	

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Course Outcomes Emphasized in Laboratory Projects / Assignments

Outcome	Number of Weeks
Homework problems addressing machine learning concepts & discriminative learning (Outcome 1)	1
Homework problems addressing generative learning (Outcome 2, 3)	1
Homework problems addressing unsupervised learning (Outcome 2, 3)	1
Homework problems addressing model selection and evaluation (Outcome 4)	1

Oral and Written Communication

No significant coverage

Written Reports		Oral Presentations	
Number Required	Approx. Number of pages	Number Required	Approx. Time for each
0	0	0	0

Social and Ethical Implications of Computing Topics

No significant coverage

Topic	Class time	Student Performance Measures

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Approximate Number of Credit Hours Devoted to Fundamental CS Topics

Fundamental CS Area	Core Hours	Advanced Hours
Algorithms	0.5	2.0
Software Design	0.5	-
Computer Organization and Architecture	-	-
Data Structures	0.0	-
Concepts of Programming Languages	-	-

Theoretical Contents

Topic	Class time
Machine Learning	12 hours

Problem Analysis Experiences

Identify problems that can be solved by machine learning

Solution Design Experiences

None

The Coverage of Knowledge Units within Computer Science Body of Knowledge[1]

Area	Topic	Type	Lecture Hours
DS	Discrete Probability	Tier1	1
IS	Basic Knowledge Representation & Reasoning	Tier2	1
IS	Basic Machine Learning	Tier2	10
IS	Reasoning Under Uncertainty	Elective	4
IS	Advanced Machine Learning	Elective	20
Total			**36**

[1]See Appendix A in *Computer Science Curricula 2013.* Final Report of the IEEE and ACM Joint Task Force on Computing Curricula, available at:
https://www.acm.org/binaries/content/assets/education/cs2013_web_final.pdf