ECE and CS 8725
Supervised Learning

Prerequisite: CS/ECE 4720/7720
or instructor consent

G. DeSouza

August 2014

Vision-Guided and Intelligent Robotics Lab
Electrical & Computer Engineering Department
University of Missouri - Columbia
Columbia, MO 65211
Description: This course introduces the theories and applications of advanced supervised machine learning methods. It covers hidden Markov model and expectation maximization (EM) algorithms, probabilistic graphical models, non-linear support vector machine and kernel methods. The course emphasizes both the theoretical underpinnings of the advanced supervised learning methods and their applications in the real world.

Instructor: Prof. Guilherme N. DeSouza
TA: N/A

G. DeSouza’s Office Hours: By appointment - EBW 325
E-Mail: DeSouzaG@missouri.edu

Course Texts:

References:
Papers from PAMI, AI, MLJ, JMLR, PR and various others will be handed out over the semester.

Course Format: Lectures will occur on Mondays, Wednesdays, and Fridays. There will be one midterm exam, plus one final project. Homework assignments (small projects) and paper reviews using a mock review site will be posted on the web and collected approximately every other week.

Lecture Notes and Assignments: Students should NOT count on availability of lecture notes. That is, students should take their own notes. However, class notes are USUALLY made available also on the web. Homework assignments will be made available in advance on the web at http://www.missouri.edu/~DeSouzaG (follow the link for ECE&CS8725).

Course Topics:
1. Hidden Markov models and EM algorithm
   a. Markov models
   b. Hidden Markov models
   c. Three main problems of HMM
   d. Maximum likelihood for HMM
   e. Forward-backward algorithm
   f. Sum-product algorithm for the HMM
   g. Viterbi algorithm
   h. Baum-Welch algorithm
   i. EM algorithms for HMM
   j. Scaling factors
2. Graphical Models
   a. Bayesian networks
   b. Conditional independence
   c. D-separation
   d. Markov random fields
   e. Factorization properties
   f. Inference on graphical models
   g. Learning the graph structure

3. Support vector machines (focused on non-linear SVM) and kernel methods
   a. VC dimension and structural risk minimization
   b. Large margin classifier
   c. Dual representation and Lagrange optimization
   d. Soft-margin classifier
   e. Kernel trick for non-linear SVM
   f. Multi-class SVM
   g. SVM for regression
   h. Relevance vector machines
   i. Constructing kernels
   j. Gaussian processes

4. Semi-Supervised Learning
   a. Generative models
   b. Low-density separation
   c. Graph-based methods
   d. Heuristic approaches
Homework/Small Projects: Homework will be in the form of small projects with two distinct parts: practical and theoretical questions. It will be assigned approximately once every two weeks.

Course Policies: Cheating is strictly prohibited. Cheating violates any concept of honesty, integrity, and engineering ethics and it shall not be tolerated. Any evidence of copying or plagiarism, partial or in full, is considered cheating. All parts caught cheating shall: 1) receive a score of 0; 2) be turned over to the Department Chairman and the Academic Provost; and 3) face the appropriate penalties established by the University, including the possibility of being expelled.

Grade Construction

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<thead>
<tr>
<th>GRADE COMPONENT</th>
<th>POINTS</th>
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<tbody>
<tr>
<td>Exam</td>
<td>100 (midterm)</td>
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<tr>
<td>Final Project</td>
<td>150 (Project and Presentation)</td>
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<td>Homeworks</td>
<td>150 (6x25)</td>
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<td>Total Points</td>
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The midterm exam may be cancelled and extra projects may be assigned instead.
# COURSE TIME SCHEDULE:

## Fall 2014

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<tr>
<th></th>
<th>HW1</th>
<th>HW2</th>
<th>HW3</th>
<th>HW4</th>
<th>HW5</th>
<th>Final Project</th>
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<td>Week 1</td>
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**Mid-Term – Oct 8th**

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<td>Week 9</td>
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<td>Week 13</td>
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**Thanksgiving Break (Nov.24 - Nov.28)**

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<td>Week 15</td>
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<td>Student Project Presentations</td>
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<td>Week 16</td>
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**FINAL EXAM: TBA**
Statement on Academic Honesty: Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

Statement on ADA: If you need accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class, or at my office.

Office location: __________ Office hours: __________

To request academic accommodations (for example, a notetaker), students must also register with the Office of Disability Services, (http://disabilityservices.missouri.edu), S5 Memorial Union, 882-4696. It is the campus office responsible for reviewing documentation provided by students requesting academic accommodations, and for accommodations planning in cooperation with students and instructors, as needed and consistent with course requirements. For other MU resources for students with disabilities, click on "Disability Resources" on the MU homepage.

Intellectual Pluralism: The University community welcomes intellectual diversity and respects student rights. Students who have questions or concerns regarding the atmosphere in this class (including respect for diverse opinions) may contact the Departmental Chair or Divisional Director; the Director of the Office of Students Rights and Responsibilities (http://osrr.missouri.edu/) or the MU Equity Office (equity@missouri.edu; http://equity.missouri.edu/) All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.