CSE 555 Introduction to Pattern Recognition

University at Buffalo SUNY

Syllabus for Spring 2009

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Instructor: Jason Corso (jcorso@cse)

Course Webpage: http://www.cse.buffalo.edu/˜jcorso/t/CSE555.

Syllabus: http://www.cse.buffalo.edu/˜jcorso/t/CSE555/syllabus.pdf.

Meeting Times: TR 11-12:20

Location: 10 Capen

Teaching Assistant: Albert Chen (aychen@cse)

Office Hours:

- Instructor: Tuesday 1-2:30 and Thursday 10-10:50.

- TA: Tuesday 9:30-11 and Thursday 12:20-13:30.

A Note On Contacting The Instructor: You are encouraged to contact the instructor or TA via the newsgroup or email. If you choose email, then you **must** 1) send the email from a buffalo.edu address and 2) include [CSE555] at the beginning of the command-line. Email that does not follow these conventions will not be read.

Main Course Material

Course Catalog Description: Foundations of pattern recognition algorithms and machines, including statistical and structural methods. Data structures for pattern representation, feature discovery and selection, classification vs. description, parametric and non-parametric classification, supervised and unsupervised learning, use of contextual evidence, clustering, recognition with strings, and small sample-size problems.

Prerequisites: It is assumed the students have a working knowledge of calculus, linear algebra, and probability theory.

Course Goals: After taking the course, the student should have a clear understanding of 1) the design and construction and a pattern recognition system and 2) the major approaches in statistical and syntactic pattern recognition. The student should also have some exposure to the theoretical issues involved in pattern recognition system design such as the curse of dimensionality. These goals are evaluated through the course project, homeworks, and exams.

Textbooks: The main (required) textbook for the course is

- Duda, R.O., Hart, P.E., and Stork, D.G. *Pattern Classification*. Wiley-Interscience. 2nd Edition. 2001.

The textbook has a website: http://www.rii.ricoh.com/˜stork/DHS.html.

Recommended supplemental textbooks are

- Bishop, C. M. *Pattern Recognition and Machine Learning*. Springer. 2007.

- Russell, S. and Norvig, N. *Artificial Intelligence: A Modern Approach*. Prentice Hall Series in Artificial Intelligence. 2003.

- Bishop, C. M. *Neural Networks for Pattern Recognition*. Oxford University Press. 1995.

- Hastie, T., Tibshirani, R. and Friedman, J. *The Elements of Statistical Learning*. Springer. 2001.

Course Work

Homeworks: There will be three homeworks, equally weighted. They will cover both theoretical and practical (implementation) aspects of the material. Students may collectively discuss the homework problems, but they must write them independently.

No sharing any of source code or written/typed materials is permitted. No stealing of any source code or written/typed materials off of the internet is permitted. No utilization of any third-party libraries, other than those explicitly mentioned in the assignment description, is permitted. Refer to the Academic Integrity statement at the end of the syllabus for more information; a zero tolerance policy on cheating will be adopted in this course.

Course Project: Each student will be required to implement a course project during the second half of the semester. Projects are not in groups, but again, discussion is permitted—however, actual working must be done alone (programming and writing). A report and five-minute demonstration of the project (to the instructor and TA) is required at the end of the semester. The project will be officially assigned immediately following spring break, and the instructor will provide 3 possible course projects including example data to work with. For example, one possible project may be to implement an AdaBoost face detector. However, students, especially those involved in or interested in pursuing research, are encouraged to pursue projects of their own design. Such a project must be discussed in person with the instructor during the first half of the semester to ensure the project is suitable.

No sharing any of source code or written/typed materials is permitted. No stealing of any source code or written/typed materials off of the internet is permitted. No utilization of any third-party libraries, other than those explicitly mentioned in the project description, is permitted. Refer to the Academic Integrity statement at the end of the syllabus for more information; a zero tolerance policy on cheating will be adopted in this course.

Programming Language and Source Code: For some homeworks and for the course project, programming will be required. Students must independently complete all programming assignments and turn in compilable/executable code. Students may choose the language from the following: Matlab 7+, Java 1.5+, and C/C++. However, your code must both compile and run on the CSE linux network (e.g., nickelback.cse.buffalo.edu).

Course Evaluation

The following is a description of how students will be evaluated in the course. The instructor reserves the right to make minor adjustments as necessary.

A final percentage score will be calculated as a weighted average of the course work according to the following table:

- Mid-Term Exam (20%)
- Final Exam (30%)
- Homeworks (8% each for 24%)
- Project (26%)

Mapping of percentage scores to letter grades will be on a curve and based on overall class performance. Letter grades will be given in the range of F to A (with minuses and pluses).

Late Work and Missed Exam Policy: **No** late work will be accepted. Ample time will be given to complete both the homeworks and the project; use it wisely. Similarly, the date of the exams will be known far in advance. Do not miss the exam. **No** make-up exams will be given. This is a firm policy. Do not expect special treatment.

Regrading: If you have a question about the grading of any piece of work, first consult with the teaching assistant who graded your work. If you cannot resolve your questions with the teaching assistant, you should consult with the instructor of the course.

Any questions about the grading of a piece of work must be raised within one week of the date that the work was returned by the teaching assistant or the instructor. In other words, if you do not pick up your work in a timely fashion, you may forfeit your right to question the grading of your work.

Incomplete ("I") Grades: Generally, incomplete ("I") grades are not given. However, very rarely, circumstances truly beyond a students control prevents him or her from completing work in the course. In such cases the instructor can give a grade of "I." The student will be given instructions and a deadline for completing the work, usually no more than 30 days past the end of the semester. University and department policy dictate that "I" grades can be given only if the following conditions are met:

- An Incomplete will only be given for missing a small part of the course.

- An Incomplete will only be given when the student misses work due to circumstances beyond his/her control.

- An Incomplete will only be given when the student is passing the course except for the missed material.

- An Incomplete is to be made up with the original course instructor within the time specied by the appropriate University regulation (see appropriate document above), and usually within the following semester.

- An Incomplete will not be given to allow the student to informally retake the entire course, and have that grade count as the grade of the original course.

Incompletes can not be given as a shelter from poor grades. It is your responsibility to make a timely resignation from the course if you are doing poorly for any reason. The last day to resign the course is Friday, March 27 2009.

Course Outline

The following is the list of topics we will cover this semester. The selection of topics has been made to provide the student with both a fair sampling and an indepth, useful know-how of the big field of pattern recognition. This has required that we drop some topics completely (e.g., Neural Networks) to allow for more indepth discussion of other topics (e.g., Dimension Reduction).

1. Introduction
2. Bayesian Decision Theory
3. Parametric Techniques
    (a) Maximum Likelihood Estimation
    (b) Bayesian Parameter Estimation
    (c) Sufficient Statistics
4. Component Analysis and Dimension Reduction
    (a) The Curse of Dimensionality
    (b) Principal Component Analysis
    (c) Fisher Linear Discriminant
    (d) Locally Linear Embedding
5. Non-Parametric Techniques
    (a) Kernel Density Estimators
    (b) Parzen Window
    (c) Nearest Neighbor Methods
6. Algorithm Independent Topics
    (a) No Free Lunch Theorem
    (b) Ugly Duckling Theorem
    (c) Bias-Variance Dilemma
    (d) Jacknife and Bootstrap Methods
    (e) Boosting
7. Clustering
    (a) K-Means
    (b) Expectation Maximization
    (c) Mean Shift
8. Support Vector Machines
9. Non-Metric Methods
    (a) Decision Trees
    (b) Syntactic Methods
10. Sequential Models
    (a) State-Space Models
    (b) Hidden Markov Models
    (c) Dynamic Bayesian Networks

Calendar

The calendar will be populated as the semester proceeds based on the above course outline and our progress.

	Week	Tuesday	Thursday	Read	Assignments
1	1/11	Introduction	Bayesian Decision Theory	Ch. 1,2	HW 1 Out
2	1/18	Bayesian Decision Theory	MLE and Bayesian Parameter Estimation	Ch. 2,3	
3	1/25	Bayesian Parameter Estimation and Sufficient Statistics	Curse of Dimensionality, PCA, and FLD	Ch. 3	HW 2 Out
4	2/1				HW 1 Due
5	2/8				
6	2/15				HW 2 Due HW 3 Out
7	2/22				
8	3/1		**Mid-Term In Class**		
	3/8	**Spring Recess – No Classes**	**Spring Recess – No Classes**		
9	3/15				Project Selection
10	3/22				HW 3 Due
11	3/29				
12	4/5				
13	4/12				
14	4/19				Projects Due
	4/26	**Reading Period**			
		Final Exam			

Additional Information

Newsgroup: There is a newsgroup, sunyab.cse.555, for this course. You must learn how to read news and subscribe to this newsgroup. You are expected to read the newsgroup on a daily basis. There will often be important material posted there, such as supplementary course notes, homework and sample exam questions, and occasionally late breaking news. You may post general course related articles to the newsgroup. Use discretion in posting articles related to homework assignments and the project: when in doubt, e-mail the TA or instructor first.

The news (nntp) server you need to connect to is news.buffalo.edu. Note that you must authenticate using your UBIT name and password to use this news server, and you must be connecting from a UB IP address (i.e. if you are not using a university machine, you need to use VPN). For further information on accessing the newsgroup, refer to http://ubit.buffalo.edu/newsgroups/index.php.

Similar Courses at This and Other Institutions: (incomplete and in no important order)

- Professor Sargur Srihari at UB. http://www.cedar.buffalo.edu/˜srihari/CSE555/index.html

- Professor Song-Chun Zhu at UCLA. http://www.stat.ucla.edu/˜sczhu/Courses/UCLA/Stat_231/Stat_231.html

- Professor Anil Jain at MSU. http://www.cse.msu.edu/˜cse802

- Professor Yann Lecun at NYU. http://www.cs.nyu.edu/˜yann/2007f-G22-2565-001/index.html

General Notes

If you dont understand something covered in class, ask about it right away. The only silly question is the one which is not asked. If you get a poor mark on an assignment or exam, find out why right away. Dont wait a month before asking. The instructor and teaching assistant are available to answer your questions. Dont be afraid to ask questions, or to approach the instructor or TA in class, during office hours, through the newsgroup or through e-mail. This course is intended to be hard work, but it is also intended to be interesting and fun. We think pattern recognition is interesting and exciting, and we want to convince you of this.

Disabilities

If you have a diagnosed disability (physical, learning, or psychological) that will make it difficult for you to carry out the course work as outlined, or that requires accommodations such as recruiting note-takers, readers, or extended time on exams or assignments, you must consult with the Office of Disability Services (25 Capen Hall, Tel: 645-2608, TTY: 645-2616, Fax: 645-3116, http://www.student-affairs.buffalo.edu/ods/). You must advise your instructor during the rst two weeks of the course so that we may review possible arrangements for reasonable accommodations.

Counseling Center

Your attention is called to the Counseling Center (645-2720), 120 Richmond Quad. The Counseling Center staff are trained to help you deal with a wide range of issues, including how to study effectively and how to deal with exam-related stress. Services are free and condential. Their web site is http://www.student-affairs.buffalo.edu/shs/ccenter/.

Distractions In The Classroom - Behavioral Expectations

The following is the text of a policy adopted by the Faculty Senate on 5/2/2000. You are expected to know and adhere to this policy.

OBSTRUCTION OR DISRUPTION IN THE CLASSROOM - POLICIES
UNIVERSITY AT BUFFALO

To prevent and respond to distracting behavior faculty should clarify standards for the conduct of class, either in the syllabus, or by referencing the expectations cited in the Student Conduct Regulations. Classroom "etiquette" expectations should include:

- Attending classes and paying attention. Do not ask an instructor in class to go over material you missed by skipping a class or not concentrating.

- Not coming to class late or leaving early. If you must enter a class late, do so quietly and do not disrupt the class by walking between the class and the instructor. Do not leave class unless it is an absolute necessity.

- Not talking with other classmates while the instructor or another student is speaking. If you have a question or a comment, please raise your hand, rather than starting a conversation about it with your neighbor.

- Showing respect and concern for others by not monopolizing class discussion. Allow others time to give their input and ask questions. Do not stray from the topic of class discussion.

- Not eating and drinking during class time.

- Turning off the electronics: cell phones, pagers, and beeper watches.

- Avoiding audible and visible signs of restlessness. These are both rude and disruptive to the rest of the class.

- Focusing on class material during class time. Sleeping, talking to others, doing work for another class, reading the newspaper, checking email, and exploring the internet are unacceptable and can be disruptive.

- Not packing bookbags or backpacks to leave until the instructor has dismissed class.

Academic Integrity

A zero-tolerance policy on cheating will be adopted in this course. The following is the formal statement of academic integrity. Source: http://www.cse.buffalo.edu/graduate/policies_acad_integrity.php

The academic degrees and the research findings produced by our Department are worth no more than the integrity of the process by which they are gained. If we do not maintain reliably high standards of ethics and integrity in our work and our relationships, we have nothing of value to offer one another or to offer the larger community outside this Department, whether potential employers or fellow scholars.

For this reason, the principles of Academic Integrity have priority over every other consideration in every aspect of our departmental life, and we will defend these principles vigorously. It is essential that every student be fully aware of these principles, what the procedures are by which possible violations are investigated and adjudicated, and what the punishments for these violations are. Wherever they are suspected, potential violations will be investigated and determinations of fact sought. In short, breaches of Academic Integrity will not be tolerated.

University Statements on Academic Integrity

The University at Buffalo Department of Computer Science and Engineering endorses and adheres to the University policy on Academic Integrity. Students should be familiar with that policy, as expressed in the following documents.:

- UB Office of Judicial Affairs statement on Academic Dishonesty. http://www.ub-judiciary.buffalo.edu/art3a.shtml#integrity

- UB Undergraduate Catalog statement on Academic Integrity. http://undergrad-catalog.buffalo.edu/policies/course/integrity.shtml

Departmental Statement on Academic Integrity in Coding Assignments and Projects

The following statement further describes the specific application of these general principles to a common context in the CSE Department environment, the production of source code for project and homework assignments. It should be thoroughly understood before undertaking any cooperative activities or using any other sources in such contexts.

All academic work must be your own. Plagiarism, defined as copying or receiving materials from a source or sources and submitting this material as one's own without acknowledging the particular debts to the source (quotations, paraphrases, basic ideas), or otherwise representing the work of another as one's own, is never allowed. Collaboration, usually evidenced by unjustifiable similarity, is never permitted in individual assignments. Any submitted academic work may be subject to screening by software programs designed to detect evidence of plagiarism or collaboration.

It is your responsibility to maintain the security of your computer accounts and your written work. Do not share passwords with anyone, nor write your password down where it may be seen by others. Do not change permissions to allow others to read your course directories and files. Do not walk away from a workstation without logging out. These are your responsibilities. In groups that collaborate inappropriately, it may be impossible to determine who has offered work to others in the group, who has received work, and who may have inadvertently made their work available to the others by failure to maintain adequate personal security. In such cases, all will be held equally liable.

These policies and interpretations may be augmented by individual instructors for their courses. Always check the handouts and web pages of your course and section for additional guidelines.

Departmental Policy on Violations of Academic Integrity

Any student accused of a violation of academic integrity will be so notified by the course director. An informal review will be conducted, including a meeting between these parties. After this review and upon determination that a violation has occurred, the following sanctions will be imposed. **It is the policy of this department that, in general, any violation of academic integrity will result in an F for the course, that all departmental financial support including teaching assistantship, research assistantship or scholarships be terminated, that notification of this action be placed in the student's confidential departmental record, and that the student be permanently ineligible for future departmental financial support.** A second violation of academic integrity will cause the department to seek permanent dismissal from the major and bar from enrollment in any departmental courses. Especially flagrant violations will be considered under formal review proceedings, which may in addition to the above sanctions result in expulsion from the University.