Prerequisites

EE 441 Linear Algebra (co-req.)  [May be waved by passing the EE placement exam.]
EE 503 or EE 464 Probability (pre-req.)
Basic familiarity with Matlab

Date, time, location

Lecture:  MW 3:30-4:50 PM, OHE 132  (and over DEN@Viterbi)
Discussion:  Th 5:00-5:50 PM, RTH 105  (and over DEN@Viterbi)

Course Description

Mathematical pattern recognition can be defined as: the categorization of input data into identifiable classes, via the extraction of significant features or attributes of the data, using mathematical techniques\(^1\).

This course covers concepts and algorithms for pattern recognition, with an emphasis on pattern classification and decision theory, incorporating machine learning techniques. The course will stress an understanding of different algorithms at both theoretical and practical levels, as well as their advantages and disadvantages. Topics will include: statistical classification and learning (Bayesian, parametric, and nonparametric); distribution free classification and learning (\(e.g.,\) perceptron, pseudoinverse/least squares, and support vector machines); artificial neural networks for pattern recognition. Treatment will include a sampling of relevant classical techniques, underlying fundamentals, and current techniques. The course will include a moderately sized course project in the second half of the semester using Matlab toolboxes, to give the student an opportunity to apply concepts from class to real-world data.

Reference:  1. Definition is adapted from Tou and Gonzalez, *Pattern Recognition Principles*. 
Course Outline

1. Introduction
   - Basic concepts in pattern recognition
   - A paradigm for pattern recognition

2. Distribution-Free Classification
   - Classifier design - different techniques
     - Discriminant functions
     - Linear, nonlinear
     - 2-class, multiclass
   - Training algorithms for supervised learning
     - Perceptron
     - Pseudoinverse/ minimum mean-squared error
     - Support vector machine
     - Others*

3. Statistical Classification
   - Statistics are known: Bayes decision theory
     - Optimal solutions for minimum-error and minimum-risk criteria
   - Statistics are partially known: Parameter estimation
     - Maximum Likelihood, Maximum A Posteriori, Bayesian Estimation
   - Statistics are unknown: Nonparametric techniques
     - Histogram, Parzen Windows, k-Nearest Neighbor classification
     - Techniques for reducing data and computational complexity
   - Supervised learning

4. Validation and data reduction
   - Validation and cross-validation
   - *Feature selection and reduction

5. Artificial Neural Networks
   - Single layer networks
   - Multiple layer networks
   - Supervised learning
   - Capabilities and limitations

* Coverage depends on time available and student interest
Administrative Information

- General information about USC’s Distance Education Network program for graduate courses and degrees: [http://gapp.usc.edu/graduate-programs/den](http://gapp.usc.edu/graduate-programs/den)

EE 559 Course Materials (lecture notes, handouts, and homeworks)

- The main web site for all course materials can be accessed from: [www.uscden.net](http://www.uscden.net)
- Course materials (lecture notes, course notes, handouts, homework assignments, etc.) will be available to all registered students at this site. Live lecture broadcasts and video archives of lectures can also be accessed from this site.
- Daily lecture notes (written out in real time during lecture) will be available after class, at the same web site (please allow 24 hours after each class for posting). Class notes for some lectures will be prepared in advance and will be available on the web site.

Course Texts

  

  
  
Computer Packages and Languages

- You will use a Matlab toolbox for some of the homework problems and for the course project(s). You can download the toolbox from the Wiley website, using a URL and password given in the computer manual listed above. Other toolboxes will also be available for the course project.

- For some computer homework problems and portions of the computer project, you will need to generate your own code rather than using the Matlab toolbox. For this, you can use any language you are comfortable with, including Matlab.

Homework, Exams, and Grading

- Homeworks (throughout semester) 20%
- Course project 25%
- Midterm exam (during regular class time; date TBA; (on or near Wed., March 12, 2014) 25%
- Final exam (Friday, May 9, 2014, 2:00 - 4:00 PM PDT) 30%
Contact Information

Instructor: Prof. B. Keith Jenkins, EEB 404A
Phone 213-740-4149; fax: 213-740-6618
Email: jenkins@sipi.usc.edu (please include “EE 559" in the subject line)
Office hours: Tu Th 3:30 - 5:00 PM.

T.A.: TBA

Grader: TBA

Distance Education Network (DEN):

For help with DEN web site access, transferring of course materials (e.g., turning in and receiving homeworks from remote sites), and viewing downloaded files and viewing video lectures, consult the help function and service/contact info on the DEN web sites:
www.uscden.net and gapp.usc.edu/graduate-programs/den .

Some of the contact information is listed below for your convenience:

General technical problems webclass@usc.edu 213-821-1321
(online services, webcasts, software)
General administrative problems denadmin@usc.edu 213-740-4488
Master Control networkcontrol@den.usc.edu 213-740-0130
(Class broadcasting, classroom telephones)
Exams and proctoring: denexam@usc.edu 213-821-3136
Homework submissions, records, and delivery (remote students): 213-740-9356
denhw@usc.edu Fax submission: 213-740-9121
Sample Applications of Pattern Recognition

• Remote Sensing
  – Environment monitoring
  – Exploration of other planets
  – Water, crop, and forest resource management

• Fingerprint Identification

• Text
  – Optical character recognition
  – Categorization of topics from text

• Speech Recognition

• Image Analysis
  – Object recognition (from pictures)
  – Flexible and adaptive industrial automation
  – Robotics
  – Autonomous vehicle guidance

• Signal Analysis
  – Radar and sonar
  – Seismic
  – Communications

• Multimedia
  – Recognition of objects, actors, words, or voices in video clips or movies

• Human-Computer Interface
  – Face, expression, and gesture recognition
  – Recognition of objects in a scene (e.g., hand against background)
  – Recognition of brain signals acquired for brain-computer interface

• Biomedical and bioinformatics
  – Gene analysis
  – DNA sequencing
  – Analysis of large amounts of data
  – EKG, EEG, CT, MRI, fMRI, PET, NIRS data

• Finance
  – Investments, including stock market analysis and prediction
  – Economic analysis (economic indicators)
  – Banking (loan risk, signature verification)
Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one’s own academic work from misuse by others as well as to avoid using another’s work as one’s own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

In this class, collaboration on techniques for solving homework assignments and computer problems is allowed, and can be helpful; however, each student is expected to work out, code, and write up his or her own solution. Use of other solutions to homeworks, computer problems, or computer projects, from any source including other students, before the assignment is turned in, is not permitted. Of course, collaboration on exams is not permitted.

Emergency Preparedness/Course Continuity in a Crisis

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.