Neural Machine Learning I

COMP / ELEC / STAT 502, Spring 2018

Elective course, 3 credits (3 contact hours per week)

Course home page: http://www.ece.rice.edu/~erzsebet/ANNcourse.html
(This website is also linked from Canvas.)
Students are responsible for being familiar with this syllabus, and with the contents of both the above and the Canvas website, and follow the postings as the course proceeds.
The information contained in the course syllabus, other than the absence policies, may be subject to change with reasonable advance notice as deemed appropriate by the instructor.

Class meets: TR 2:30 – 3:45pm DCH 1064
Instructor: Erzsébet Merényi
email: erzsebet@rice.edu
Office/Phone: DCH 2082, 713-348-3595
Office hour: Tue 4 – 5pm, or by appointment
Teaching Assistants and contact information: as posted on the course home page above.
TA advising: as posted on the course home page above, subject to change.

Short course description

Review of major Artificial Neural Network paradigms. Analytical discussion of supervised and unsupervised learning. Emphasis on state-of-the-art Hebbian (biologically most plausible) learning paradigms and their relation to information theoretical methods. Applications to data analysis such as pattern recognition, clustering (information discovery), classification, non-linear PCA, independent component analysis, with lots of examples from image and signal processing and other areas.

Brief Sample List of Topics

Introduction: What is an Artificial Neural Network (ANN), defining characteristics
Review of Basics: from Calculus, Information Theory and Statistics
Associative Memory recall from partial and noisy samples, stability
Supervised Lerning: Simple and Multi-Layer Perceptrons
Evaluation of Learning and Generalization Performance
Unsupervised Learning: Hebbian learning, PCA nets, Competitive Learning (SOMs, LVQs)

Recurrent nets: Hopfield and Boltzmann Machines, Simulated Annealing
Speeding Up Supervised Learning and Structure Optimization
Objective Functions for ANN Learning: information theoretical functions
Identifying Independent Sources (Blind Source Separation) with ANNs

A more detailed sample course outline is posted at
http://www.ece.rice.edu/~erzsebet/ANNcourse.html/CourseOutline

Exercises, home works, exam and course project will involve programming in the student's choice of Matlab, C or R (Fortran is also acceptable). Code handouts will be in Matlab.

Detailed Course Schedule

A detailed schedule of class topics will come on-line in a timely manner at the course web site http://www.ece.rice.edu/~erzsebet/ANNcourse.html under Course Schedule along with reading assignments from text book and lecture notes. I will also indicate here when home work assignments are posted in Canvas, along with due dates, post the dates of upcoming tests, and all relevant logistics. The materials (such as lecture notes and home work assignments) indicated in the Course Schedule will be downloadable from Canvas.

Pre-requisites

- No previous knowledge of Artificial Neural Nets is assumed.
- Basic linear algebra (MATH 355, ELEC 302 or equivalent is helpful) and basic calculus (such as in CAAM 322 or MATH 335 or equivalent);
- Basic probability distributions and statistics (such as in ELEC/STAT 331 or equivalent); Basic information theoretical notions (ELEC 241 or equivalent); These will be briefly reviewed in the course.
- ELEC/COMP 440 or ELEC 535 is an advantage.

If you have not taken the above courses, you need to provide evidence that you have the background knowledge and obtain the instructor's consent.
Having taken ELEC 430 and ELEC 431 or ELEC 531 and 533 automatically qualifies.

Course Materials

The course will be based on Lecture Notes, scheduled as described at the course web site http://www.ece.rice.edu/~erzsebet/ANNcourse.html under Course Schedule .

Recommended reading will be selected parts of the following books. All are available at www.amazon.com, or at the Fondren Library at Rice. You can also borrow my copies for short periods of times.

On neural networks

- Frederick Ham and Ivica Kostanic: Principles of Neurocomputing for Science & Engineering. McGraw-Hill, 2001.
- Simon Haykin: Neural Networks. A Comprehensive Foundation. McMillan, New Jersey, 1999. (2nd Edition)
- Christopher M. Bishop: Neural Networks for Pattern Recognition. Oxford University Press, 1995.

On machine learning (neural and other)

- Christopher M. Bishop: Pattern Recognition and Machine Learning. Springer, 2007.

Further suggested reading is listed at the course web site under Course Materials.

Objectives of the Course

1. Student understanding of concepts, and mastery, of the main types of neural machine learning models and methods, and their applications to data mining, clustering, classification and regression.

2. Student mastery of both theoretically approaches and using neural network simulations for solving data analysis problems. Understanding and practicing correct methodology for good neural network learning and generalization, and assessment of the quality of the learning (the generalization capability of trained networks).

3. Student competence in communicating the methods and results of data analyses with neural networks.

Assignments, Grading Policies and Other Logistic Requirements

Grades will be made up of the following components, with approximate weights as shown:

25% - Homework assignments
10% - Quiz 1
10% - Quiz 2
25% - Exam 1
25% - Course Project
5% - Classroom participation

This break down is ***subject to change depending on resources that will be available to the instructor for grading***. Parts of points 1. – 4. below may change accordingly.

As of January 9, 2018, the grading / TA support available for this class is insufficient for full grading of individual homeworks. Therefore, the following innovation has been introduced:

Students do homeworks in groups. The groups, formed by self-organization, will be permanent throughout the semester. Students in a group work together, agree on, and produce a homework solution, then submit copies of the exact same homework solution to Canvas, each under their own name (or we do group assignments if we figure out how that works in Canvas). Each student in a group will receive the same grade points for the particular homework unless they state contributions in a proportion different from equal percentage. In each homework, they will state the names of the group members, and the percentages of their contributions if unequal. Pizza Points you earn by various bonus challenges in home works or tests will be used to boost your final grade, by a TBA scheme.

The homework grouping does not affect quizzes and exams, which will be done individually and will be graded individually.

1. Homework assignments

There will be approximately four or five homeworks in the first half of the semester. There will be only one or two homeworks in the second half of the semester, in order to allow time for the Course Project. The assignments themselves will be posted in Canvas. Homeworks will be due, by default, before the beginning of class on the due date as specified in Canvas. Due dates will also be shown in the Course Schedule in a timely manner. **Solutions from previous years are off-limit.** You are required to upload an electronic copy (a pdf file) to Owl space. You are not required to type everything but if you have parts produced non-electronically you need to scan your hard copy into a pdf file on a high-quality scanner. If you have problems with electronic upload you can bring a hard copy to class or drop it in the designated wall pocket next to my office door before the deadline, and also notify me of this fact before the deadline. You will be asked to upload the e-copy once the upload problems are fixed. A summary of required formats, file names, and other requirements are posted here for your convenience. Please be sure to thoroughly read and follow them.

1.1 Late homework policy

Homework will be due on the due date and time posted with the Assignment in Canvas. If the deadline indicated in the Course Schedule should be different, then the deadline posted in Canvas applies. After the due date, but before solutions are handed out, homework can be turned in for 50% credit. After solutions are handed out, 0% credit will be issued.

2. Tests

There will be three tests. Quiz 1 and Quiz 2 (approx. 40 - 45 min, in class, closed notes/books/phones/computers), and a midterm exam. The exact dates of these will be posted in the Course Schedule in a timely manner, as well as announced in class. The anticipated dates are early - mid February (Quiz 1), early - mid March (Midterm), and late March or early April (Quiz 2). The Exam will be take-home, open book and open notes but using restricted time, and other resources (such as internet) will be restricted, and you will be required to give the honor pledge. The exact requirements and details will be given with the exams. **Test solutions from previous years are strictly off-limit.**

3. Course Project
A Project will be done over an approximately four-week period in the second half of the semester. Students will form groups by self-organization :-). The project groups can be the same or different from the home work groups. Each group will submit a project proposal on approximately March 10 (exact date TBD, will be announced in class and will be posted in the Course Schedule). It is anticipated that by that time the major ANN paradigms will have been discussed in class and students will be able to select a project topic, either from a list provided by me, or devise their own. I will review and approve each proposal (or discuss necessary modifications) before students start executing plans. Details, requirements and the characteristics of a successful Project are described here.

4. Class Participation You will be expected to keep up with the material we review in class and answer questions in class. Asking relevant questions or participating in discussions will also earn you scores.

Missed assignments If you must miss (or be late with) a homework, or a test due to an extraordinary circumstance please notify me and the TA(s) as much ahead of time as possible, and **make arrangements with me** for completing the missed assignment. If, in extreme emergency, you are unable to provide advance notice, please let me know as soon as possible afterwards, and I will work with you on a solution accordingly.

Expectations Regarding Honor Code, Collaboration, and Citation

In preparing home works, students are encouraged to work in groups and consult freely any material and anyone. However, each individual will write and turn in his or her own solution, which they are expected to understand. If the solution is the result of group work, each group member will write the names of the collaborators on their solution. For tests students will be required to state and sign the Rice Honor Pledge and adhere to the Rice Honor Code. Solutions from previous years are off-limit. In all work, students are expected to be scrupulous about proper citation of sources (where applicable), as required both as a matter of integrity and formally as a part of the Rice Honor Code.

Class Attendance and Absence Policy

Students are strongly advised to attend all classes. 5% of the grade is composed of participation and performance in class. Students who must miss a class or assignment because of unavoidable circumstances should consult with the instructor well in advance so that alternative arrangements may be made.

University Disability Accommodation Policy

The University seeks to foster an environment of broad access and feasibly equal opportunity to education. The Office of Disability Support Services (DSS; Allen Center, Room 111; 713-348-584; adarice@rice.edu) supports and implements federal guidelines under the

Rehabilitation Act of 1973 and the Americans with Disabilities Act. Students with documented disabilities requiring accommodation under Rice's established policies should consult DSS and the instructor; all such consultations and accommodations will be held confidential to the extent feasible.

Use of Machines in the Classroom

Cell phones must be turned off – or rendered silent – within the classroom. If you need to take an urgent call, please set your phone to vibration and take the call outside the room. Laptops or other small devices may be used in class only for specific class purposes. If you have an urgent need to be online for other purposes during class time, feel free to do so **. . .** but elsewhere.