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## ***Course Syllabus (Fall 2016)***

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### **Course Information**

ACN5314/HCS 5314 Computational Models in the Behavioral and Brain Sciences (3 semester hours).

### **Professor Contact Information**

Dr. Richard Golden (GR4.814) Email: [golden@utdallas.edu](mailto:golden@utdallas.edu), Office Hours by Appointment.

### **Teaching Assistant Contact Information**

Mr. James Ryland Email: [jwr071000@utdallas.edu](mailto:jwr071000@utdallas.edu), Office Hours to be Scheduled.

**Time and Location:** Thursday 5:30pm-6:45pm GR4.204 (This is a Hybrid Course which includes on-line lectures)

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### **Course Pre-requisites, Co-requisites, and/or Other Restrictions**

Pre-requisite: No Prerequisites but background in the areas of linear algebra, computer programming, experimental psychology, and/or neuroscience will be very helpful.

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### **Course Description**

This course covers key ideas and concepts which are essential to the development of computational models in the behavioral and brain sciences. All of the major machine learning architectures will be described and illustrated using MATLAB computer programs. Topics covered include: single and multi-layer artificial neural network models, recurrent neural network models, Boltzmann machines, constraint satisfaction networks, self-organizing networks, supervised, unsupervised, and reinforcement learning algorithms. The course emphasizes how many machine learning architectures and constraint satisfaction algorithms are related to computational models in the behavioral and brain sciences and how such algorithms can be used to refine existing models and develop entirely new models. Students planning on pursuing the advanced mathematical modeling sequence: ACN6348, ACN6347, ACN6349 will also find this course helpful in obtaining an overview of the critical core ideas.

### **Student Learning Objectives/Outcomes**

1. Learn how to do Computational Sufficiency Analyses in Psychology and Neuroscience using Machine Learning Methods
2. Learn how to analyze and design knowledge representations
3. Learn how to analyze and design computational models
4. Students Propose, Implement, and Communicate motivation, method, and results of a computational modeling or machine learning project they have developed.

### **Required Textbook and Materials**

- 1) Fundamentals of Computational Neuroscience by Thomas Trappenberg (2010 paperback edition). Oxford University Press. ISBN 978-0-19-956841-3 (paperback) (second edition)
- 2) Lectures Notes by Golden (these are located on ELEARNING the website).
- 3) Jordan Linear Algebra Book Chapter (located on ELEARNING website)

## Optional Course Materials

- 1) Anderson's (1995). *An Introduction to Neural Networks*. MIT Press.  
(this book is available on-line to UTD students). (1995, MIT, 0-262-01144-1)
  - 2) *Student Edition of MATLAB Software* (optional.) ([http://www.mathworks.com/academia/student\\_version](http://www.mathworks.com/academia/student_version))
  - 3) Abdi, Valentin, and Edelman (1998). *Neural Networks*. Sage Publications.  
(ISBN 0-7619-1440-4)
  - 4) Dr. Golden's Lectures will be Video Recorded and Posted Regularly.
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## Assignments & Academic Calendar

### Lab Assignments

All lab assignments will be completed on-line. Students may discuss lab assignments among themselves by posting questions to the class discussion board for that module. Lab assignments will be available sometime during the week when the lectures for that assignment are presented and will be due approximately 1-2 weeks after the lectures for that assignment. Late lab assignments will not be graded.

### Project Assignment: Develop Your Own Computational Model

Each student will be required to present at the end of the course a *final project* which describes an application of neural network technology to their particular area of interest (e.g., neuroscience application, application in cognitive psychology, application to financial data analysis, application in engineering, application in computer science, application in artificial intelligence). The format of the final project should be similar to a journal article that was published in a journal such as "*Neural Networks*", "*Journal of Computational Neuroscience*", "*Neural Computation*", or in the *Neural Information Processing Systems Conference* (<https://papers.nips.cc/>). **The final final project should be 5-9 pages long, 1.5 inch line spacing, 1 inch margins, 12 pt font, and be written in the format described in the lecture notes with approximately 1-2 pages devoted to the introduction (what you planned to do and why) (25% of grade), 1-2 pages devoted to the method (what you did) (25% of grade), 1-2 pages devoted to the results (what you learned) (25% of grade), and 1-2 pages devoted to the discussion section (what it means) (25% of grade).**

Please submit a PDF copy of a journal article you have read that is most closely related to your submission!!!

Note that the final project is not simply the description of an algorithm and some algorithm output. It must emphasize a practical application in an areas such as: artificial intelligence (which requires describing why the problem in artificial intelligence is important), cognitive psychology (which requires describing relevant cognitive behavioral data model explains), or neuroscience (which requires describing relevant neuroscience data model explains).

### Schedule

Module 1 (8/25): Models and Theory (Lecture Notes, Trappenberg, Ch. 1)

Module 2 (9/1): Computational Modeling (Lecture Notes, Trappenberg, Ch. 1)

Module 3 (9/8): Neuroscience (Lecture Notes, Trappenberg, Ch. 2, Ch 5.1)

Module 4 (9/15): MATLAB and Computational Neuroscience (Lecture notes, Trappenberg, Ch. 2; Appendix E)

Module 5 (9/22): Realistic Simplified Neural Models (Lecture Notes, Trappenberg, Ch. 3)

Module 6 (9/29): Abstract Linear Neural Models (Lecture Notes, Trappenberg, Ch. 4)

Module 7 (10/6): Neural Linear Subspaces (Lecture Notes, Jordan Book Chapter)

### **MIDTERM (on-line) (October 7-11)**

Module 8 (10/13): Linear Algebra for Connectionist Systems (Lecture Notes, Jordan Book Chapter)

Module 9 (10/20): Analysis and Design of Representations (Lecture Notes, Trappenberg, 7.5)

Module 10 (10/27): Perceptrons (Lecture Notes, Trappenberg, Ch. 6)

Module 11 (11/3): Gradient Descent for Single Layer Nets (Lecture notes, Trappenberg, Ch. 6)

Module 12 (11/11): Gradient Descent for Multi-Layer Nets (Lecture notes, Trappenberg, Ch. 6)

Module 13 (11/17): Designing “Hints” into Computational Models (Lecture notes, Trappenberg, Ch. 6)

**THANKSGIVING BREAK** (11/21-11/26)

Module 14 (12/1): Mental Models and Neurocontrol (Lecture Notes, Trappenberg, Ch. 9)

Module 15-16 (12/6): Constraint Satisfaction and Genetic Algorithms (Lectures Notes, Trappenberg, Ch. 8)

**FINAL EXAM (on-line) (December 9-13)**

### **Grading Policy**

*(including percentages for assignments, grade scale, etc.)*

Grades will be calculated according to the following weighting system.

Midterm (25%), Final Exam (25%), Lab Exercises (15%), Final Project Paper (35%).

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### **Course & Instructor Policies**

*(make-up exams, extra credit, late work, special assignments, class attendance, classroom citizenship, etc.)*

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### **Field Trip Policies**

#### **Off-campus Instruction and Course Activities**

*Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at the website address [http://www.utdallas.edu/BusinessAffairs/Travel\\_Risk\\_Activities.htm](http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm). Additional information is available from the office of the school dean. Below is a description of any travel and/or risk-related activity associated with this course.*

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### **Student Conduct & Discipline**

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD publication, *A to Z Guide*, which is provided to all registered students each academic year.

The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the *Rules and Regulations, Board of Regents, The University of Texas System, Part I, Chapter VI, Section 3*, and in Title V, Rules on Student Services and Activities of the university's *Handbook of Operating Procedures*. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391).

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

## **Academic Integrity**

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work.

Scholastic dishonesty includes, but is not limited to, statements, acts or omissions related to applications for enrollment or the award of a degree, and/or the submission as one's own work or material that is not one's own. As a general rule, scholastic dishonesty involves one of the following acts: cheating, plagiarism, collusion and/or falsifying academic records. Students suspected of academic dishonesty are subject to disciplinary proceedings.

Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.

## **Email Use**

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.

## **Withdrawal from Class**

The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

## **Student Grievance Procedures**

Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's *Handbook of Operating Procedures*.

In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the dean will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.

Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

### **Incomplete Grade Policy**

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.

### **Disability Services**

The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m.

The contact information for the Office of Disability Services is:

The University of Texas at Dallas, SU 22

PO Box 830688

Richardson, Texas 75083-0688

(972) 883-2098 (voice or TTY)

Essentially, the law requires that colleges and universities make those reasonable adjustments necessary to eliminate discrimination on the basis of disability. For example, it may be necessary to remove classroom prohibitions against tape recorders or animals (in the case of dog guides) for students who are blind. Occasionally an assignment requirement may be substituted (for example, a research paper versus an oral presentation for a student who is hearing impaired). Classes enrolled students with mobility impairments may have to be rescheduled in accessible facilities. The college or university may need to provide special services such as registration, note-taking, or mobility assistance.

It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.

### **Religious Holy Days**

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated.

The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.

If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.

***These descriptions and timelines are subject to change at the discretion of the Professor.***