COSC-5590.001 SELECTED TOPICS
Introduction to Machine Learning
School of Engineering and Computing Sciences
Fall 2017

A. COURSE INFORMATION

Course number/section: COSC-5590.001
Class meeting time: TR 12:30 – 1:45 PM
Class location: CI 108
Course Website: bb9.tamucc.edu

B. INSTRUCTOR INFORMATION

Instructor: Dr. Alaa Sheta
Office location: CI-342
Office hours: TR 2:00-5:00 PM
Telephone: 825-3711
e-mail: alaa.sheta@tamucc.edu
Appointments: Must be scheduled at least a week in advance by email

C. COURSE DESCRIPTION

Machine learning is a set of techniques that have been successfully used in the past few decades for data analysis, process automation, function optimization, model building and many others. These techniques have been explored in a diversity of fields such as robotics, self-driving cars, big data, control of autonomous systems, image analysis, object recognition, data mining, business and financial forecasting, transportation systems, antenna design, medical care systems and many others. ML is a subdivision of artificial intelligence that gives machines the ability to learn and adapt with various acquired knowledge and experience. In this course, a student will learn about the state of the art on machine learning and get to know how they can carry out these evolving learning algorithms. ML algorithms attempt to mimic how human brain works. Our plan is to develop many exercises on how these ML algorithms work in practical applications in both industry and basic science. We plan to cover topics such as evolutionary computation, fuzzy logic; artificial network networks, classification based decision trees and clustering. Students will gain the experiences on a number of programming tools and a variety of applications of machine learning.

D. PREREQUISITES AND COREQUISITES

Prerequisites
None.

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)
No required book.
Optional Textbook(s) or Other References

Supplies
None

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

By the end of this course, students should be able to:

1. Explore various software tools for building machine learning systems. Students will get a hand experience on two programming languages (Python and Matlab).
2. Understand the basic idea of system modeling/function optimization.
3. Student will get a hand experience on number of methods to handle the data set for modeling problems such as data pre-processing and how to split the data training and testing dataset.
4. Understand how we can build a simple regression model with single and multiple variables. This is a common technique to solve various prediction problems.
5. Understand how evolutionary computation algorithms inspired from the nature selection mechanism.
6. Understand the meaning of search space/landscape and difficulties associated with search for minimum or maximum of a function.
7. Understand the meaning of fitness/evaluation function values that guide a search problem. There are various evaluation functions that can be used for function optimization.
8. Learn how to formulate a real-life problem such that a Machine Learning (ML) algorithm can be used to solve it.
9. Student should be able to evaluate the strengths and weaknesses of several machine learning algorithms and understand which algorithm is suitable for which problem.
10. Understand the benefits and weaknesses of Artificial Neural Networks (ANN) in solving various function approximation problems.
11. Learn how fuzzy logic can be used to approximate nonlinear/complex function based set of linear models and how the problem domain can be decomposed to various sub-domain using a membership functions.
12. Understand various methods to develop a classifier using decision trees using Gini and Entropy.
13. Solving unsupervised learning problems using clustering. We will discuss the K-means clustering algorithm.
14. To be able to assess and understand the key challenges on using ML in applications such as Robot path planning and system identification.
15. Learn about the expansion of ML techniques and their future impact.

G. INSTRUCTIONAL METHODS AND ACTIVITIES

This course will be a mixture of lectures and discussions. The student is expected to actively participate in all class activities. The student is also expected to do outside work on assignments, reading, class presentation and project documentation.

H. MAJOR COURSE REQUIREMENTS AND GRADING

This is a theory and application course that demands all students attend all classes! Regular completion of all reading, homework, and other outside assignments, are absolutely essential for success in this course. Your course grade will be decided on your performance in the programming homework assignments, term projects, two exams and final exam. The distribution of points is as follows:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
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<tbody>
<tr>
<td>Two Exams</td>
<td>30</td>
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<tr>
<td>Homework and Programming Assignments</td>
<td>20</td>
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<tr>
<td>Term Project</td>
<td>20</td>
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<td>Class Activities and Quizzes</td>
<td>10</td>
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<tr>
<td>Final Exam</td>
<td>20</td>
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Grade Scale:  A (90-100%)  B (80-89%)  C (70-79%)  D (60-69%)  F (< 60%)

Readings
1. The reading assignment will be provided on Bb every week.
2. It is the student duty to do the reading.
3. If you have any question about the reading please let me know as early as possible.
4. You may visit during the office hours or setup a meeting via email.
5. Inability to finish the reading might affect your learning outcomes.
# COURSE CONTENT/SCHEDULE

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>ASSIGNMENTS</th>
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<tbody>
<tr>
<td>Week 1:</td>
<td>Course Overview and Guidelines</td>
<td>Reading: <em>Machine Learning: A Probabilistic Perspective</em>, Ch.1</td>
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<tr>
<td>8/29/2017</td>
<td>What is Machine Learning (ML)? Discussion on ML applications.</td>
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<td>8/31/2017</td>
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<td>Week 2:</td>
<td>Programming Language for ML:</td>
<td>Lecture notes and slides</td>
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<tr>
<td>9/5/2017</td>
<td>Python Programming</td>
<td>HW1: Python</td>
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<tr>
<td>9/7/2017</td>
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<td>Week 3:</td>
<td>Programming Language for ML:</td>
<td>Lecture notes and slides</td>
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<tr>
<td>9/12/2017</td>
<td>Matlab Programming</td>
<td>HW2: Matlab</td>
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<td>9/14/2017</td>
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<td>Week 4:</td>
<td>Linear Regression with one/many variables</td>
<td>Lecture notes and slides</td>
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<tr>
<td>9/19/2017</td>
<td>Some applications on linear regression: Business Forecasting and System Modeling</td>
<td>HW3: Linear regression</td>
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<td>9/21/2017</td>
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<td>Week 5:</td>
<td>Introduction to Evolutionary Computation</td>
<td>Reading: <em>An Introduction to Genetic Algorithms</em> by Jenna Carr.</td>
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<td>9/26/2017</td>
<td>Genetic Algorithms and Genetic Programming</td>
<td>HW4: Parameter Estimation Using GAs</td>
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<tr>
<td>9/28/2017</td>
<td>Project Proposal delivery</td>
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<td>Week 6:</td>
<td>Exam 1 (10/03/2017)</td>
<td>Reading: Introduction to fuzzy logic by Franck Dernoncourt</td>
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<td>10/3/2017</td>
<td>Introduction to Fuzzy Logic Systems</td>
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<td>10/5/2017</td>
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<td>Week 7:</td>
<td>Design and Applications of Fuzzy Logic Systems</td>
<td>HW5: Implementation of FL system.</td>
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<tr>
<td>10/10/2017</td>
<td>Project Progress Presentation and Progress Report</td>
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<td>10/12/2017</td>
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<td>Week 8:</td>
<td>Artificial Neural Networks (ANNs) Representation</td>
<td>Reading: <em>Artificial Neural Network and Supervised Learning</em>.</td>
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<tr>
<td>10/17/2017</td>
<td>Learning Algorithms for ANN</td>
<td>HW6: ANN</td>
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<td>10/19/2017</td>
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<td>Week 9:</td>
<td>Implementation and Applications of ANN</td>
<td>Activities on applications of ANN.</td>
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<td>10/24/2017</td>
<td>Comparison and Review of the techniques developed so far (GAs, GP, FL, ANNs)</td>
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<td>10/26/2017</td>
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<td>Week 10:</td>
<td>Classification based Decision Trees</td>
<td>Lecture notes and slides</td>
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<tr>
<td>10/31/2017</td>
<td>Exam 2 (11/02/2017)</td>
<td>HW7: Classification based Decision Tree</td>
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<td>11/2/2017</td>
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<td>Week 11:</td>
<td>Classification based Decision Trees (Conti)</td>
<td>Reading: Chapter 3 from <em>Machine Learning</em> by Tom Mitchell.</td>
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<td>11/7/2017</td>
<td>Explore ML Applications</td>
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<td>11/9/2017</td>
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Week 12:
11/14/2017
11/16/2017
K-means Clustering
Explore ML Application
Lecture notes and slides
HW8: Clustering

Week 13:
11/21/2017
11/23/2017
Term Project Presentations (3 projects)
Thanksgiving Holiday (11/23/2017)
Final Report due on 11/21/2017 for all students-
No late submission are allowed.

Week 14:
11/28/2017
11/30/2017
Term Project Presentations (3 projects)

Week 15:
12/5/2017
12/7/2017
Term Project Presentations (3 projects)
Reading day

Final Exam on Tuesday, December 12, 2017 from 11:00 AM-1:30 PM.

Note: Changes in this course schedule may be necessary and will be announced to the class by the Instructor. The assignments and exams shown are directly related to the Student Learning Outcomes described in Section F.

I. COURSE POLICIES

Course Syllabus: We will meet in lecture on Tuesdays and Thursdays, when new material will be presented. Non-text material may also be included in the lectures. The assignments, quizzes, and exams will be given during the class hours. You are responsible for all the material presented during the lecture.

Homework and Programming Assignments: There will be 8-9 homework assignments that reflect a direct implementation of course topics.

1. Programming assignment will be given every week. It will be given either on Tuesday or Thursday every week.
2. All assignment will be due the following Saturday at 12:00 PM.
3. You need to submit your HW on Bb.
4. Any assignment MUST have a cover page which include the assignment title, assignment number, and student name. 10% will be deducted if submission guidelines are not followed.
5. You need also to include the code for the assignment in a pdf format. Compressed file are not allowed. 50% will be deducted from your grade if you submitted a compressed file.
6. You need to include a description of the process you followed to develop your code, any tuning parameters, tables and figures. Submitting the results without an explanation is not accepted. 50% will be deducted from your grade.
7. For late submission, maximum two days after the deadline. In this case, 50% will be deducted from your grade.
8. It is your responsibility to check frequently the posted contents, assignments or announcement on Bb.
Team assignment/project:
1. For team assignment, if any, every team member has to make submission on Bb.
2. For team project, every team member has to make submission on Bb.
3. Failure to do that will lead to zero grade for that student.

Selection of the Term Project:
1. You/your team need to meet with Dr. Sheta at the first week to discuss various aspects related to the selection of your term project.
2. You get points on making that meeting.

What your project needs:
1. Searching to build an acceptable background about the project subject.
2. Select appropriate technique to solve the problem.
3. Be able to analyze the data collected or pre-process the data.
4. Understand the advantages and disadvantages of each technique.
5. Select an appropriate representation/formulation for your problem.
6. Know how to test the performance of your results.
7. And finally, develop a conclusion.
8. Give a clear presentation and a technical report based the format and guidelines provided by the instructor.

Proposal Guidelines:
1. The background section:
   You need to refer to the previous work and say how you're extending it. What are the ideas you are suggesting?
2. The research statement section:
   State the technical problem you intend to solve. Indicate how it might be useful. You need to answer the question on why you selected this topic and how you plan to explore possible solution to the problem at hand. This can be brief; it is just an introduction to the next section.
3. The technical approach section:
   This is the core of the proposal. It's where you spell out your technical plan and explain the project design. Evaluation issues would also be addressed in this section.
4. The milestones section:
   This section will provide a work plan for carrying out the project. This is your schedule for getting the project done.
5. The references section:
   You need to mention any references you'll use, and sources for data, software, and other materials.
Project deliverables due dates:

- Project Proposal (09/28/2017)
- Progress presentation (10/12/2017)
- Progress Report (10/12/2017)
- Final report (11/21/2017)

Schedule of the Term Project: The project will be include both theoretical and programming parts. The goal of the project is the implementation of a ML algorithm to solve a practical real-life problem. The final project report is due 11/21/2017 along with an in-class presentation by each team on the days 11/21, 11/28, 11/30, 12/5/2017. All project’s topic must be approved by the instructor. Each student need to provide a proposal of the project on/before 9/28/2017. Each student/team will have to give a short (i.e. 10-15 min.) in class presentation after the approval of the topic on 10/12/2017 based the provided guidelines.

Attendance/Tardiness: You are expected to be in attendance, punctual, and prepared for class. If you are more than 10 minutes late to class, you will be counted as tardy. Please make sure that you will never be tardy to any of your classes or accept the consequences.

Quizzes: Quizzes will be conducted any time in the lecture without a prior notice. Please be always ready.

Exam contents and dates: Exams will cover part/all lecture, assignments, quizzes and reading material. Exams must be taken on the hour they are scheduled. In the event, if you cannot attend the class to take the exam due to some emergency or some unavoidable situation (such as serious illness, death in the family, participation in university sports, religious observations, and so on) you must notify me as soon as possible before the exam and also you must validate your absence by providing me a document (e.g., with a letter from your doctor). If you do not understand or have question about the exam content, it is your responsibility to ask questions. Do that early enough before the exam, at least 24 hours. The first exam will be given on October 03, 2017, the second exam will be given on November 2, 2017 during the scheduled class time. The final exam day is December 12, 2017 from 11:00 AM-1:30 PM.

Grading Error: All questions concerning a test score or grading of a returned test or assignment must be resolved within one week. It is always a good idea to keep all of your work until the end of the semester. In case of any recording errors or doubts, you may produce them for correction or verification.

Extra Credit: There is no EXTRA CREDIT

Academic Honesty Policy: You are expected to avoid all forms of academic dishonesty as defined in Catalog. In addition, students are expected to behave in an ethical manner in all class activities. If you feel uncertain about a particular activity, please speak to me BEFORE problems arise. Ethical behavior is a requirement for passing this course. All work submitted for grading must be the student's own work. Plagiarism will result in a score of 0 (zero) for the work or dismissal from the course and the Dean of Students office will be notified. No copying from another student's work, of any class, is allowed. It is the student's duty to allow no one to
copy his or her work. Anyone found cheating and/or copying, in the exams or assignments, in the instructor's opinion, will receive an automatic F for the course.

**Collaboration:** There is no collaboration allowed on homework assignments.

**Attendance:** You must attend all classes. In-class attendance will affect your grade. You are responsible for any materials covered or handed out or announcements made for the tests, homework assignments in your absence. Records of your attendance will be maintained and reported to the university. Students found missing classes without the instructor’s permission will be automatically withdrawn from the course.

**Absence from class:** Students are responsible for all materials covered in class and assigned. Should a student be absent from class, it is his/her responsibility to get the notes, etc. for that missed class. More important, should there be assignments, it is the student responsibility to obtain such assignments. No excuse will be accepted for assignments not turned in because the student was absent when it was due.

**Cell Phone Use:** Cell phones and pagers must be turned off during class. First violation receives a warning. All succeeding violations result in a ten points deduction on the last exam. Any violation during a quiz or exam results in a ten percent deduction off the corresponding paper. No warnings for quizzes or exams.

**Laptop Use:** Laptops, Tablets cannot be used in the class.

**Food in Class:** No food in the class or labs.

**Student Security Statement:** Please read the Student Security Statement.

**J. COLLEGE AND UNIVERSITY POLICIES**

- **Academic Integrity (University)**
  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

- **Classroom/Professional Behavior**
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This
prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

- **Statement of Civility**
  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

- **Deadline for Dropping a Course with a Grade of W (University)**
  I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. *Please consult with your academic advisor, the Financial Aid Office, and me, before you decide to drop this course.* Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Please consult the Academic Calendar ([http://www.tamucc.edu/academics/calendar/](http://www.tamucc.edu/academics/calendar/)) for the last day to drop a course.

- **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage at [http://sci.tamucc.edu/students/GradeAppeal.html](http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.
If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

http://disabilityservices.tamucc.edu/

- **Statement of Academic Continuity**

  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

**K. OTHER INFORMATION**

- **Academic Advising**

  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College’s Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.

**GENERAL DISCLAIMER**

I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.