ECH 6937 Fundamentals of Artificial Neural Networks (Class Number 22869)
Class Periods: MWF, Period 9 (4:05-4:55 PM)
Location: Matherly 116
Academic Term: Spring 2022

Instructor: Spyros A. Svoronos

Phone: 352-392-9101 (Landline Office)
         352-378-1342 (Landline Home)
         If you leave messages with return phone numbers I will call you back
         I do not carry a cell phone
E-mail: svoronos@ufl.edu
         E-mails must include a call-back phone number.
         Without it, they may not receive a response.
Office Hours : MTW 5:15-6:30 PM, F 1:30-2:30 PM,
         via Zoom: https://ufl.zoom.us/j/6379945549 with passcode 0
Do not hesitate to ask questions both in class and outside class.

Teaching Assistant/Peer Mentor/Supervised Teaching Student: None

Course Description

(3 credits) Introduction to the fundamental aspects of artificial neural networks and deep learning, including chemical engineering examples. Python coding of neural networks, first from scratch including object oriented programming, and later using the Keras API.

Course Pre-Requisites / Co-Requisites

Chemical Engineering student with programming ability in at least one programming language (not necessarily Python)

Course Objectives

The course will teach many of the core concepts behind artificial neural networks (ANNs) and deep learning. Important concepts, such as the backpropagation algorithm, will be mathematically derived. To reinforce understanding, the concepts will be put to practice with Python code written by the students. The code will be applied to chemical engineering problems as well as to the problem of handwritten number recognition utilizing 70,000 28x28-pixel grey-scale images (the MNIST set). By the end of this course, students will be able to:
- Understand the principles behind ANN algorithms
- Write Python code from scratch and develop their own ANN libraries
- Use the Keras API
- Understand the challenges and pitfalls of deep learning and potential remedies
- Understand and design Convolutional Neural Networks (CNNs)

Materials and Supply Fees: N/A

Required Textbooks, Manuscripts, and Software

- *Neural Networks and Deep Learning* by Michael Nielsen,
  http://neuralnetworksanddeeplearning.com/
  Cost: Free, a $5 donation is suggested
- *Python in easy steps* by Mike McGrath
  https://www.amazon.com/s?k=python+in+easy+steps&ref=nb_sb_noss_1
  Cost: $10.69 - $15.99
- *Automate the Boring Stuff with Python* by Al Sweigart, no starch press
  https://automatetheboringstuff.com/
  Cost: Can read on-line for free, $24.99 for paperback printing
- Python Classes and Their Use in Keras – Machine Learning Mastery
  https://machinelearningmastery.com/python-classes-and-their-use-in-keras/
  Cost: Free
- Software: Laptop computer running Windows and Excel is **required**

Recommended Materials:

- More Special Features in Python – Machine Learning Mastery
  https://machinelearningmastery.com/python-special-features/
  Cost: Free
- Hands-on Machine Learning with Scikit-Learn, Keras &TensorFlow, **2nd Edition**
  Cost: $75
  This is an advanced text. It is not needed for the class but it is a very good reference.

Spring 2021 Videos: https://uflorida-my.sharepoint.com/:f:/g/personal/svoronos_ufl_edu/EtBnr53oz3NLqlCy4xVmqEgBKKl3l_lEbLdH99V2hRfa7g?e=IAY0Ye

Course Topics:

Weeks 1:	Introduction to artificial neural networks (ANNs) and deep learning
	The beginning: Perceptrons (homework 1)
Weeks 2-3:	Sigmoid neurons
	The basic structure of ANNs
	Gradient descent
	Fitting and overfitting
Weeks 4-6:	Lessons in Python developing part of the code to be used later (homework 2-4)
Weeks 7-9:	The first ANN program without explanation of backpropagation
	The backpropagation algorithm and its coding (homework 5)
Week 10:	Introduction to Keras (homework 6)
Weeks 11-12:	The cross-entropy cost function
	Regularization methods
	Initializing weights
	Heuristics for hyper-parameter tuning (homework 7)

Week 13:   The vanishing gradient problem and deep learning
Weeks 14-15: Deep convolutional networks (homework 8)

Attendance Policy:

Class attendance <u>or</u> attendance of the first office hour (in Zoom) after a missed class is required. I recognize that the current pandemic situation may force some students to miss class for long periods of time. I am therefore providing access to recordings of the spring 21 offering of the class and accompanying PowerPoint slides. Most of the lectures will have equivalent spring 2021 lectures. If that's not the case, I will post Powerpoint slides of these lectures. So if you miss a class but watch and understand the corresponding spring 21 video or the class slides you should be ok. In case of class absences, I require that you attend the first office hour after a missed class (in Zoom) and ask any questions you may have. If you join that office hour, your class absence will be considered excused, otherwise not (unless there is documented valid excuse). Unexcused absences will significantly impact the class attendance and participation grade which makes up 5% of your total grade (see below).

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Course Assessment:
1. A midterm Honorlock exam weighing 30% of the grade.
   Date: Tuesday March 15 (5:15 - ? PM)
2. A take home final exam weighing 35%.
   Handed out: Monday April 18
   Due: Wednesday April 20 midnight
3. Homework weighing 30%. Each homework problem will be graded in a scale from 0 to 3 with a 3 earned only for perfect answers.
4. Class participation weighing 5%.

Grading:

1. For each student, Overall points are calculated as follows:

Overall Points = 0.30*MidtermGrade + 0.35*FinalGrade +
                 0.30*HomeworkGrade + 0.05*ClassParticipationGrade

where
- Exam grades are 0-100
- HomeworkGrade = (Total homework points earned)/(maximum possible points) *100
- Class participation grade:

85 if student never misses class (without excuse) and never speaks or messages. This number is multiplied by the fraction of times the student was present in class. Then the grade is raised according to how frequently a student answers or asks questions.

2. The students are sorted in the order of decreasing overall points and then the table below is used to assign grades:

Overall Points	Grade
> midpoint of max gap of grades in range 85 +/- 2.5 (referred to as midgap 85 +/- 2.5)*	A
midgap 85 +/- 2.5 to midgap 80 +/- 2.5	A-
midgap 80 +/- 2.5 to midgap 75+/- 2.5	B+
midgap 75 +/- 2.5 to 70.00	B
69.99 to midgap 62.5 +/- 2.5	B-
midgap 62.5 +/- 2.5 to midgap 57.5 +/- 2.5	C+
midgap 57.5 +/- 2.5 to 50.00	C
49.99 to midgap 35 +/- 5	C-
midgap 35 +/- 5 to midgap 25 +/- 5	D+
midgap 25 +/- 5 to midgap 2.5 +/- 2.5	D
midgap 2.5 +/- 2.5 to 0	D-
Will be pursued for honesty violations	E
*The students are sorted according to overall points and the gap refers to the difference between two sorted students in that range. For example, if the grades between 87.5 and 82.5 (range 85 +/-2.5) are 87.4, 86.3, 83.1, and 82.6, 86.3 will be the last A and 83.1 the first A-	

ADDITIONAL INFORMATION

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student

who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

• Your academic advisor or Graduate Program Coordinator
• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or
http://www.police.ufl.edu/.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus: https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints: http://www.distance.ufl.edu/student-complaint-process.