ECE 802-602
Neural Networks and Deep Learning
a hands-on computational course on
Architectures, Learning and Applications
Fall 2019

TIME: Tu Th 1:00-2:20 p.m.
ROOM: 1202 Engineering Building
CREDITS: 3 units
INSTRUCTOR: Professor Fathi Salem
2308D Engineering Building
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Phone: 517-355-7695
OFFICE HRS: Tu & Th 2:20-3:20. Other meeting times, need to be agreeably scheduled. I am available via (email) and D2L.

PREREQUISITES:
Graduate standing, and familiarity with basic undergraduate-level multi-variable calculus, difference or differential equations, linear algebra and some probability and statistics. Software requirements include familiarity with programming/coding. Strong preference is for Python. We will use popular Deep Learning Libraries (e.g. Keras2.0, Tensorflow).

COURSE OBJECTIVES: This course is a student-oriented course. It has the goal of enabling the student to acquire capabilities and a working knowledge in the current and developing domain of computational Neural Networks and Deep Learning or "deep learning." Historically, since 2012, it began with *deep* architectural networks and the family of adaptive stochastic gradient descent (SGD) learning mechanisms. The course will coach the student through the main/dominant architectures and learning mechanisms with a view towards software implementation and hands-on ability to tackle current applications. It emphasizes some code developing but mostly using existing libraries/packages to enable the student to incrementally acquire the knowledge of deep learning in current practice.

COMPUTING PLATFORMS/LIBRARIES:
There are numerous packages or libraries available for "Neural Networks & Deep Learning," eg. Scikit-learn, etc. There are also a host of platforms/libraries publically available (i.e., free) for "Deep Learning" research and deployment. These include **Keras**, **Tensorflow** (Google), **Caffe** (UC Berkeley), **Nvidia**, Torch, PyTorch (Facebook), others libraries from Microsoft , Amazon,….
See http://www.deeplearning.net or search for more.

We will discuss the pros and cons of some of these libraries in the class lectures & notes, we shall focus on using Python-based codes, Keras and Tensorflow. Of course, you are welcome to use/explore any that is most suitable for you.

COURSE DESCRIPTION:
This course provides an introduction to the current state-of-the-art of deep neural networks with emphasis on implementations and project execution. The buz word now is "deep learning." The course will identify the elements of "deep learning". What makes a basic neural network become a deep learning network. The popular architectures are (i) feedforward: deep neural networks (DNN), convolutional neural network (ConvNets), and (ii) Feedback: (simple) recurrent neural networks (RNN), Long Short Term Memory (LSTM) RNNs, Gated RNNs, etc., and also (iii) a combination of the feedforward and feedback architectures. The main learning used is frequently a form of the Stochastic Gradient Descent (SGD) and its variations

The course will focus on the advantages and limitations of several neural models and architectures. Common and new applications of neural networks will also be highlighted during the class.

We shall use Gitlab (https://gitlab.msu.edu) for assignment release and submissions. Please read up the handout on Gitlab on the D2L class site if you are not familiar with it. All enrolled students will receive an email invite to you're the class group: ece884fs2019.

MAJOR TOPICS:

Basics:

1. Elements of deep neural networks: The building blocks and architectures
2. Adaptive and Learning processes: Gradient, Energy, Entropy -based methods and Systems.

Supervised Learning:

3. Deep Neural Networks (DNN): auto-encoders, sparse representation, local connections, convolutional networks
4. Convolutional Neural Networks (ConvNets): on its own
5. Recurrent Neural Networks (RNN): rnn, irrn, lstm, GRN, and other gated RNNs

Unsupervised Learning:

6. Information-Theoretic Models and learning: Independent Component and entropy-based methods
7. Applications, applications and project

Example Reading Material:

-See http://www.deeplearning.net

-On-line Textbook: By Michael Nielsen**,** see **http://neuralnetworksanddeeplearning.com**

-Online Textbook: http://www.deeplearningbook.org

We encourage you to pursue all (online) resources, e.g., at http://www.deeplearning.net

ADDITIONAL REFERENCE MATERIAL: will be provided from the WWW/ internet.

COURSE WEB SITE: The primary web site is on the D2L Course Management System. Please go to the following URL: https://d2l.msu.edu and log-in with your MSUNet ID and password. This site is available to enrolled class members.

ATTENDANCE: Classroom attendance/participation is expected.

GRADING: Grading will be based on 3 assignments (mini-projects), a current paper presentation or special mini-project (midterm), and a final project, where students will be expected to apply the techniques covered and learned in prior projects to current practical scientific and engineering applications. The grade will be distributed as follows:

- Assignments: 3 Assignments (A1:10%, A2:15%, A3:20 %) 45%
- One "mid-term" Mini-Project & Presentation/Assessment, 15%
- Final Term Presentation & Project: 40%

Three small projects assignments will focus on DNN, ConvNet, and RNN, each, and will be given as take-home assignments. The Midterm will be based on a presentation and a summary assessment/evaluation of a current practical paper or application. The Final Project grade will be based on a final project report and an in-class presentation during the Final Exam period (**Thursday, Dec. 13, 2018, 12:45-2:45 pm in rm 2245 EB**).

Note: Assignments must be turned in on the due date to receive credit. **No make-up of assignments will be allowed without a written medical excuse.**

IMPORTANT DATES (Please refer to the Registrar's website at http://www.reg.msu.edu/ for a detailed calendar):

ACADEMIC HONESTY

Article 2.3.3 of the Academic Freedom Report states: "The student shares with the faculty the esponsibility for maintaining the integrity of scholarship, grades, and professional standards." In addition, this instructor adheres to the University regulations, policies, and ordinances on academic honesty and integrity, as specified in General Student Regulation 1.0, Protection of Scholarship and Grades; the all-University Policy on Integrity of Scholarship and Grades; and Ordinance 17.00, Examinations, all of which are available on the MSU Web site (www.msu.edu). Students who violate these rules may receive a penalty grade, including, but not limited to, a failing grade on the assignment or in the course. The following conduct is specifically cited: (1) Supplying or using work or answers that are not one's own; (2) Providing or accepting assistance with completing assignments or examinations; (3) Interfering through any means with another's academic work; (4) Faking data or results

LIMITS TO CONFIDENTIALITY

Essays, journals, and other materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors, may not be able to maintain confidentiality when it conflicts with their responsibility to report certain issues to protect the health and safety of MSU community members and others. As the instructor, I must report the following information to other University offices (including the Department of Police and Public Safety) if you share it with me:

--Suspected child abuse/neglect, even if this maltreatment happened when you were a child,
--Allegations of sexual assault or sexual harassment when they involve MSU students, faculty, or staff, and
--Credible threats of harm to oneself or to others.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In almost all cases, it will be your decision whether you wish to speak with that individual. If you would like to talk about these events in a more confidential setting you are encouraged to make an appointment with the MSU Counseling Center.