DO NOT TYPE IN THIS BOX

Bulletin # : 3

Academic Year : 2019-20

FLORIDA INTERNATIONAL UNIVERSITY
UNIVERSITY CURRICULUM COMMITTEE
Proposal for a New Course

1. **School/College** Engineering and Computing

   Div./Dept. in Which Taught School of Computing and Information Sciences

2. | CAP | 6 | XXX | | 3 |
   |---|---|---|---|---|
   | Alpha Prefix | 1st Digit | Last 3 Digits | "C"-lec-lab "L"-Lab | Cr. Hrs. |

   CIP Code *(Leave this blank):*

CAP 6619

3. **Grading Method (select one):** ■ Graded ☐ Pass/Fail

4a. **Course Title** Advanced Topics in Machine Learning

b. **Abbreviated course Title** *(for computer class schedules, transcripts)* Adv. Topics in ML

LIMITED TO 25 Characters *(including spaces)*

5. **Statewide Course Numbering Subject Matter Area** CAP (Computer Applications)

6. **Catalog Description/Major Topics** *(not to exceed 200 characters including spaces)*

College of Medicine and College of Law: Attach description not exceeding 1,000 characters including spaces.

Advanced course on machine learning principles and techniques. Students propose, implement, and present a collaborative project with advanced machine learning techniques.

7. **Attach detailed syllabus course outline and course justification on separate page(s).**
8. **Prerequisite(s):** CAP 5610 - Introduction to Machine Learning
9. **Corequisite(s):** None
10. **Objective(s) of Course:**

Provide students with a solid and comprehensive understanding of advanced machine learning algorithms to solve real-world problems in IoTs, smart cities, personalized medicine, etc.

11. **Does this course duplicate/overlap other courses at FIU?** ■ No ☐ Yes

    If yes, please explain:

12. **What other closely related department(s) have been consulted about this course?**

    None

13. **Is this course used for the assessment of a program or a certificate (if yes, then send a notification to assessment@fiu.edu)?** ■ No Yes

PROPOSAL REQUESTED BY:

Faculty Contact Ananda Mohan Mondal / Miguel Alonso Jr (Type name) (Signature) 11 / 01 / 2019

amondal@fiu.edu / malonsoj@fiu.edu (Email address) 305-348-4588 (Phone number)

Chairperson (Dept./Div.) Ram Iyengar (Type name) (Signature) 11 / 25 / 2019

Chairperson (Curr. Comm.) Wei-Chiang Lin (Type name) (Signature) 12 / 5 / 2019

College/School Dean John Volakis (Type name) (Signature) 12 / 10 / 2019

Submit one original form. Attach one copy of the course justification and course syllabus, course description, objectives, major topics and textbooks.

Advanced Topics in Machine Learning
Instructor: Ananda Mohan Mondal / Miguel Alonso Jr

Course Justification

Machine learning techniques are continuing to evolve, as more data is being collected and ever more powerful computer is made cheaply available. For example, Deep Learning (DL) has emerged as a powerful tool for prediction as the amount of available training data has increased due to the improvement in high-throughput data generation technologies in the areas of Internet-of-Things (IoT), Smart Cities, Deep Sequencing of human genome, etc. DL models have grown in size over time, as computing infrastructure has improved in terms of both hardware and software, and are being used to solve increasingly complex problems with a high level of accuracy more and more every day. Moreover, innovation will continue in the area of DL and new techniques will be devised to meet this demand. In order to maintaining pace and US competitiveness in Artificial Intelligence, preparing and training our students with these evolving machine learning techniques is crucial for our success to prepare right kind of workforce. The proposed course will teach state-of-the-art advanced machine learning principles and techniques related to deep learning. Additionally, the course will cover the most impactful state of the art techniques as they evolve in real-time.

At present, there are machine learning courses at FIU including Introduction to Machine Learning (CAP 5610) for Computer Science students and Machine Learning Techniques & Application (CAP 5622) for non-Computer Science students, which introduce general techniques in machine learning, but lacks depth, especially for DL, at an advanced level. The proposed course, Advanced Topics in Machine Learning, will teach a number of advanced machine learning techniques including deep feedforward networks, regularization for deep learning, sequence modeling, linear factor models, autoencoders, and deep generative models.

There are many positions in industry, national labs, and academia that require a solid background in Machine Learning. In order to better serve our students and prepare them for the job market, as well as for research and development, there is a crucial need for a course that covers advanced topics in machine learning. The proposed course, Advanced Topics in Machine Learning, will provide students with the opportunity to become competitive in both job market and research and development. This course can also benefit non-CS students in the College of Engineering and Computing who are interested in applying advanced machine learning techniques and tools in their research.

School of Computing and Information Science

Course Title: Advanced Topics in Machine Learning **Date:** 11/01/2019

Course Number: CAP 6XXX

Number of Credits: 3

Subject Area: Intelligent Systems	**Subject Area Coordinator:** **email:**
Catalog Description: Advanced course on machine learning principles and techniques. Students propose, implement, and present a collaborative project with advanced machine learning techniques.	
Textbook: Ian Goodfellow, Yoshua Bengio, and Aaron Courville. ***Deep Learning***. The MIT Press, Cambridge, Massachusetts, 2016.	
References: Articles from relevant Journals and Conferences.	
Prerequisite Courses: CAP 5610 - Introduction to Machine Learning	
Corequisite Courses: None	

Type: **Elective**

Prerequisite Topics:

- Calculus
- Linear Algebra
- Introductory Machine Learning
- Introductory Statistics concepts
- Basic Programming (e.g., Python, MATLAB or R)

Course Outcomes:

Students who successfully complete this course will be able to:

1. Describe and explain a selection of concepts, algorithms and models used in deep learning to solve real-world problems;
2. Apply the most established deep learning algorithms;
3. Formulate a deep learning problem from scratch and utilize appropriate machine learning algorithms to solve the formulated problem;
4. Describe techniques that are believed to be important for future research;
5. Identify and explain metrics for optimizing deep models.

Outline:

	Topic	Number of Lecture Hours (Total: 37.5 hours 15 weeks * 2 lectures week * 1.25 hrs lecture)	Outcome
1.	**Machine Learning Basics:** Supervised and unsupervised learning; Overfitting and underfitting; Hyper parameters and validation sets; Stochastic gradient descent.	2	1
2.	**Deep Feedforward Networks:** Architecture Design; Hidden units; Back propagation.	2	1, 2
3.	**Regularization for Deep Learning:** Norm penalties; noise robustness; early stopping; sparse representation; dropout; adversarial training.	2	1, 3, 5
4.	**Optimization for Training Deep Models:** Challenges in neural network optimization; Parameter initialization strategies; Algorithms with adaptive learning rates.	2	5
5.	**Convolutional Networks:** Convolution operation; Variants of convolution function; Efficient convolution algorithms; Neuroscientific basis for convolutional networks	3	1, 2, 3, 5
6.	**Sequence Modeling:** Recurrent neural networks; Recursive neural networks, Long Short-Term Memory and Other Gated RNNs.	4	1, 2, 3, 5
7.	**Practical Methodology:** Performance Metrics; Default Baseline Models; Selecting Hyperparameters; Debugging Strategies;	2	3,5
8.	**Applications of Established Deep Learning:** Computer Vision; Speech Recognition; Natural Language Processing.	2	2, 3
9.	**Linear Factor Models:** Probabilistic PCA and Factor Analysis; Independent Component Analysis.	3	1, 4
10.	**Autoencoders:** Regularized Autoencoders; Denoising Autoencoders; Contractive Autoencoders.	3	1, 4
11.	**Deep Generative Models:** Boltzmann Machines; Restricted Boltzmann Machines; Deep Belief Networks; Deep Boltzmann Machines; Boltzmann Machines for Real-Valued Data; Convolutional Boltzmann Machines; Directed Generative Nets; Evaluating Generative Models.	5	4, 5

Wei-Chiang Lin

From: Ning Xie <nxie@cis.fiu.edu>
Sent: Monday, December 02, 2019 10:20 PM
To: Wei-Chiang Lin; Cesar Levy; Elias Alwan; Ioannis Zisis; Wallied Orabi; Mark Allen Weiss
Subject: Fwd: Approval of newly proposed course - Advanced Topics in Machine Learning

Hi all,

I am forwarding the approval email of ECE of the graduate course proposal we conditionally approved in our last week's meeting. Thanks.

Best,
Ning

---------- Forwarded message ---------
From: Shekhar Bhansali <sbhansa@fiu.edu>
Date: Mon, Dec 2, 2019 at 9:32 PM
Subject: Re: Approval of newly proposed course - Advanced Topics in Machine Learning
To: iyengar <iyengar@cis.fiu.edu>
Cc: Ananda Mondal <amondal@fiu.edu>, Sundararaj Iyengar <iyengar@fiu.edu>, Shu-Ching Chen <chens@cs.fiu.edu>, Xudong He <hex@cs.fiu.edu>, Jason Liu <liux@cis.fiu.edu>, Ning Xie <nxie@cis.fiu.edu>, Miguel Alonso Jr <malonsoj@fiu.edu>, Ariana Taglioretti <ataglior@cs.fiu.edu>, Mark Allen Weiss <weiss@cs.fiu.edu>, Ariana Taglioretti <ataglior@fiu.edu>, ecef@eng.fiu.edu <ecef@eng.fiu.edu>

Dr Iyengar

As you are aware ECE philosophy has been that every department should be free to do what it thinks is best for its students.

Consistent with ECE philosophy ECE would have no objections. Let's hope SCIS faculty extend the same courtesy in the future (you have always been personally very supportive of ECE)

Regards

Shekhar

On Dec 3, 2019, at 4:33 AM, iyengar <iyengar@cis.fiu.edu> wrote:

Dear Dr. Bhansali,

I write to you regarding the School of Computing and Information Sciences' development of a much-needed course for Computer Science students titled "Advanced Topics in Machine Learning" at the 6000 level under the course prefix CAP.

The intent is for this course to be offered beginning in Fall 2020. The graduate committee of SCIS unanimously approved the course on November 20, 2019. However, the College of Engineering Curriculum Committee has "conditionally" approved the course on the basis that, as the representative from ECE pointed out, your department already has several Machine Learning courses. The representative requested that the SCIS communicate with you to enumerate what makes our proposed course different from the Machine Learning courses offered by ECE and request a final clearance.

The rationales for this course and how it is different from the offering in the ECE, are explained below.

1. Our cornerstone Machine Learning course, CAP 5610 - Introduction to Machine Learning, was proposed by late Professor Tao Li in October 2005 (passed away 2018) and was approved by the entire faculty on November 1, 2005 to make sure that the course was available to be offered in the Fall of 2006. CAP 5610 introduces general techniques in machine learning, but lacks depth, especially for deep learning, at an advanced level. The proposed course, Advanced Topics in Machine Learning, will teach a number of advanced machine learning techniques including deep feedforward networks, regularization for deep learning, sequence modeling, linear factor models, autoencoders, and deep generative models.

2. The proposed course will emphasize theoretical and interpretability aspects of deep learning approaches, as opposed to the application of deep learning to common problems in ECE, such as those problems discussed in the applied machine learning courses offered by the ECE department. Below is a list enumerating the differences:

a. EEL 5813 (Neural Networks – Algorithms and Applications) – This course focuses on basic principles in Artificial Neural Networks whereas the Advanced Topics in Machine Learning will focus on a theoretical treatment of advanced deep learning models. The course also focuses on applications in the electrical and computer engineering fields. Our proposed course will focus on general theoretical questions relevant in the Machine Learning research community such as sample complexity, generalization, training time, transfer learning, active learning, domain adaptation, etc.

b. EEL 6812 (Advances in Neural Networks)– This course focuses on advanced concepts and applications in Artificial Neural Networks with a focus on engineering applications. The Advanced Topics in Machine Learning course takes a theoretical, research driven approach, as opposed to a conceptual and application driven approach, again, focusing on general theoretical questions relevant in the Machine Learning research community.

c. EEL 6816 (Electronic Neural Systems) – This course focuses on the intersection of biological neural networks and electronics, as opposed to advanced machine learning techniques, embodied in software, as our proposed course does.

d. CNT 6150 (Advanced Sensor & IoT Data Analysis with Deep learning) and CNT 6154 (Advanced IoT Applied Machine Learning) – These courses focus on applied machine learning and deep learning to data collected from sensors and IoT devices. Our proposed course will be focused on benchmark datasets unrelated to the IoT industry, as well as, focusing on theoretical aspects of Advanced Machine Learning techniques as mentioned previously.

Thank you for your consideration in approving the proposed course, Advanced Topics in Machine Learning.

Best,

Ram Iyengar

Director and Distinguished University Professor

FIU SCIS