COURSE OUTLINE

TME 6016: Foundations of Deep Learning in Computer Vision

Instructor	Mahdi S. Hosseini	**Term**	2022/WI
Office	Head Hall H133	**Day**	Monday's
Phone	TBD	**Time**	9:00AM – 11:50AM
Email	mahdi.hosseini@unb.ca	**Classroom**	TBD
Website	www.unb.ca/tme/	**Office Hours**	After Class or by appointment

Students are encouraged to contact the instructor at any time for assistance.

COURSE DESCRIPTION

The purpose of this special topic course is to provide foundations and recent advances in designing, training, and testing of deep learning pipelines in computer vision applications using Convolutional Neural Networks (CNNs). The problem of image representation for general computer vision applications will be the core interest of this course. Students will learn how to design a deep CNN model from scratch for a particular computer vision problem, train the network with fast and high precision accuracy optimization algorithms, and optimize its hyper-parameters for fine tuning. The course syllabi will include Multi-Array (Tensor) Analysis, Convolution Layer Design, Feature Pooling, Activation Layers, Feature Normalization, Feature Classifiers, Loss-Functions, Gradient Back-Propagation, Stochastic Optimization, Generalization Problem, Data Augmentation techniques, Hyper-Parameter tuning, Data Augmentation, Transfer Learning, as well as three major applications in computer vision will be discussed in natural imaging, satellite imaging, and medical imaging.

1. Layers and Blocks
2. Convolutional layers
3. Pooling Methods
4. Activation Functions
5. Normalization
6. Feature Classification
7. Loss-Function
8. Gradient Back-Propagation
9. Stochastic Optimization
10. Generalization Problem
11. Hyper-Parameter Tuning
12. Data Augmentation
13. Transfer Learning
14. State-of-the-Art in CNN
15. Computer Vision Applications

***Note: the orders of the course topics are subject to revision

PREREQUISITES

The prerequisites will be enforced.

- **Python Programming** (e.g. PyTorch, Tensorflow, Keras): you need to have basic knowledge/ preliminary experience with Python programming. This course, including assignments and projects, involve with Python coding and you should be feeling comfortable to further learn how to code in Python language and gain experience.
- Introduction to Calculus and Linear Algebra
- Preliminaries in Machine Learning

COURSE MATERIALS

Two main textbooks are chosen for reference book for the class: Deep Learning by Goodfellow et al., and Dive-2-DeepLearning by Zhang et al. Further readings are listed below in the Course Schedule, either in the form of lecture notes, text-book chapter(s), scientific papers, and video lectures. They will be all available online on web for free.

The following links provide some preliminaries for basic understandings of the course and what to expect:

- Deep Learning textbooks i.e. Deep Learning by Goodfellow et al., and Dive-2-DeepLearning by Zhang et al.
- Stanford online YouTube Lecture courses on Convolutional Neural Network by Professor Andrew Ng
- Stanford online YouTube lecture courses on Machine Learning by Professor Andrew Ng
- You will also find many useful YouTube lectures by Professor Geoffrey Hinton's Coursera course on Neural Networks and Machine Learning.

PROFESSIONAL BEHAVIOUR

The lectures are carried in-class and you need to have your phones on silent mode and put away. The use of Laptops/Notebooks are allowed for **class purpose only**. You should arrive the class session prior to the beginning of lecture so the class can start ontime. Your score in class participation is partially considered by your active engagement in discussions and teamwork during the class.

COURSE OUTCOMES

The course introduces students the necessary knowledge background for designing Convolutional Neural Networks (CNNs) in broad computer vision application as a series of Data Science course lecture series. Students will learn the foundations in deep learning from both theory and application viewpoints. This is achieved through a combination of lectures, textbook/scientific paper readings, coding lab, group project activities, and series of assignments to explore specific techniques, and acquire the insights required for practical developments of deep learning in computer vision related projects.

This course also offers 50min python lab during each session which follows from the same course material during the course session for implementation. You will learn how to implement sections of deep learning pipeline in Python programming and gives you better understanding of the pipeline.

LECTURE HOURS

Each lecture is divided into three main sections:

(a) lecture on course-topics (1 hour),

(b) Python Coding lab following up from course notes and reading material (1 hour),

(c) Team project discussion and progress update in an informal presentation format (50 min).

GRADING SCALE

The following grading scale is used in all TME courses:

90-100	A+	65-69	B-
85-89	A	60-64	C+
80-84	A-	55-59	C
75-79	B+	50-54	D
70-74	B	<50	F

MARKING SCHEME

Mandatory components that will determine the overall course grade will include:

- Class participation and active engagement in discussions
- Three Assignments (Mini-Project series)
- Proposal for team-based course project
- Midterm presentation for team project
- Midterm report for team project
- Weekly updates and progresses on team project
- Final presentation for team project
- Final report for team project

The final grade for this course is based on the following breakdown:

List of Components	% of Total Grade
Participation and Discussion Engagement	+ 5% (Extra Bonus)
Three (3) Assignments	3 x 10%
Proposal for team-based course project	10%
Midterm presentation for team project	5%
Midterm report for team project	10%
Six weekly updates/progresses for team project	6 x 5%
Final presentation for team project	5%
Final report for team project	10%
TOTAL OF ALL COMPONENTS	100%

Note: Instructions of the components will be delivered during the lecture

COURSE POLICIES

1. **CLASSES AND TUTORIALS**

   Classes will be on Monday's

2. **ASSIGNMENTS**

   Assignments provide meaningful scenarios of the course outlines that allow you to analyze and explore specific problems that bridge theory all the way to Python coding implementation. There will be three assignments in total and the scores count towards your final mark.

3. **COURSE PROJECT**

   You will be assigned to a project team of Two(2). The project assignments will be decided after asking students to discuss the potential ideas among themselves. Each team will be asked to choose a topic and write a proposal. The validity of the project proposal will be assessed by the lecturer. Based on the feedbacks, you will be asked to work as a team to design a layout plan for successful execution of the project.

Projects are expected to take place during the course time frame. Each team will participates in development of the project and prepare for presentation and a report for mid-term. Provided by the comments and feedback, the team will carry on to complete the project by the final term for presentation and finalized report project.

The projects will be evaluated based on the mid-term progress and final-term deliverables including Performance review of each team member, Presentations, Reports, Supplementary materials (e.g. PyThon Codes, Access to Data, Readme files, etc).

Any additional guidelines and deadlines for projects will be provided in class.

4. CLASS PARTICIPATION

Participation is your active involvement in the actual class experience and is highly valued within the TME program. Your class participation mark will be assigned by the instructor and is based on the level and quality of the discussion that you contribute to the course and on the level and quality of your class assignment submissions. Careful preparation/review of the assigned class materials, regular/prompt class attendance, voicing your opinion during class discussions, and the perceptiveness of your comments will be reflected in your class participation grade.

Each student's class participation and professionalism grade is based on our 5 P scale:

Present	Prompt	Prepared	Participated	Perceptive
1	2	3	4	5

Tentative Course Schedule

Please refer to the Reading link from each Chapter to clearly understand the expectations/outcome of the each course section.

	Date	Topic	Readings	Assignment Due
Week-1	Monday, Jan 10th, 2022	Preliminaries from Linear Algebra and Calculus	Chapter-2: Dive-2-DeepLearning	
Week-2	Monday, Jan 17th, 2022	Layers and Blocks	Chapter-5: Dive-2-DeepLearning	
Week-3	Monday, Jan 24th, 2022	Convolutional layers, Pooling Methods,	Chapter-6: Dive-2-DeepLearning	
Week-4	Monday, Jan 31st, 2022	Activation Functions, Feature Normalization	Chapters-4&7.5: Dive-2-DeepLearning	
Week-5	Monday, Feb 7th, 2022	Feature Classification	Chapters-4: Dive-2-DeepLearning	Project Proposal, Due on Feb 11th, 11:59PM
Week-6	Monday, Feb 14th, 2022	Loss-Function, Gradient Back-Propagation	Chapters-4: Dive-2-DeepLearning	Assignment-1, Due on Friday Feb 18th, 11:59PM
NB Family Day - University Holiday				
Week-7	Monday, Feb 28th, 2022	Optimization Algorithm	Chapters-11: Dive-2-DeepLearning	
Winter Term break				
Week-8	Monday, Mar 14th, 2022	Generalization Problem, Hyper-Parameter Tuning	Chapters-11: Dive-2-DeepLearning	Midterm Presentation (during the class), and Midterm Report (Due before class)
Week-9	Monday, Mar 21st, 2022	Data Augmentation, Transfer Learning	Chapters-13: Dive-2-DeepLearning	Assignment-2, Due on Monday Mar 21st, 11:59PM
Week-10	Monday, Mar 28th, 2022	State-of-the-Art in CNN, Pros and Cons	Chapters-7: Dive-2-DeepLearning	
Week-11	Monday, Apr 4th, 2022	Computer Vision Applications: CIFAR10 Image Classification	Chapters-13: Dive-2-DeepLearning	
Week-12	Monday, Apr 11th, 2022	Computer Vision Applications: Object Detection, Semantic Segmentation	Chapters-13: Dive-2-DeepLearning	Assignment-3, Monday Apr 11th, 11:59PM
				Final Presentation and Final Report

ACADEMIC INTEGRITY

The University of New Brunswick places a high value on academic integrity and has a policy on plagiarism, cheating and other academic offences.

Plagiarism includes:

1. quoting verbatim or almost verbatim from any source, including all electronic sources, without acknowledgement;
2. adopting someone else's line of thought, argument, arrangement, or supporting evidence without acknowledgement;
3. submitting someone else's work, in whatever form without acknowledgement;
4. knowingly representing as one's own work any idea of another.

Examples of other academic offences include: cheating on exams, tests, assignments or reports; impersonating somebody at a test or exam; obtaining an exam, test or other course materials through theft, collusion, purchase or other improper manner, submitting course work that is identical or substantially similar to work that has been submitted for another course; and more as set out in the academic regulations found in the Undergraduate Calendar.

Penalties for plagiarism and other academic offences range from a minimum of F (zero) in the assignment, exam or test to a maximum of suspension or expulsion from the University, plus a notation of the academic offence on the student's transcript.

For more information, please see the Undergraduate Calendar, Section B, Regulation VIII.A, or visit http://nocheating.unb.ca. It is the student's responsibility to know the regulations.

Have a Complaint or Suggestion?

The J Herbert Smith Centre is committed to quality and looks to you, the students, for input. Although we encourage you to deal directly with any of the Centre's personnel when bringing forth any problems, deficiencies, or suggested improvements in any area of the program, as a student you may prefer to do so anonymously.

Please make your submission in writing to the Dean of Engineering Office in Room C-28. The Faculty Office will forward the submission (without your name on it) to the Centre for processing and you can check with their office for any updates on actions from the Centre. All submissions are handled in such a way as to ensure that immediate action is taken, when required, and that corrective and/or preventive action is planned, documented and implemented. Follow up is conducted on each submission to ensure that the problem is remedied.

You may also contact Erin Thomas at the J Herbert Smith Centre for further information or assistance pertaining to this course or the Diploma in Technology Management & Entrepreneurship (DTME).

Erin Thomas

J Herbert Smith Centre - H225

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