IT594: Deep Neural NLP & Applications

Instructor: Sourish Dasgupta

Prerequisites: Programming in Python

Slot: M.Tech. (ML) III / M.Sc. DS III / B.Tech (CS/ICT/MnC) VII Semester

Category: Technical Elective/ ML. Sp. Elective

Course Credits(L--T--P--Cr): 3--0--2--4

Lectures: Yes (Offline)

Lab and Practical: Yes

TA contact info: TBD

Course Description:

This course is designed for students who want to pursue a career as an NLP research engineer or research scientist. The aim of this course is to make the students industry-ready with a solid theoretical foundation of modern deep neural paradigmatic revolution in the field of NLP and a very strong hold on industry-standard Neural NLP tools. A subsequent course on NLP using Deep Learning is recommended to make this a success.

Course Structure

- **Lecture:** Learn the theories (including mathematical and linguistic underpinning) of the foundation of modern Deep Neural NLP with the sufficient context of how classical concepts form its basis,
- **Project:** The course will be project-driven, where a specific Natural Language Processing (NLP) problem will be defined and given. Every lecture will be designed in the context of solving the specific NLP problem with an introduction to necessary technologies. Weekly assignments will be given, and assignments will be designed as necessary stepping stones toward the completion of the project.

Suggested Books (optional):

- Yoav Goldberg: A Primer on Neural Network Models for Natural Language Processing

Course Outcomes:

After successful completion of the course, the student will have the ability to -

- Complete an end-to-end real-life industry-level NLP project
- Thorough understanding of the fundamentals of the paradigm of Neural NLP - their pros and cons
- Design and implement industry-standard NLP systems.
- Thorough understanding of industry-standard NLP libraries such as SpaCy and HuggingFace NLP.

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
X	X	X			X				X	X	X

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Evaluation Scheme

- **Mid-semester Exam:** 20 %
- **End-semester Exam:** 30 %
- **Group Project-Assignments:** 20 % (group size will be a maximum of 4 students)
- **Term paper presentations:** 30% (group presentation)

Grading Policy

For Credit:
AA: >=85%; AB: >=75%; BB: >=65%; BC: >=55%; CC: >=45%; CD: >=35%; DD: >=25%; F: <25%
For Audit:
Pass: >=25%

Course Plan:

Units	Topics	Number of Lectures
Introduction to NLP (and project)	• What is NLP (and NLU)? • Applications of NLP • Syntax vs. Semantics vs. Pragmatics • Introduction of project topic	1
Semantics	• Understanding meaning - distributional vs. compositional semantics • Limitations of distributional semantics • Limitations of compositional semantics	2

Embedding-based Representation of document semantics	• Representing documents accurately: Document Representation Learning
	  ○ Feature-function and weight learning
	  ○ Term-Frequency based
	  ○ Shallow neural model-based “static embeddings” - word2vec and variants
	  ○ Introduction to Deep neural model-based embedding
	• Introduction to SpaCy
		4

Language Models (LMs)	• Language Models
	  ○ Language Models & Semantics
	  ○ N-gram modeling
	  ○ Skip-gram modeling (and Word2Vec)
	  ○ Conditional LMs
		6

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	○ RNN-based LMs ○ LSTM-based LMs ● Introduction to HuggingFace	
Attention Modeling	● Attention in LMs ○ Generalized Attention ○ Self Attention	6
Transformer-based Large LMs (LLMs)	● Encoder-Decoder-based Transformer Model ● Encoder-only BERT Model ● Decoder-only GPT Model	6
Prompt-based In-Context Learning	● In-context Learning ● Prompt Engineering	2
Introduction to Augmented LMs (ALMs)	● Information Retrieval Augmented LMs ● Reinforcement Learning Augmented LMs	2
Dialogue Bots: The case of ChatGPT-styled Large ALMs	● Reinforcement Learning via Human Feedback (RLHF) ● LLMs vs. Dialogue-based ALMs	4
LLMs and Reasoning	● Reasoning in AI ● Various categories of NLP reasoning ● Reasoning w.r.t LLMs (what it is and what it is not)	3

Lectures: 36 (tentative)