Course program and reading list

Semester 1 Year 2023

School: Efi Arazi School of Computer Science M.Sc.

Information-theoretic analysis of neural language models

Lecturer:

Dr. Alon Kipnis  alon.kipnis@runi.ac.il

Course No.: 3890  Course Type: Seminar  Weekly Hours: 3  Credit: 3

Course Requirements: Final Paper  Group Code: 231389001  Language: Hebrew

Prerequisites

Prerequisite:

52 - Calculus I
53 - Calculus II
54 - Linear Algebra I
55 - Linear Algebra II
56 - Discrete Mathematics
59 - Data Structures
69 - Logic And Set Theory
417 - Introduction To Computer Science
3141 - Machine Learning from Data

Course Description

In this semi seminar-style class, we use tools from information theory to analyze and
explore modern language models that are based on transformer neural networks. The goal of this class is to provide mathematical background for data compression and apply learned concepts to develop novel applications in natural language processing. This class is in a semi-seminar format: the instructor will provide a mathematical premier for data compression from information theory. Participants will prepare and deliver classes on subsequent topics, including live demonstrations of code snippets.

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Course Goals

- Understand the following concepts in information theory
  - Information source
  - Entropy, conditional entropy
  - Lossless and almost lossless data compression
- Understanding concepts and implementations of basic language models:
  - Unigram
  - n-gram
  - skip-gram
- Understanding the basic structure of a transformer neural network and its training mechanism
- Understanding how to translate the output of a language model based on transformers to next-word probabilities.

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Grading

- 60% Class presentation assignment
- 20% Home assignments (maximum of two throughout the semester)
- 20% Attendance and Participation

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Lecturer Office Hours

Wednesday 14:00 – 15:00

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Reading List

- Chapters 1-5 of “Elements of information theory” by M. Thomas and T. Cover. 2006. (Second Edition)