CS 539 Natural Language Processing with Deep Learning

Instructor	Stefan Lee Office Hours: See Canvas
TA	Xiangxi Shi Office Hours: See Canvas
Prerequisites	Required: Machine Learning: CS 534 or equivalent Recommended: Deep Learning: CS 535 or equivalent
Credits	3
Course Description	Advanced topics in Natural Language Processing focused on techniques in Deep Learning for representing, reasoning about, and generating natural language. Recent techniques, their application to common problems, and the ethics around their use will be covered.
Learning Resources	Required but freely available online from authors: *Jurafsky and Martin, 2019.* Speech and Language Processing. [PDF] *Goodfellow, Bengio, and Courville, 2016.* Deep Learning. [PDF] Referred to as SLP and DL respectively below. In addition to the above textbooks, students will read publicly available research articles that illustrate specific applications and algorithms.

Student Learning Outcomes

At the completion of the course, students will be able to...

1. Explain a broad set of open natural language processing problem areas and their challenges
2. Understand the fundamentals of deep language modelling and representation learning
3. Implement and train common NLP techniques within deep learning frameworks
4. Be able to present and discuss deep learning projects in NLP

Course Schedule

The course covers deep learning techniques for NLP (⚒), how they are applied to common applications (⚑), and ethical considerations of their use (⚖). Topics are subject to change but this is our roadmap.

	Date	Topic	Suggested Reading	Logistics
1	**1/4**	**Introduction and Course Logistics** **Representing Words** • Words and Word Senses	SLP 6-6.1 [PDF]	
	1/6	• Distributional Hypothesis • Vectoral Semantic Embeddings ⚒	SLP 6.2-6.8 [PDF] Mikolov et al., 2013a [PDF]	**HW1 Out**

	1/8	• Vectoral Semantic Embeddings (cont.) ⚒ • Bias In, Bias Out -- Dangers of Learning from History ⚖	SLP 6.9-6.11 [PDF] Mikolov et al., 2013b [PDF]	
2	1/11	**Deep Learning Concepts in NLP** • Feed-forward Neural Networks ⚒ • Computation Graphs and Backpropagation ⚒	DL 5.1 [PDF] DL 6 [PDF]	
	1/13	• Computation Graphs and Backpropagation (cont.) ⚒ • Convolutional Neural Networks ⚒ • Recurrent Neural Networks ⚒	DL 9.1-9.3 [PDF] DL 10-10.2.3 [PDF]	
	1/15	• Recurrent Neural Networks (cont.) ⚒ • Backpropagation through Time ⚒	DL 10-10.2.3 [PDF]	
3	1/18	**Martin Luther King Jr. Day (no lecture)**	*Where Do We Go From Here*, Speech by MLK Jr. [PDF]	
	1/20	**Representing Language** • Contextualized Representations ⚒ ○ Sentiment Classification ⚑	SLP 9-9.1 [PDF] SLP 9.2.3 [PDF] Tia et al., 2015 [PDF]	**HW1 Due** **HW2 Out**
	1/22	• Contextualized Representations (cont.) ⚒ ○ Semantic Role Labelling ⚑ • Privacy and Policing Speech ⚖	SLP 9.2.2 [PDF] SLP 20 - 20.1 [PDF] SLP 20.6.2 [PDF] Kim et al., 2014 [PDF] Jurgen et al, 2017. [PDF]	
4	1/25	**Generating Language** • Generative Language Models ⚒	SPL 7.5 [PDF] SLP 9.2.1 [PDF]	
	1/27	• Generative Language Models (cont.) ⚒ • Decoding Strategies ⚒	SLP 9.3-9.4 [PDF] SLP 10.2 [PDF] Holtzman et al. 2020 [PDF]	**Initial Project Idea Due**
	1/29	• Exposure Bias ⚒	Bengio et al. 2015 [PDF]	
5	2/1	• Evaluating Generated Language ⚒ • Author Bots, Astroturfing, and Amplifying Bias ⚖	SLP 3.2 [PDF] Papineni et al., 2002 [PDF] Hovy & Spruit, 2017 [PDF]	
	2/3	**Attention in Language Models** • Introduction to Attention Mechanisms ⚒	SLP 10.3 [PDF] Bahdanau et al., 2016. [PDF] LilLog [WWW]	**HW2 Due** **HW3 Out**
	2/5	• Attention (cont.) • Self-Attention and Transformer Models ⚒	Vaswani et al., 2017. [PDF] Alammar [WWW]	
6	2/8	• Self-Attention and Transformer Models (cont) ⚒	Radford et al., 2018 [PDF]	
	2/10	**Project Proposal Presentations**		
	2/12	**Project Proposal Presentations**		
7	2/15	**Self-Supervised Language Representations** • BERT, ELMO, and more ⚒	Peters et al. 2018.[PDF] Delvin et al., 2019 [PDF]	
	2/17	• Transfer Learning ⚒	Radford et al., 2019 [PDF] Brown et al., 2020 [PDF]	**HW3 Due** **HW4 Out**
	2/19	**NLP Problem Areas And Notable Techniques**	DL 12.4.5 [PDF] Guzman´ et al, 2019. [PDF]	

		• Machine Translation 🚩 ○ Low-Resource Languages in the Big Data Era ⚖️		
8	**2/22**	• Question Answering 🚩	SLP 25.1.8 [PDF] Rajpurkar et al, 2018 [PDF] Kamath et al, 2020. [PDF]	
	2/24	• Abstractive Text Summarization 🚩	See et al. 2017 [PDF]	
	2/26	• Natural Language Inference 🚩 ○ Annotation Artifacts and False Progress ⚖️	Bowman et al.,2015 [PDF] Gururangan et al, 2018 [PDF]	
9	**3/1**	• Semantic Parsing 🚩	SLP 16 [PDF] Wang et al, 2016 [PDF]	
	3/3	**Grounding Language** • The Symbol Grounding Problem • Multimodal Fusion ⚒️	Harnad, 1990. [PDF]	**HW4 Due**
	3/5	• Vision-and-Language Pretraining ⚒️	Lu et al. 2019 [PDF] Lu et al, 2020 [PDF]	
10	**3/8**	• Visual Question Answering 🚩 • Referring Expressions 🚩	Agrawal et al. 2016 [PDF]	
	3/10	**Final Project Presentations**		
	3/12	**Final Project Presentations**		

Evaluation of Student Learning

- **Attendance [5% of final grade]**
  Attendance at Zoom sessions will be collected at five random lectures.

- **Quizzes [10% of final grade]**
  Quizzes and surveys will be given out periodically on Canvas to track comprehension of the material and course engagement . Surveys will be graded on participation.

- **Assignments [55% of final grade]**
  Four assignments including programming portions and question answering portions. Programming portions will be based on skeleton code in PyTorch. Topics covered include word vectors, RNNs and language representation, language modeling, and attention mechanisms.

- **Final Project [30% of final grade]**
  NLP-focused project with groups of 4 students to be done during the second half of the term. The project is self-defined but may be a reimplementation of a recent paper on instructor approval. The project includes three deliverables with details outlined below.

  Idea Submission for Review [5%]
  By 1/27 student teams should be formed and submit an initial idea draft for review. Students are encouraged to reach out to the instructor if they need help brainstorming. Submission will be

through an assignment form on Canvas and will include:

- **Who is on the team?**
- **A tentative title for the project**
- **Brief description of project goals and proposed methods**
- **Reference to at least 3 related works**

Proposal Presentation [10%]

An influential former DARPA director George Heilmeier developed a set of questions to frame thinking about proposed research projects -- these are now known as the Heilmeier Catechism. These have been adapted into the rubric below. For projects replicating recent papers, answer the questions on behalf of the paper where appropriate. **Proposals will be no longer than 10 minutes and will be graded out of 40 points.** Proposals should include content to address the following questions:

- **[5 pts] What are you trying to do? Articulate your objectives using almost no jargon.**
  Explain in plain English what exactly you are hoping to achieve. Avoid using any domain-expert terminology. Think about explaining the overall goal of your project to someone who has never taken a machine learning class.

- **[5 pts] How is it done today, and what are the limits of current practice?**
  Without this context, it won't be possible for anyone to judge the merits of your proposal. You are expected to do some literature review to find closely related work to your proposed work.

- **[5 pts] What is new in your approach and why do you think it will be successful?**
  This is the core of what you are proposing. Is your project a new problem domain? If so, how is it different from existing ones and how do you plan to tackle it? Is your project a new technique for an existing problem? If so, how does your method differ and why do you think this difference should improve things? Is your project a piece of analysis? If so, how are you confident your proposed measure will reflect what you intend to study?

- **[5 pts] Who cares? If you are successful, what difference will it make?**
  Explain why you are doing this project in practical terms. If you succeed, what will change in the world? What will we be able to do that we weren't able to do before? Is something faster? More accurate? Easier to interact with? Less biased? Better understood? Tell us.

- **[5 pts] What are the risks and how long will it take?**
  Provide a timeline for your project work and identify the parts that you think are most likely to be difficult or that you are uncertain about how long they will take. Being able to estimate "project risk" is important when doing research work in both academia and industry.

- **[5 pts] What are the midterm and final "exams" to check for success?**
  Be specific. Tell us how you intend to evaluate success. What dataset or experiment? What

metrics? How will you evaluate significance?

An additional 10 points will be based on presentation quality:

- **[5 pts] Appropriate Use of Figures / Tables / Visualizations**
  Visual elements like figures, tables, and charts can be very useful for explaining complex concepts or conveying results. They can also be misleading, confusing messes when used poorly. Are yours clear? Do they contribute positively to understanding the information?

- **[5 pts] Overall Clarity of Presentation**
  Is your presentation clearly structured? Is it timed appropriately? Are you using the slides to reinforce what you are saying (good) or are you consistently reading your slides to the audience (bad)? Is everything on your slides relevant (good) or are you skipping over / not explaining things you included on the slides (bad)?

Final Presentation [15%]:
Research is messy. The final project presentation is not to judge whether your results are "good" or not. Rather, it is meant to evaluate the level of effort in the project, your understanding of what you've done and how it relates to existing work, and your ability to interpret and communicate your results. **Final presentations will be no longer than 10 minutes and graded out of 40 points based on the following criteria:**

- **[5 pts] Problem Statement and Related Work**
  In your presentation, clearly but quickly remind everyone what your project is about and how your approach differs from existing literature on the topic.

- **[20 pts] Project Effort**
  Effort on the project should equate to approximately one homework assignment's worth of effort per group member (~4 x 2 weeks). Be clear about what you've produced -- code, experimental protocols, empirical results, analysis, theoretic results, etc. If you are starting from an existing codebase, tell us what it provided and what you added to it.

- **[5 pts] Explanation of Experiments and Results**
  In your presentation, describe the experiments you performed to evaluate your project's progress. Define metrics, datasets, and experimental protocol. Compare your approach to any relevant baselines.

- **[5 pts] Novelty of Project Contributions**
  Projects that examine novel problems, approaches, or analysis are especially valuable.

- **[5 pts] Conclusions and Take-aways**
  In your presentation, interpret your results in the context of NLP more broadly and describe

the conclusions and take-aways from your results. This should include what you would have done differently if you had to repeat the project and what might be next steps if you were to continue working on it.

- **[5 pts] Overall Presentation Quality**
  As in the proposal, make sure your presentation is clear, timely, and makes proper use of included figures and plots.

Late Work Policy

Every student will be allotted 7 “late days” for the term that can be used at will. Using a late day extends the deadline for an assignment by 24 hours. These cannot be applied to project related deliverables or quizzes -- only assignments. Otherwise, late work loses 20% credit per day. To use a late day, include “I am using X late days for this assignment.” in your assignment submission comment on Canvas.

Collaboration Policy

Aside from the final project, students are expected to work independently. High-level discussion of topics is allowed, but any low-level details, sharing of code, or collaborative programming are prohibited. Likewise, the use of existing code from unauthorized online resources is prohibited.

Zoom Policy

Cameras are not required to be on during lecture. It is however strongly encouraged. Side conversations in chat are prohibited. Any offensive, abusive, or inappropriate text, audio, or video will not be tolerated. Students in violation will be removed from lecture immediately and may be reported to the university.

Code of Student Conduct

All course interactions including but not limited to assignments, quizzes, projects, in-class discussions, and online posts are governed by the student code of conduct (https://beav.es/codeofconduct).

Statement Regarding Students with Disabilities

Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval please contact DAS immediately at 541-737-4098 or at http://ds.oregonstate.edu. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

Reach Out for Success

University students encounter setbacks from time to time. If you encounter difficulties and need assistance, it’s important to reach out. Consider discussing the situation with an instructor or academic advisor. Learn about resources that assist with wellness and academic success at oregonstate.edu/ReachOut. If you are in immediate crisis, please contact the Crisis Text Line by texting OREGON to 741-741 or call the National Suicide Prevention Lifeline at 1-800-273-TALK (8255)