UNIVERSITY OF CENTRAL FLORIDA

CAP 6640 - Computer Understanding of Natural Language

Section: 0001

College of Engineering and Computer Science

Department of Computer Science

Course Information

Term: Spring 2026
Class Meeting Days: TR
Class Meeting Time: 12:00PM - 01:15PM
Class Meeting Location: CB1 O307
Modality: P
Credit Hours: 3.00

Instructor Information

Name: David Mohaisen
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Office Hours
Tuesday, 2:00 PM - 3:00 PM
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Teaching Assistants

Yohan Hmaiti

Course Description

CAP 6640 ECS-CS 3(3,0)Computer Understanding of Natural Language: PR: CAP 5636. A study of the different approaches to build programs to understand natural language. The theory of parsing, knowledge representation, memory, and inference will be studied. Spring.

This course provides a rigorous graduate-level introduction to Natural Language Processing, focusing on both foundational linguistic principles and modern neural approaches. Students will study statistical and neural representations of language, syntactic and semantic modeling, sequence and generative architectures, and large language models. The course emphasizes evaluation, generalization, reasoning, and responsible deployment of NLP systems, with coverage of ethics, bias, and societal impact. Through lectures, assignments, exams, and a semester-long project, students develop the ability to critically analyze, implement, and evaluate NLP models in real-world contexts.

The covered contents during this semester include the following (modules and lectures):

Module 0: Syllabus and Introduction.
Lecture 1: Introduction, Syllabus, and Policies

Module 1: Foundations of NLP and Linguistic Structure
Lecture 2: Foundations of Natural Language Processing: History, Tasks, and Linguistic Levels
Lecture 3: Distributional Semantics and Word Embeddings: Word2Vec and Optimization
Lecture 4: Learning and Evaluating Word Representations: Optimization, Negative Sampling, and Sense Ambiguity

Module 2: Neural Models for Classification and Structured Prediction
Lecture 5: Neural Network Classifiers and Sequence Labeling for NLP
Lecture 6: Training Neural NLP Models: Max-Margin Learning, Embedding Fine-Tuning, and Backpropagation
Lecture 7: Syntactic Parsing in NLP: Context-Free Grammars, Dependency Structures, and Neural Parsers

Module 3: Language Modeling and Sequential Architectures
Lecture 8: Language Modeling: N-Grams, Sparsity, and Neural Language Models
Lecture 9: Recurrent Language Models: RNNs, LSTMs, GRUs, and Evaluation
Lecture 10: Sequence-to-Sequence Models: Bidirectional RNNs, Attention, and Neural Machine Translation

Module 4: Alternative Neural Architectures and Representation Units
Lecture 11: Convolutional Neural Networks for NLP: Phrase Modeling and Sentence Classification
Lecture 12: Advanced CNN Architectures and Gated Models for NLP
Lecture 13: Subword and Character-Level Modeling: BPE, WordPiece, and Unigram Tokenization

Module 5: Natural Language Generation and Inference
Lecture 14: Natural Language Generation: Summarization, Dialogue Systems, and Reinforcement Learning
Lecture 15: Conversational QA and Story Generation: Multimodal NLG and Evaluation
Lecture 16: Decoding Strategies for Language Models: Greedy, Beam Search, and Sampling

Module 6: Meaning, Discourse, Semantic Structure, and Generalization
Lecture 17: Coreference Resolution and Discourse-Level Understanding in NLP
Lecture 18: Semantic Composition and Structured Meaning in NLP: From Compositionality to Scene Parsing
Lecture 19: Unified and Multi-Task Learning in NLP: Question Answering as a General Framework

Module 7: Large Language Models and Advanced Capabilities
Lecture 20: Large Language Models: Architectures, Pretraining, Alignment, and Scaling
Lecture 21: Reasoning in Language Models: Human Cognition, Chain-of-Thought, and Limitations
Lecture 22: Reasoning in Language Models: Human Cognition, Chain-of-Thought, and Limitations

Module 8: Ethics, Bias, and Responsible NLP
Lecture 23: Ethics, Bias, and Responsible NLP: Dual Use, Social Harm, and Mitigation
Lecture 24: Ethics, Bias, and Responsible NLP: Dual Use, Social Harm, and Mitigation

Student Learning Outcomes

After successful completion of this course, students will be able to:

- Identify and explain the core linguistic and statistical foundations of natural language processing.
- Analyze and evaluate word-, sentence-, and document-level representations.
- Apply neural architectures for classification, parsing, and sequence modeling.
- Design and assess language models and generative systems.
- Evaluate NLP systems using benchmarking, robustness analysis, and error analysis.
- Analyze discourse structure, semantic composition, and generalization in language understanding.
- Understand the design, training, and alignment of large language models.
- Critically assess reasoning capabilities and claims in language models.
- Identify ethical risks, bias, and dual-use concerns in NLP systems.

Required Course Materials and Resources

Course Slides and Assigned Readings
Notes: Course materials consist of lecture slides, selected readings, and research papers. Material is partially inspired by Stanford CS224n, with additional emphasis on applications, evaluation, ethics, and modern LLMs.

Course Assessment and Grading Procedure

Grade Distribution

Assignments: 24 percent
Six assignments, each worth 4 percent of the final grade.

Midterm Exams: 40 percent
Two midterm exams, each worth 20 percent.

Project: 28 percent
Individual semester-long project with proposal, milestone, and final report.

Attendance: 8 percent

Assignments
There are six assignments, each worth four percent of the final grade. Assignments assess conceptual understanding and analytical reasoning based on lecture material. All assignments must be typed and submitted electronically in PDF format.

Exams
There are two midterm exams conducted during lecture time. Exams are closed-book and open-notes. Students may use one two-sided handwritten letter-size cheat sheet. No makeup exams will be given except in extreme and documented circumstances.

Project
Students will complete an individual semester-long project. Project topics must be selected from the approved list. The project includes a proposal, a milestone report, and a final report. Detailed rubrics and submission instructions will be provided.

Project Topics
Projects focus on one of the following areas (see canvas for the full list of projects):

Group 1: Benchmarking and Evaluation of NLP Systems

1. **Comprehensive Benchmarking of Large Language Models**: Evaluate and compare LLM performance across tasks such as QA, summarization, and reasoning using standardized benchmarks.
2. **Zero-Shot vs. Few-Shot Prompting Effectiveness**: Analyze how different prompting strategies impact performance across diverse NLP tasks.
3. **Hallucination Detection and Measurement in LLMs**: Quantify hallucination behaviors and study their dependence on task type and prompt design.

4. **Robustness Evaluation Under Linguistic Perturbations**: Assess LLM stability when inputs are paraphrased, noised, or adversarially modified.

Group 2: Domain-Specific Language Understanding

5. **Benchmarking Code Generation Capabilities of LLMs**: Compare LLMs on standardized code generation benchmarks using functional correctness metrics.
6. **Automated Program Repair with Large Language Models**: Investigate the effectiveness of LLMs in identifying and fixing real-world software bugs.
7. **Semantic Code Understanding by LLMs**: Analyze how well LLMs capture program semantics such as control flow and data dependencies.
8. **Domain Adaptation for Technical and Scientific Texts**: Study LLM performance when applied to specialized domains such as legal, medical, or scientific documents.

Group 3: Multimodal and Cross-Modal NLP

9. **Text-to-Image Generation and Prompt Control**: Evaluate how linguistic structure and prompt design influence image generation quality and alignment.
10. **Multimodal Reasoning with Text and Vision**: Assess LLM performance on tasks requiring joint understanding of textual and visual inputs.
11. **Natural Language to Structured Representation Conversion**: Study the effectiveness of LLMs in translating text into tables, schemas, or knowledge graphs.
12. **Cross-Modal Consistency and Alignment Analysis**: Analyze semantic consistency between generated content across multiple modalities.

Group 4: Security and Trustworthiness of NLP Systems

13. **Prompt Injection Attacks and Defensive Techniques**: Evaluate vulnerabilities of LLMs to prompt injection and assess mitigation strategies.
14. **LLM-Based Anomaly Detection in System Logs**: Apply LLMs to identify abnormal patterns in system or network logs.
15. **Malware Detection Using Language Models**: Investigate the effectiveness of LLMs in classifying malicious code or textual indicators.
16. **Reliability and Uncertainty Estimation in LLM Outputs**: Study methods for detecting low-confidence or unreliable model responses.

Group 5: Ethics, Bias, and Fairness in NLP

17. **Measuring Demographic Bias in Large Language Models**: Analyze disparities in LLM outputs across demographic attributes using established fairness metrics.
18. **Bias Propagation in Multilingual NLP Systems**: Study how biases transfer across languages and cultures in multilingual models.
19. **Ethical Boundary Testing in Sensitive Content Generation**: Evaluate LLM behavior when prompted with ethically sensitive or harmful scenarios.
20. **Trade-offs Between Fairness and Performance in NLP Models**: Analyze how bias mitigation techniques affect accuracy, robustness, and utility.

Assignment Schedule

Due Date	Assignment Name	Assignment Type	Points
1/19/26	Proposal	Written Report	3
1/26/26	Assignment 1	Homework	4
2/9/26	Assignment 2	Homework	4
2/23/26	Assignment 3	Homework	4
2/26/26	Milestone	Written Report	10
3/9/26	Assignment 4	Homework	4
4/6/26	Assignment 5	Homework	4
4/20/26	Assignment 6	Homework	4
4/16/26	Final Report	Written Report	15
3/3/26	Midterm 1	Exam	20
4/23/26	Midterm 2	Exam	20

Grading Scale

Grading Scale

Letter Grade	Percentage
A	94-100%
A-	90-93%
B+	87-89%
B	84-86%
B-	80-83%
C+	77-79%
C	74-76%
C-	70-73%
D+	67-69%
D	64-66%
D-	61-63%
F	0-60%

Policies for Course Grade

Makeup Work Policy

No makeup exams or assignments.

Missed/Late Assignments

All coursework, including assignments, exams, and projects, must be completed individually. Discussion of course material is permitted, but all submitted work must be original. Sharing solutions, code, or written materials is prohibited and constitutes an academic integrity violation.

Assignments submitted within 24 hours after the deadline will be graded at 50 percent of the score they would have received if submitted on time. Assignments submitted more than 24 hours late will receive a grade of zero. Deadlines are strict, and submissions even one second late are considered late.

All submissions will be checked using university-provided similarity detection tools. Submissions with a similarity score of 30 percent or higher will receive a grade of zero. Accumulating three similarity violations during the semester will result in automatic failure of the course.

Attendance

Attendance at in-person lectures is mandatory. Eight percent of the final grade is allocated to attendance. Students must attend at least 80 percent of lectures to receive full attendance credit. Lecture recordings, when available, will not be posted beyond two weeks from the lecture date and are provided only for approved accommodations. Course logistics, assignments, projects, and exams will be discussed only during lectures.

Citations and Figures
All sources must be properly cited unless the work is entirely original. Figures must be created by the student. Hand-drawn figures are acceptable.

Accommodations
Students requiring accommodations must register with Student Disability Services and provide official documentation. Reasonable accommodations will be provided in accordance with university policy.

Artificial Intelligence (AI) Use Policy

The use of generative AI tools, including ChatGPT, for any graded coursework is strictly prohibited. Submitting AI-generated content without explicit permission will result in severe academic consequences, including possible failure of the course.

Disability Access & Accommodations

The University of Central Florida is committed to providing equal access to all students with disabilities (ADHD, learning disabilities, Autism, chronic medical conditions, physical disabilities, etc.). To receive consideration for reasonable disability-related course accommodations, disabled students must contact Student Accessibility Services (SAS) and complete the steps required for SAS to review accommodation requests. More information can be found on the UCF Student Accessibility Services website under the

Start Here tab or by contacting SAS directly (Ferrell Commons 185; sas@ucf.edu; Phone - 407-823-2371).

Approved accommodations are shared with course instructors via the SAS Course Accessibility Letter. Implementing certain accommodations may require discussion about specific considerations of the course design, course learning objectives, and the individual academic and course challenges experienced by the student. While students with disabilities or chronic health needs are also encouraged to discuss any course concerns with professors in addition to contacting SAS, professors are not required to facilitate disability-related adjustments to the course unless the professor has received a Course Accessibility Letter from SAS that outlines approved accommodations.

Academic Integrity

Students should familiarize themselves with UCF's Code of Conduct at Student Conduct and Integrity Office. According to Section 1, "Academic Misconduct," students are prohibited from engaging in:

1. Academic misconduct is defined as any submitted work or behavior that obstructs the instructor of record's ability to accurately assess the student's understanding or completion of course materials or degree requirements (e.g., assignment, quiz, and/or exam). Examples of academic misconduct include but are not limited to: plagiarism, unauthorized assistance to complete an academic exercise; unauthorized communication with others during an examination, course assessment, or project; falsifying or misrepresenting academic work; providing misleading information to create a personal advantage to complete course/degree requirements; or multiple submission(s) of academic work without permission of the instructor of record.
2. Any student who knowingly helps another violate academic behavior standards is also in violation of the standards.
3. Commercial Use of Academic Material. Selling of course material to another person and/or uploading course material to a third-party vendor without authorization or without the express permission of the University and the instructor of record. Course materials include but are not limited to class notes, the instructor of record's slide deck, tests, quizzes, labs, instruction sheets, homework, study guides, and handouts.

4. Soliciting assistance with academic coursework and/or degree requirements. The solicitation of assistance with an assignment, lab, quiz, test, paper, etc., without authorization of the instructor of record or designee is prohibited. This includes but is not limited to asking for answers to a quiz, trading answers, or offering to pay another to complete an assignment. It is considered Academic Misconduct to solicit assistance with academic coursework and/or degree requirements, even if the solicitation did not yield actual assistance (for example, if there was no response to the solicitation).

Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule*. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct and Academic Integrity, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designated on one's transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc.

Let's avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

Title IX

Title IX prohibits sex discrimination, including sexual misconduct, sexual violence, sexual harassment, and retaliation. If you or someone you know has been harassed or assaulted, you can find resources available to support the victim, including confidential

resources and information concerning reporting options at Let's Be Clear and UCF Cares.

For more information on access and community engagement, Title IX, accessibility, or UCF's complaint processes contact:

- Title IX – ONAC – Office of Nondiscrimination & Accommodations Compliance & askanadvocate@ucf.edu
- Disability Accommodation – Student Accessibility Services – Student Accessibility Services & sas@ucf.edu
- Access and Community Engagement (including the Ginsberg Center for Inclusion and Community Engagement, Military and Veteran Student Success, and HSI Initiatives)
- UCF Compliance and Ethics Office – Compliance, Ethics, and Risk Office & complianceandethics@ucf.edu
- The Ombuds Office is a safe place to discuss concerns.

Reporting an Incident or Issue

If you believe you have experienced discrimination by any faculty or staff member, contact the Office of Nondiscrimination & Accommodations Compliance via the ONAC website or at 407-823-1336. You can also choose to report using the UCF Integrity Line either anonymously or as yourself at 1-855-877-6049 or by using the online form. UCF cares about you and takes every report seriously. For more information see the Reporting an Incident or Issue Webpage.

Deployed Active-Duty Military Students

Students who are deployed active-duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make arrangements.

Campus Safety

At UCF's Public Safety and Police, safety is the top priority. Emergencies on campus are rare, but if one should arise, it's important to be familiar with some basic safety and security concepts.

- In an emergency, always dial 911.
- Every UCF Classroom has an Emergency Procedure Guide posted on a wall near the door, which will show you how to respond to a variety of situations. This guide can also be found online here.
- In the event of an active threat, remember **AVOID, DENY, DEFEND**. Choose the best course of action and act immediately. Watch the video here to learn more.
    - **AVOID**. Pay attention to your surroundings and have an exit plan. Get as much distance and as many barriers between you and the threat as quickly as possible.
    - **DENY**. When avoiding is difficult or impossible, deny the threat access to you and your space. Lockdown by creating barriers, turning the lights off and remaining quiet and out of sight. Make sure your phone is silenced, but do not turn it off.
    - **DEFEND**. When you are unable to put distance between yourself and the threat, be prepared to protect yourself. Commit to your actions, be aggressive and do not fight fairly. Do whatever it takes to survive.
- For emergencies on campus, UCF will utilize the UCF Alert system. All UCF students, faculty, and staff are automatically enrolled to receive these email and text alerts, however, it's a good idea to frequently ensure your contact information is up to date.

Financial Aid Accountability

All instructors are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete this activity by the end of the first week of classes or as soon as possible after adding the course. Failure to do so may result in a delay in the disbursement of your financial aid.

Class Schedule

Course Schedule

Week	Topic
1	Syllabus and Introduction
2	Foundations of NLP and Linguistic Structure
3	Foundations of NLP and Linguistic Structure
4	Neural Models for Classification and Structured Prediction
5	Language Modeling and Sequential Architectures
6	Language Modeling and Sequential Architectures
7	Alternative Neural Architectures and Representation Units
8	Alternative Neural Architectures and Representation Units
9	Natural Language Generation and Inference
10	Natural Language Generation and Inference
11	Meaning, Discourse, Semantic Structure, and Generalization
12	Meaning, Discourse, Semantic Structure, and Generalization
13	Large Language Models and Advanced Capabilities
14	Large Language Models and Advanced Capabilities
15	Ethics, Bias, and Responsible NLP
16	Ethics, Bias, and Responsible NLP