Natural Language Processing, IST664 (CIS668) Wednesdays – 9:30 AM to 12:15 PM

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Office Hours: By Appointment

Catalog Description:

Linguistic and computational aspect of natural language processing technologies. Lectures, readings, and projects in the computational techniques required to perform all levels of linguistic processing of text. Additional work required of graduate students.

Important Note:

This section of IST664/CIS668 will offer a pilot test of a new textbook, *Natural Language Processing in Action* (Manning Publications, 2019) by Kane, Howard, and Hapke. Please preview this textbook before registering for this section.

Overview:

With the growth of the internet over the past 25 years, the world is awash with text written by people. Text created by humans is commonly called "natural language" – this term encompasses the broad diversity in the forms, styles, dialects, vocabularies, and even character sets used. Natural language processing is therefore the art and science of using computers and software to ingest, filter, organize, and analyze naturally occurring texts. This course is designed to develop an understanding of how Natural Language Processing (NLP) techniques work to process text for various practical and research applications. This goal will be achieved by:

- Readings, lectures, and class discussions of the multiple levels of linguistic analysis
 required for a computer to accept natural language input, transform it, interpret it, and
 carry out a particular application;
- Lab exercises and assignments in using computational techniques required to perform these levels of natural language processing of text, and,
- Examinations of real-world applications that incorporate substantive NLP modules.

We will examine and discuss the techniques of NLP at the various levels of linguistic analysis, going through tokenization, word-level semantics, Part-Of-Speech tagging, syntax, semantics and on up to the discourse level. The course will also include consideration of the use of NLP techniques in practical applications. These will include Information Retrieval, Question Answering, Sentiment Analysis, Summarization and Dialogue Systems.

Note that natural language processing shares concepts and techniques with the area of data science known as text mining, but also has distinctive origins, emphases, concepts, and

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techniques. While we will sometimes make connections with text mining, but IST664 is not a course in text mining.

Prerequisite / Co-requisite:

None. The course uses the programming language Python, primarily in the Jupyter Notebook environment, but does not require any previous experience with programming languages.

Audience:

The course is intended primarily for M.S. students in Information Management, Computer Science, Computational Journalism, or Linguistics, though it may be of interest and value to students in other programs.

Credits:

3 credits

Learning Objectives:

At the end of the course the student will be able to

- 1. Define and describe the various levels of linguistic analysis,
- 2. Define and demonstrate the computational techniques used to understand text at each linguistic level and what the challenges are for those techniques
- 3. Process text through the various language levels using the resources of the Natural Language Toolkit (NLTK)
- 4. Learn essential uses of the programming language Python in the Jupyter notebook environment
- 5. Describe how NLP is used in many types of real-world applications.

Texts / Supplies:

As noted above, this section of the course is pilot testing a new textbook which can be purchased online or at the bookstore in an eBook or paperback edition:

Lane, H., Howard, C., & Hapke, H. (2019). *Natural Language Processing in Action*. Shelter Island, NY: Manning Publications.

The online books cited below will be used for reference, background, and code examples:

Jurafsky, D., & Martin, J. H. *Speech and Language Processing.*, 3rd edition. Prentice-Hall. Use the draft of the third edition at https://web.stanford.edu/~jurafsky/slp3/

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Bird, S., Klein, E., & Loper, E. *Natural language processing with Python*, http://www.nltk.org/book/.

Additional supplementary readings will be available on Blackboard.

Course Requirements and Expectations:

• Gutenberg Text Processing Assignments (50%) [learning objectives 1-4]

There will be five individual text processing assignments during weeks 2 - 10 of the course. For each assignment, you will use as input one of the plain text books in the list at the end of this syllabus. Each student will produce results using their own Project Gutenberg book (i.e., no two students may use the same book). The tasks will be of increasing difficulty.

• In-Class Midterm Exam (20%) [learning objectives 1, 2, and 4]

The class session for Week 7 will have a closed book, closed laptop, in-person, paper-based midterm exam focusing on NLP concepts. The exam will contain some small code snippets but will not require any coding as such.

• NLP Tutorial Jupyter Notebook (25%) [learning objectives 1-5]

You will choose a specific NLP topic to explore, and present it in the form of a free-standing tutorial as a publicly available Jupyter notebook. Your tutorial will consist of an extensive amount of explanatory text interspersed with small snippets of working code. The best of these tutorials will become part of a library of resources (with full attribution of your authorship) for future Syracuse University students (and others as well). When you submit your tutorial, please also submit the Turnitin test record of your tutorial's content. You can find instruction on how to do so from here:

https://researchguides.library.syr.edu/ld.php?content_id=40765513.

The evaluation of the tutorial includes three aspects: the *tutorial content*, the *quality of the code* and the overall *usability, usefulness, and originality*.

- a). The tutorial content needs to include these five sections:
 - 1) Your name as the original author
 - 2) A 250-word introduction to the tutorial, related important definitions, etc.
 - 3) The code snippets interspersed with explanations
 - 4) Conclusion, including suggestions for additional readings and resources
 - 5) Bibliography including all code/text sources consulted in creating the tutorial
- b). The code in your tutorial will be evaluated based on:
 - 1) That the code actually works and does not throw any errors
 - 2) Your familiarity and facility with the topics your code demonstrates;
 - 3) The quality of the code including comments and stylistic considerations

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c). The usability, usefulness, and originality of your tutorial will be evaluated based on the value of the topic and the explanations to other NLP learners, the overall quality of the tutorial, including grammatically correct, conceptually correct, and understandable explanations, and importantly, that it does not duplicate another available resource.

Below is a list of the areas and topics that you may be interested in exploring. Or, you may propose another area of interest to you. Remember the importance of originality – your own learning (and that of others who use your tutorial) will be greatly enhanced by choosing a topic that does not already have a useable tutorial online.

- Machine Translation Challenges Related to Specific Language Pairs
- Detection of Particular Classes of Content (e.g., offensive speech, propaganda, misinformation)
- Content Moderation Issues and Challenges
- Evaluation Metrics (existing or emerging methods for quantifying the performance quality of an NLP technique)
- Language Generation including Chatbots
- Enabling resource production for "Low Resource" languages (e.g., bilingual dictionary induction)
- Natural Language Understanding
- Automatic Summarization
- Question/Answering Systems
- Image to Text
- New Approaches to Classic Problems in NLP: Polysemy, Sarcasm, Humor

Professionality (10%)

As a Syracuse University graduate, we expect you to uphold the highest standards of professionality including honesty, integrity, respectful communications, lifelong commitment to learning, supporting others, punctuality, and appreciation of the diverse talents and capabilities of colleagues and coworkers. Active participation in the class is expected, particularly with respect to answering questions that the professor addresses to the class. The professor judges a student's class participation based on the following guidelines:

- Arriving on time to class and prepared to do your best work when class begins
- Attentiveness to the course content; reading the assigned readings for each week prior to coming to class and be ready to discuss them in class.
- Active participation in the small group discussions/activities in the class. This
 means not only offering information, but also listening to others and working
 constructively with them
- o Respectful communication with your peers and the instructor

Week Assessments F	
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2	Text Processing Assignment 1	10
4	Text Processing Assignment 2	10
6	Text Processing Assignment 3	10
7	In Class Midterm Exam	20
8	Text Processing Assignment 4	10
9	Proposal for Jupyter Notebook Tutorial	5
10	Text Processing Assignment 5	10
14	Final Submission of Jupyter Notebook Tutorial	20
15	Professionality (determined by the instructor after the last	10
	day of classes)	
	Total	105

Note: The assessment table intentionally contains 105 points rather than 100. This gives you a buffer in case you get sick or must travel. There will be no extra credit assignments. There will be no make-up exam. Late work will be penalized.

Week by Week:

Week	Topic	Reading and Due Dates
1	Course Overview and Introduction to NLP	Required: Lane, Chapter 1
		Optional: Preface,
		Chapter 1: Language Processing and Python (section 1&2)
2	Levels of Language and Corpus	Required: Lane, Chapter 2
	Linguistics, Tokenization, Regular Expressions	Optional: http://www.nltk.org/book/ch02.html
		Optional: http://www.nltk.org/book/ch03.html
		Optional: https://web.stanford.edu/~jurafsky/slp3/2.pdf
3	Word Frequencies, Vector	Required: Lane, Chapter 3
	Representations, N-gram	
	Models, Zipf's Law	Optional: http://www.nltk.org/book/ch04.html
		Optional: http://www.nltk.org/book/ch05.html
		Optional: https://web.stanford.edu/~jurafsky/slp3/3.pdf
	Semantic Analysis, Singular	Required: Lane, Chapter 4
4	Value Decomposition, PCA,	
	Morphology	Optional: http://www.nltk.org/book/ch06.html
		Optional: https://web.stanford.edu/~jurafsky/slp3/4.pdf
5		Required: Lane, Chapter 5
	Neural Networks for NLP	
		Optional: https://web.stanford.edu/~jurafsky/slp3/7.pdf
6	Word Vectors and Word	Required: Lane, Chapter 6
	Senses	
		Optional: https://web.stanford.edu/~jurafsky/slp3/18.pdf

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7	Midterm Exam in Class	No reading or assignments due
8	Neural Networks and Word Order, Semantic Representations, Lexical Semantics	Required: Lane, Chapter 7 Optional: http://www.nltk.org/book/ch08.html Optional: https://web.stanford.edu/~jurafsky/slp3/9.pdf
9	Recurrent Networks (RNNs) and	Required: Lane, Chapter 8 Optional: http://www.nltk.org/book/ch09.html
	Some Applications	Optional: https://web.stanford.edu/~jurafsky/slp3/11.pdf
10	LSTMs, Word Prediction, and Simple Chat	Required: Lane, Chapter 9
		Optional: http://www.nltk.org/book/ch10.html
11	Sequence to Sequence Tasks, Encoder-Decoder Models	Required: Lane, Chapter 10 Optional: http://www.nltk.org/book/ch11.html
		Optional: https://web.stanford.edu/~jurafsky/slp3/C.pdf
12	Named Entity Extraction and Question Answering	Required, Lane, Chapter 11 Optional: http://www.nltk.org/book/ch07.html Optional: https://web.stanford.edu/~jurafsky/slp3/17.pdf Optional: https://web.stanford.edu/~jurafsky/slp3/23.pdf
13	Dialog Engines	Required: Lane, Chapter 12 Optional: https://web.stanford.edu/~jurafsky/slp3/24.pdf
14	Summary and Future Directions	Required: Lane, Chapter 13 Optional: http://www.nltk.org/book/ch12.html
15	No class	Jupyter Notebook Tutorial Due https://www.gutenberg.org/ebooks/19942.txt.utf-8

Grading:

Grades are assigned based on the quality of the work. The instructor's professional judgments of all submitted work are final. Work submitted after the deadlines shown in Blackboard will only be accepted at the discretion of the instructor and will be subject to a late penalty. Work should not be submitted to the instructor by email. If you upload the wrong file to Blackboard, ask your instructor to reset the attempt. Erroneous uploads are not a valid excuse for late submission of work, so plan ahead and don't wait to submit until the last moment. Here's a grading table to translate points to final letter grade:

A = 95-100; A- = 90-94.99; B+ = 85-89.99; B = 80-84.99; B- = 75-79.99

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C+ = 70-74.99; C = 65-69.99; C- = 60-64.99; >60 = F

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University Attendance Policy

Attendance in classes is expected in all courses at Syracuse University. Students are expected to arrive on campus in time to attend the first meeting of all classes for which they are registered. Students who do not attend classes starting with the first scheduled meeting may be academically withdrawn as not making progress toward degree by failure to attend. Instructors set course-specific policies for absences from scheduled class meetings in their syllabi.

It is a federal requirement that students who do not attend or cease to attend a class to be reported at the time of determination by the faculty. Faculty should use "ESPR" and "MSPR" in Orange Success to alert the Office of the Registrar and the Office of Financial Aid. A grade of NA is posted to any student for whom the Never Attended flag is raised in Orange Success. More information regarding Orange Success can be found http://orangesuccess.syr.edu/getting-started-2/

Students should also review the University's religious observance policy and make the required arrangements at the beginning of each semester

Specific Course Policies

- Many of the work products for this course are in the form of Jupyter notebooks. We will generally work on these in Google's "colab" environment. When you submit a Jupyter notebook assignment you should download the ipynb file from colab and submit it. Note the importance of originality and citation: Any work that was produced by others (such as code fragments that appear online) should have an accompanying source citation. Anything you submit that does not have a citation will be attributed to you which means that you will be held responsible for plagiarism if the work you submit as your own is not original.
- There will be NO make-up exam for the midterm. You should plan your semester carefully to avoid being absent for the Week 7 class.
- A student who misses classes will lose professionalism points. For each absent class, the student will lose five points.
- Integrity is a crucial element of being a data scientist or information professional. You
 may consult the Internet for code examples to help you with your homework or
 projects. You MUST give credit whenever you reuse someone else's code. A code block
 that contains someone else's code should contain as comment that names the author of
 the code and another comment containing the URL where the code was found.

Syracuse University Policies:

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Syracuse University has a variety of other policies designed to guarantee that students live and study in a community respectful of their needs and those of fellow students. Some of the most important of these concerns:

Diversity and Disability (ensuring that students are aware of their rights and responsibilities in a diverse, inclusive, accessible, bias-free campus community) can be found https://www.syracuse.edu/life/accessibilitydiversity/

Religious Observances Notification and Policy (steps to follow to request accommodations for the observance of religious holidays) can be found http://supolicies.syr.edu/studs/religious_observance.htm

Orange SUccess (tools to access a variety of SU resources, including ways to communicate with advisors and faculty members) can be found http://orangesuccess.syr.edu/getting-started-2/

Disability-Related Accommodations:

Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. There may be aspects of the instruction or design of this course that result in barriers to your inclusion and full participation in this course. I invite any student to meet with me to discuss strategies and/or accommodations (academic adjustments) that may be essential to your success and to collaborate with the Office of Disability Services (ODS) in this process.

If you would like to discuss disability-accommodations or register with ODS, please visit their website at http://disabilityservices.syr.edu./ Please call (315) 443-4498 or email disabilityservices@syr.edu for more detailed information.

ODS is responsible for coordinating disability-related academic accommodations and will work with the student to develop an access plan. Since academic accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible to begin this process.

Academic Integrity Policy:

Syracuse University's Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of

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participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. SU students are required to read an online summary of the University's academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term check-in on MySlice.

Note: In this course, all group members are expected to participate actively and make sure that no plagiarism or other violations of the Academic Integrity occurs in the group reports. If I suspect any type of plagiarism or cheating, I will consult with the academic integrity panel.

Educational Use of Student Work

Student work prepared for University courses in any media may be used for educational purposes, if the course syllabus makes clear that such use may occur. You grant permission to have your work used in this manner by registering for, and by continuing to be enrolled in, courses where such use of student work is announced in the course syllabus.

I intend to use academic work that you complete this semester for educational purposes in this course during this semester. Your registration and continued enrollment constitute your permission.

I intend to use academic work that you complete this semester in subsequent semesters for educational purposes. Before using your work for that purpose, I will either get your written permission or render the work anonymous by removing all your personal identification.

As a generally accepted practice, honors theses, graduate theses, graduate research projects, dissertations, or other capstone projects submitted in partial fulfillment of degree requirements are placed in the library, University Archives, or department for public reference.

Discrimination or Harassment

The University does not discriminate and prohibits harassment or discrimination related to any protected category including creed, ethnicity, citizenship, sexual orientation, national origin, sex, gender, pregnancy, disability, marital status, age, race, color, veteran status, military status, religion, sexual orientation, domestic violence status, genetic information, gender identity, gender expression or perceived gender.

Any complaint of discrimination or harassment related to any of these protected bases should be reported to Sheila Johnson-Willis, the University's Chief Equal Opportunity & Title IX Officer. She is responsible for coordinating compliance efforts under various laws including Titles VI, VII,

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IX and Section 504 of the Rehabilitation Act. She can be contacted at Equal Opportunity, Inclusion, and Resolution Services, 005 Steele Hall, Syracuse University, Syracuse, NY 13244-1120; by email: titleix@syr.edu; or by telephone: 315-443-0211.

Federal and state law, and University policy prohibit discrimination and harassment based on sex or gender (including sexual harassment, sexual assault, domestic/dating violence, stalking, sexual exploitation, and retaliation).

If a student has been harassed or assaulted, they can obtain confidential counseling support, 24-hours a day, 7 days a week, from the Sexual and Relationship Violence Response Team at the Counseling Center (315-443-4715, 200 Walnut Place, Syracuse, New York 13244-5040). Incidents of sexual violence or harassment can be reported non-confidentially to the University's Title IX Officer (Sheila Johnson Willis, 315-443-0211, titleix@syr.edu, 005 Steele Hall). Reports to law enforcement can be made to the University's Department of Public Safety (315-443-2224, 005 Sims Hall), the Syracuse Police Department (511 South State Street, Syracuse, New York, 911 in case of emergency or 315-435-3016 to speak with the Abused Persons Unit), or the State Police (844-845-7269).

I will seek to keep information you share with me private to the greatest extent possible, but as a professor I have mandatory reporting responsibilities to share information regarding sexual misconduct, harassment, and crimes I learn about to help make our campus a safer place for all.

Course evaluations:

There will be an end of course evaluation for you to complete this term. This evaluation will be conducted online and is entirely anonymous. You will receive an official notification in your email account with the evaluation website link and your passcode. Please take the time and fill out this evaluation as your feedback and support of this assessment effort is very much appreciated. The school carefully reviews ratings and comments that you submit, and these factor into decisions about course, program and instructor development.

Use of Blackboard:

This course involves the use of Syracuse University's Blackboard system as an online tool. The environment is composed of a number of elements that will help you be successful in both your current coursework and your lifelong learning opportunities. To access <u>Blackboard</u>, [http://blackboard.syr.edu] use your Syracuse University NetID & Password. This specific course will appear in your course list.

To search for answers to your Blackboard questions, visit the <u>Answers self-help knowledge</u> [https://answers.syr.edu/display/blackboard01/Blackboard]. If you have problems logging in or need assistance with Blackboard, contact the ITS Service Center at: <a href="https://enewsreductor.neeductor.

Text Processing Books

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During the initial class session, you will choose or be assigned to one of the following books. You may download a copy of the book to use locally on your computer but generally speaking your code should refer to your book by its URL as shown in the table or in the Project Gutenberg website. Each student will use their particular book for the five text processing assignments.

Fundamentains On The Mandame	between 11 was a section between 15 lead 10.4 10.4 10.4 to
Frankenstein; Or, The Modern	https://www.gutenberg.org/files/84/84-0.txt
Prometheus by Mary Wollstonecraft	
Shelley	https://www.sutonbous.com/6iles/4242/4242.0 htt
Pride and Prejudice by Jane Austen	https://www.gutenberg.org/files/1342/1342-0.txt
The Great Gatsby by F. Scott Fitzgerald	https://www.gutenberg.org/files/64317/64317-
	<u>0.txt</u>
Alice's Adventures in Wonderland by	https://www.gutenberg.org/files/11/11-0.txt
Lewis Carroll	
A Tale of Two Cities by Charles Dickens	https://www.gutenberg.org/files/98/98-0.txt
The Importance of Being Earnest: A	https://www.gutenberg.org/files/844/844-0.txt
Trivial Comedy for Serious People by	
Oscar Wilde	
Metamorphosis by Franz Kafka	https://www.gutenberg.org/files/5200/5200-0.txt
The Picture of Dorian Gray by Oscar	https://www.gutenberg.org/files/174/174-0.txt
Wilde	
The Adventures of Sherlock Holmes by	https://www.gutenberg.org/files/1661/1661-0.txt
Arthur Conan Doyle	
Adventures of Huckleberry Finn by	https://www.gutenberg.org/files/76/76-0.txt
Mark Twain	
The Scarlet Letter by Nathaniel	https://www.gutenberg.org/files/25344/25344-
Hawthorne	<u>0.txt</u>
The Strange Case of Dr. Jekyll and Mr.	https://www.gutenberg.org/files/43/43-0.txt
Hyde by Robert Louis Stevenson	
Heart of Darkness by Joseph Conrad	https://www.gutenberg.org/files/219/219-0.txt
A Christmas Carol in Prose; Being a	https://www.gutenberg.org/files/46/46-0.txt
Ghost Story of Christmas by Charles	
Dickens	
Dracula by Bram Stoker	https://www.gutenberg.org/files/345/345-0.txt
Anthem by Ayn Rand	https://www.gutenberg.org/files/1250/1250-0.txt
The Hound of the Baskervilles by	https://www.gutenberg.org/files/2852/2852-0.txt
Arthur Conan Doyle	
The Adventures of Tom Sawyer,	https://www.gutenberg.org/files/74/74-0.txt
Complete by Mark Twain	
Walden, and On The Duty Of Civil	https://www.gutenberg.org/files/205/205-0.txt
Disobedience by Henry David Thoreau	
Discondition by Helliy David Historia	

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Dubliners by James Joyce	https://www.gutenberg.org/files/2814/2814-0.txt
Peter Pan by J. M. Barrie	https://www.gutenberg.org/files/16/16-0.txt
Treasure Island by Robert Louis	https://www.gutenberg.org/files/120/120-0.txt
Stevenson	
The Wonderful Wizard of Oz by L. Frank	https://www.gutenberg.org/files/55/55-0.txt
Baum	
Candide by Voltaire	https://www.gutenberg.org/ebooks/19942.txt.utf-
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