Syllabus: LINGUIST 592B - Speech Processing

Basic course info

Course:	17162 /3 units	**Instructors:**	Kristine Yu / Cerys Hughes
Meetings:	TTh 13:00 - 14:15 / ILC N470	**Office:**	ILC N422 / TBA
Office hours:	By appointment	**E-mail:**	krisyu@linguist.umass.edu ceryshughes@umass.edu

Web resources:

- **Webpage: https://ling592b.krisyu.org**
  - For course organization, announcements, links to course material
- **Slack workspace: https://ling592bfall21.slack.com/**
  - For discussion, chat, collaboration
- **Github repository: https://github.com/ling592b-f21**
  - For distributing in-class materials, etc.
- **Github classroom: https://classroom.github.com/classrooms/89481956-ling592b-f21-classroom**
  - Just for distributing and submitting homework assignments

Prerequisites Instructor permission. Some experience with programming (e.g. LINGUIST 409), some phonetics background (e.g. LINGUIST 414), some background in calculus, linear algebra, and/or statistics helpful.

Description This is an advanced undergraduate/graduate-level course introducing computation with the speech signal. Students will learn fundamentals of digital speech representation and acoustic feature extraction and be introduced to statistical learning methods for feature selection. Other topics will be covered, depending on student interest.

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1 Learning goals and objectives

This course has the following general UMass Linguistics departmental student learning objectives: the ability to reason analytically about language, basic quantitative and computational competence in language research, the ability to communicate about language, and the ability to work as an effective member of a team. In particular, you will:

1. **Acquire basic mathematical and computational competence in understanding standard algorithms used to process the speech signal**

- Understand the mathematical foundations underlying signal processing (Fourier synthesis/decomposition)
- Become familiar with basic *time-domain methods* for smoothing and periodicity detection
- Understand the duality between time and frequency domain representation and methods (Fourier transform)
- Become familiar with basic *frequency-domain methods* for analyzing spectra, filtering, and periodicity detection
- Become familiar at an introductory level with *neural networks and deep learning* approaches to speech

2. **Gain experience in following best practices for communal, reproducible software development**
   - Learn the basics of version control for coding (commits, merging, etc. , using git and Github)
   - Practice literate programming
   - Practice explaining your code clearly to other people
3. **Apply the technical knowledge and skills you learn to a substantial phonetic question of your choice**

2 Course work and assessment

Requirements and grading

- Course participation (10%)
- Assignments (50% total, 10% each for 5 assignments)
- Term project presentation (15%)
- Term project writeup (25%)

Attendance Due to the on-going pandemic, we will be flexible with students attending class in-person or remotely. Since this is a small class, if all students are attending in person for a class session, we will not also be over Zoom, but if anyone prefers to/cannot attend in person for a particular class session, we will run a hybrid class session. Whether you attend remotely or in-person, we expect you to be ready for class at 1:00pm—in your seat, with your computer out if you are attending in person, or in our Zoom room with your video on and audio muted if you are attending remotely. Our Zoom link is:
https://umass-amherst.zoom.us/j/98128975013?pwd=dVpIYld5Y21pOWNZWXNKSzBuTUw0dz09.
You can also download a .ics calendar file for our Zoom meetings.

Course participation Each class meeting will begin with a set of review questions, linked from the course webpage. **You must be logged in with your UMass account in order to access the review questions.** Your participation grade will come from receiving credit for completing the review questions in each class meeting. Each class meeting's review question set will count equally towards the grade. In exceptional circumstances when you have an excused absence (see attendance policy at end of syllabus), you can still complete the review question later and still get credit.

- *Extra credit opportunity: experimental participation*
  As part of this course, you are encouraged to earn 4 credits of experimental participation (=2% extra in course participation grade, i.e., 1 experimental credit = 0.5% in the course) in the Experimental Linguistics labs, which are located in the Linguistics department in the Integrative Learning Center.

To browse the range of experimental opportunities available to you, please sign onto the SONA systems website for the Linguistics department: https://umassxling.sona-systems.com

After the Add/Drop period ends, you may receive an email inviting you to set up a SONA account. If you do not receive this email, you may go to the web address above and request an account on your own. If you do this, be sure to select any and all linguistics courses you are in this semester when you log in.
On SONA, you will be able to sign up for experiments that look interesting to you. Very short experiments will give one credit; more typically, a single experimental session will count as two experimental credits. If you are unable to sign up for an experiment, you may contact the experimenters directly through the SONA system.
If you would like more information on how to use SONA systems as a participant, here is a brief YouTube tutorial on how to use it: .
Participation in experimental research is highly encouraged, as it gives you insight into the day-to-day work of linguists studying human language. However, if you do not wish to participate in experimental research, you may receive extra credit by doing an alternative assignment. These will be made available on SONA as well.

Software We will be using Python 3 in this course. If you are a beginning Python user, please download Anaconda, following these installation instructions from Software Carpentry for Installing Python Using Anaconda. If you are already a fluent/advanced Python user, I'll assume that you have an environment you already work with and know how to install packages.

Assignments There will be an assignment roughly every 1-2 weeks during the first part of the course. These may involve reading and questions about the reading, as well as coding. **Because of the variety of backgrounds of students in the course, assignments will have a core component that everyone is expected to do, and then potentially an individual component, tailored to the student's background (as we will work out together)**. For example, a student with significant programming/mathematics background but little/no linguistics/phonetics background may be asked to do a challenge problem involving coding and a basic problem/reading assignment to develop their linguistics/phonetics background. Or a student with little programming/mathematics background but significant linguistics/phonetics background may be asked to do a challenge problem involving linguistics/phonetics and a basic coding or math problem to develop their technical skills.

Assignments will be released on Thursdays and **due the following Thursday before class at 1pm**, via our Github Classroom. Turn in your assignments via Github classroom. Your code should be self-contained in a repository and ready for us to run. See late work policy at end of syllabus.

Projects Each student will participate in a group research project over the course of the semester that will culminate in an individual final write-up and a class presentation. We will discuss project ideas and start working on them in the 5th or 6th week of the semester.

Tentative course outline Subject to adjustment! For the most updated version see the course webpage.

- Week 1: Introduction; digital representations of speech
- Weeks 2-3: The time domain – smoothing, Fourier decomposition, periodicity detection
- Weeks 4-5: The frequency domain – Fourier transforms, spectra, filters, cepstrum
- Week 6-7: Feature extraction and acoustic modeling; finite state transducers

  - First look at research projects
- Week 8: Introduction to neural nets; perceptron
- Week 9 on: Deep Learning approaches to speech
- Week 14: Wrap-up, final project presentations
  - Final project write-ups due Friday 12/16, 11:59PM (last day of semester)

Selected Resources

- Who is Fourier? (Transnational College of LEX 1995)
- The Fourier Transform and its Applications (Osgood 2007, EE 261 Stanford)
- Think DSP (Downey 2017)
- Introducing speech and language processing (Coleman 2005)
- Introduction to Digital Speech Processing (Rabiner and Schafer 2007)

Additional course policies

Elasticity Statement As the course proceeds during the semester, there may be some changes made to the syllabus, e.g., adjustment of topics according to student interest, assignment timing changes. All such changes will be announced. The course webpage will always be kept up-to-date.

Names and Pronouns Everyone has the right to be addressed by the name and pronouns that they use for themselves. Students can indicate their preferred/chosen first name and pronouns on SPIRE, which appear on class rosters. Please let me know what name and pronouns I should use for you if they are not on the roster. A student's chosen name and pronouns are to be respected at all times in the classroom. For more resources on pronouns, see https://www.umass.edu/stonewall/pronouns.

Late work/attendance policy Late submission of work (assignments, exams, final project write-up) is allowed up to 1 week after the original due date, but 10% will be deducted for each late day. Exceptions are made in cases of extreme illness or emergencies that are communicated to the instructor in a timely manner.

See the university policy on class absence here: http://www.umass.edu/registrar/students/policies-and-practices/class-absence-policy. **Notify the instructor when you are absent. You are responsible for catching up for missed class materials; feel free to contact the instructor if you are confused about anything.**

COVID-related policies For the health and safety of all members of our campus community, students are expected to follow all COVID-related policies on campus. At the start of the Fall 2021 semester, there are two policies in effect that deserve special mention. First, students are required to follow the COVID-19 Daily Self-checklist (https://my.umass.edu/on_campus/emerg_response/_/self_checklist). Students who are ill must not attend class, and they will be offered reasonable accommodations for missed work. Second, students must follow the masking policy while it remains in effect. Your instructor will remind you to wear a mask that securely covers your mouth and nose, and direct you to a nearby mask station if you do not have one. If you are unwilling to mask, you will be asked to leave the class. If you do not leave the class, the instructor will end the class, and the Dean of Students office will be informed that you have disrupted class and violated the Guidelines for Classroom Civility and Respect (https://www.umass.edu/dean_students/campus-policies/classroom). Anyone with a mask exemption must provide prior written notice to the instructor and must maintain at least six feet of distance from faculty and other students at all times.

Accommodation Statement The University of Massachusetts Amherst is committed to making reasonable, effective and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you are in need of accommodation for a documented disability, register with Disability Services to have an accommodation letter sent to your faculty. It is your responsibility to initiate these services and to communicate with faculty ahead of time to manage accommodations in a timely manner. For more information, consult the Disability Services website at http://www.umass.edu/disability/.

Academic Honesty Statement Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent (http://www.umass.edu/dean_students/codeofconduct/acadhonesty/).

Civility Statement The University of Massachusetts Amherst strives to create an environment of academic freedom that fosters the personal and intellectual development of all community members. In order to do this, the University protects the rights of all students, faculty and staff to explore new ideas and to express their views. A necessary condition for these pursuits is an acceptance of the spirit of inquiry and a respect for diverse ideas and viewpoints. For true academic freedom to exist, this acceptance and respect must exist in both the overall campus environment and in the classroom.

While the principle of academic freedom protects the expression and exploration of new ideas, it does not protect conduct that is unlawful and disruptive. The University preserves a high standard for members of the community in terms of mutual respect and civility. While each member of the community holds a number of rights, privileges and responsibilities, those individuals who disrespect the rights of others or who act in a ways that discredit themselves or the University may forfeit privileges or receive sanctions. As members of an academic community, we are obligated to be exemplary, both in our behaviors and in our attitudes. This obligation is especially important within the classroom context since this is one of the primary ways that learning and growth are fostered.

Learning and the exchange of ideas may take place in many settings, including the formal classroom. When students and faculty come together, the expectation is always that mutual respect and civility will prevail to ensure that every student has the optimum opportunity to learn and that each faculty member has the best opportunity to teach. Disruptions of any kind affect the atmosphere of civility that is expected and interfere with the opportunity for learning and growth to which both faculty and students are entitled.

Differences of opinions or concerns related to the class should be welcomed if presented in a mutually respectful manner. The challenging of viewpoints is part of the academic experience, but should occur in a manner that opens up dialogue and does not threaten any member of the learning community.

Each faculty member is responsible for the classroom environment, which includes creating a setting for the safe and open exchange of ideas by all students. Each student is responsible for ensuring that his or her own behavior promotes these goals. Disruption of the learning process will not be tolerated and may lead to disenrollment or disciplinary action, as outlined in the accompanying procedures.

Student behavior or speech that disrupts the instructional setting or is clearly disrespectful of the instructor or fellow students will not be tolerated. Disruptive conduct may include, but is not limited to:

1. rude or disrespectful behavior
2. unwarranted interruptions
3. failure to adhere to instructor's directions
4. vulgar or obscene language, slurs or other forms of intimidation
5. physically or verbally abusive behavior

For full guidelines, see the UMass Amherst Classroom Civility and Respect Guidelines at: https://www.umass.edu/dean_students/campus-policies/classroom and also: https://www.umass.edu/diversity/sites/default/files/dignity_and_respect_in_the_classroom.pdf.