Computational Sound

COMS 3430 - Fall 2023

Instructor Info

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Office Hrs: Announced weekly

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Course Info —

Prereq: COMS 3157 or 4 semesters of CS

Tuesday, Thursday, 6:10-7:25pm

75 min Lecture, 2x/week

TBA

Capped at 24 students

Overview

In this course, we explore the variety of roles that computation can play in the analysis, creation, and performance of music. We start with the fundamentals of sound in the digital domain, covering issues of representation and audio synthesis. We then move through various synthesis techniques including the additive, subtractive, frequency modulation (FM), and amplitude modulation (AM) synthesis. After covering some core DSP techniques, we put these concepts into performative practice by exploring "live coding". In the space of live coding, we examine various programming language designs to understand how various domain specific languages (DSLs) support live coding.

Grading Scheme

Grading for this course follows Barnard's official grading policy [1]. Note that the official grading policy does not list percentages - grades are assigned according to the instructors holistic evaluation of your performance. As a rough guide as to what to expect, refer to the below percentages, but keep in mind that all grading decisions ultimately are based upon a complete review of your performance and may deviate from the standard percentiles of grading without prior notice.

Additionally, at most one A+ will be awarded each semester in each class taught by the instructor.

10%	Participation
60%	~4 Homeworks at ~15% each
30%	Final Project

Material

Any required journal articles and book chapters will be provided.

Curtis Roads and John Strawn. The computer music tutorial. MIT press, 1996.

Andy Farnell. Designing Sound. MIT Press, 2010.

Puckette, M. S. (2007). The theory and techniques of electronic music. Singapore, Singapore: World Scientific Publishing Company.

Late Policy

The late policy of this classes follows a policy found in many Barnard/Columbia CS courses. Each day (24-hour period) or partial day late incurs a 20% penalty on the assignment, up a 100% penalty. This mean if you submit a homework more than 5 days late, you will receive no credit. Any homework that is not submitted will not incur any late days. However, you are allowed a total of 6 "flex" days, to be used as you wish throughout the semester. Late hours round up to the nearest day (so 3 hours counts as 1 day, and 25 hours counts as 2 days). To use a "flex" day, simply submit your work late - we will keep track for you. If you exceed the number of late days, you will be penalized according the regular late policy stated above.

If there is a situation that you feel should be exempt from this policy, you must reach out over email, with a note from your Dean, at least 48-hours prior to the due date of the assignment. If you reach out less than 48-hours prior to the due date of the assignment, no exceptions will be granted - this is the point of the flex days. There will be no general exceptions made to the late policy regardless of any accommodation status - all exceptions must be made on a per assignment basis.

This policy does not apply to the final project, which cannot be accepted after the due date except in exceptional circumstances and with a note from your Dean.

Class Attendance Policy

You are not explicitly graded on attendance, but 10% of your grade is allocated to participation. You participation in class is graded on your in-person engagement in class discussion and activities. While slides are made available for every class, Zoom lectures will not be offered upon student request.

[1] https://catalog.barnard.edu/barnard-college/academic-policies-procedures/grading-academic-honors/

FAQs

Will I learn how to be a DJ?/Will we make dope electronic beats?

No, this course will focus on the underlying computation issues of dealing with digital music.

Does that mean there is no creative aspect to this course?

Not at all! In fact, many assignments will require creativity not only from a technical perspective, but also from an artistic and musical perspective.

Do I need to have a strong background in music?

No, only an interest. You should be able to read music in Western notation, but we will not need more advanced topics you would know with a background in music.

What is computer music anyway?

It depends on who you ask. As we will see in this course, there is a wide range of interesting and valuable problems in the domain of audio for which computation plays an intergral role.

Honor Code

You are expected to hold yourself to the highest standard of academic integrity and honesty, as reflected in the Barnard Honor Code. Approved by the student body in 1912 and updated in 2016, the Code states:

We, the students of Barnard College, resolve to uphold the honor of the College by engaging with integrity in all of our academic pursuits. We affirm that academic integrity is the honorable creation and presentation of our own work. We acknowledge that it is our responsibility to seek clarification of proper forms of collaboration and use of academic resources in all assignments or exams. We consider academic integrity to include the proper use and care for all print, electronic, or other academic resources. We will respect the rights of others to engage in pursuit of learning in order to uphold our commitment to honor. We pledge to do all that is in our power to create a spirit of honesty and honor for its own sake.

Wellness Statement

It is important for undergraduates to recognize and identify the different pressures, burdens, and stressors you may be facing, whether personal, emotional, physical, financial, mental, or academic. We as a community urge you to make yourself–your own health, sanity, and wellness–your priority throughout this term and your career here. Sleep, exercise, and eating well can all be a part of a healthy regimen to cope with stress. Resources exist to support you in several sectors of your life, and we encourage you to make use of them. Should you have any questions about navigating these resources, please visit these sites:

- `http://barnard.edu/primarycare`
- `https://barnard.edu/about-counseling`
- `http://barnard.edu/wellwoman/about`
- Stressbusters Support Network

Center for Accessibility Resources & Disability Services

If you believe you may encounter barriers to the academic environment due to a documented disability or emerging health challenges, please feel free to contact me and/or the Center for Accessibility Resources & Disability Services (CARDS). Any student with approved academic accommodations is encouraged to contact me during office hours or via email. If you have questions regarding registering a disability or receiving accommodations for the semester, please contact CARDS at (212) 854-4634, cards@barnard.edu, or learn more at `barnard.edu/disabilityservices`. CARDS is located in 101 Altschul Hall.

Affordable Access to Course Texts & Materials

All students deserve to be able to study and make use of course texts and materials regardless of cost. Barnard librarians have partnered with students, faculty, and staff to find ways to increase student access to textbooks. By the first day of advance registration for each term, faculty will have provided information about required texts for each course on CourseWorks (including ISBN or author, title, publisher, copyright date, and price), which can be viewed by students. A number of cost-free or low-cost methods for accessing some types of courses texts are detailed on the Barnard Library Textbook Affordability guide (library.barnard.edu/textbook-affordability). Undergraduate students who identify as first-generation and/or low-income students may check out items from the FLIP lending libraries in the Barnard Library (library.barnard.edu/flip) and in Butler Library for an entire semester. Students may also consult with their professors, the Dean of Studies, and the Financial Aid Office about additional affordable alternatives for having access to course texts. Visit the guide and talk to your professors and your librarian for more details.

Learning Outcomes

- Demonstrate familiarity with the foundations of digital representation and manipulation of sound
- Identify key open problems, and solution spaces, in the domain of computer music
- Ability to read and understand DSP code and systems
- Ability to connect musical concepts to mathematical structures to provide deeper in musical understanding
- Gain fluency in the practice of live coding

Class Schedule

Date	In-class topics	TODOs
MODULE 1: Digital Signal Processing for Audio (Wk 1-4)		
Sept 5	Computer Music as a Field	
	Puckette, *Four Surprises* (in-class reading)	
Sept 7	Basics of Digital Audio	Farnell, Ch. 7.1, 7.2 (9 pages)
	ADSR, LFOs	Roads, Ch. 1 (47 pages)
	Building a keyboard	
Sept 12	Psychoacoustics	Cook, Ch. 6 (10 pages)
	Wegel and Lan, 1924: Demo	Roads, Ch. 23 (17 pages)
	Fletcher-Muson Experiment	
Sept 14	Intro to Signal Graphs in WebAudio	
	Additive Synthesis and Bells	Roads, Ch. 3 (30 pages)
Sept 19	Modulation (AM/FM) Synthesis	Roads, Ch. 4 (42 pages)
	Build your own synth	Farnell, Part IV
		HW 1 (Build a keyboard) due
Sept 21	Filters	Roads, Ch. 10, Farnell, Ch 16.7
Sept 26	Comb Filter, Allpass Filter	Remote class
Sept 28	Convolution, Spatialization	Remote class
Oct 3	Physical Modelling, Language translation	
	Z-plane estimation Experiment	HW 2 (Build a synth) due
Oct 5	Kaplus-Strong walkthrough	
MODULE 2: Audio Plugins (Wk 5-7)		
Oct 10	Intro to Audio Plugins and JUCE	Pirkle, Designing Audio Plugins, Ch. 1
Oct 12	Multichannel/Ambisonics	(visit to CMC)
		HW 3 (Farnell Synthesis) due
Oct 17	FFT and Convolution	

	Machine Learning & Audio	DDSP: Differentiable Digital Signal Processing, Engel et. al, ICLR 2020
Oct 19	More JUCE	
Oct 24	More JUCE	
Oct 26	Demo Day in CMC	HW 4 (JUCE Plugin) due

MODULE 3: Live Coding (Wk 8-11)

Oct 31	Intro to Live Coding with SonicPi	
	Ethos of Live Coding	
Nov 2	Creative Systems Framework	Wiggins, Geraint A., and Jamie Forth. "Computational Creativity and Live Algorithms." In *The Oxford Handbook of Algorithmic Music*.
	Pattern based Live Coding with Tidal	
Nov 7	No class, Election Day	
Nov 9	Language models for Live Coding	
	✎ Build your own Live Coding tool	
Nov 14	Live Coding visuals with Hydra	✎ Response to Lanksy, *A View from the Bus*, 1990
Nov 16	The role of automated composition	Roads, The Technology of Music, Ch. 21
	Cellular automata	Neirhaus, Ch. 3
	Markov models	Neirhaus, Ch. 8
	👣 Ge Wang in-class Reading	Miranda, Ch. 8
Nov 21	12-tone composition	
	Pitch Set Theory	The Framework of Music Theory as Represented with Groups, Zhang, 2009
	Pitch Set Theory Generalized	
		✎ Lab 4 (Live Coding) due
Nov 23	No class (school holiday)	

Final Project + Assorted Topics (Wk 12-13)

Nov 28	Neural Networks for automated composition with `magenta.js`	Magenta.js: A JavaScript API for Augmenting Creativity with Deep Learning, Roberts et al., 2018
		✎ Lab 6 (Automated Composition)
Nov 30	Music Information Retrieval (MIR)	
Dec 5	Final Presentations	
Dec 7	Final Presentations	

Disclaimer

This syllabus (dates, the nature and number of projects, readings, topics, grading policy, etc) are subject to change either by necessity or design. Any changes will be reflected in a new syllabus and/or announced in class and on Canvas.