Berkeley
UNIVERSITY OF CALIFORNIA

CNMAT

CARMINE-EMANUELE CELLA

MUSIC 159
SYLLABUS –SPRING 2021

INSTRUCTOR

Carmine-Emanuele Cella
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PhD musical composition
PhD applied mathematics

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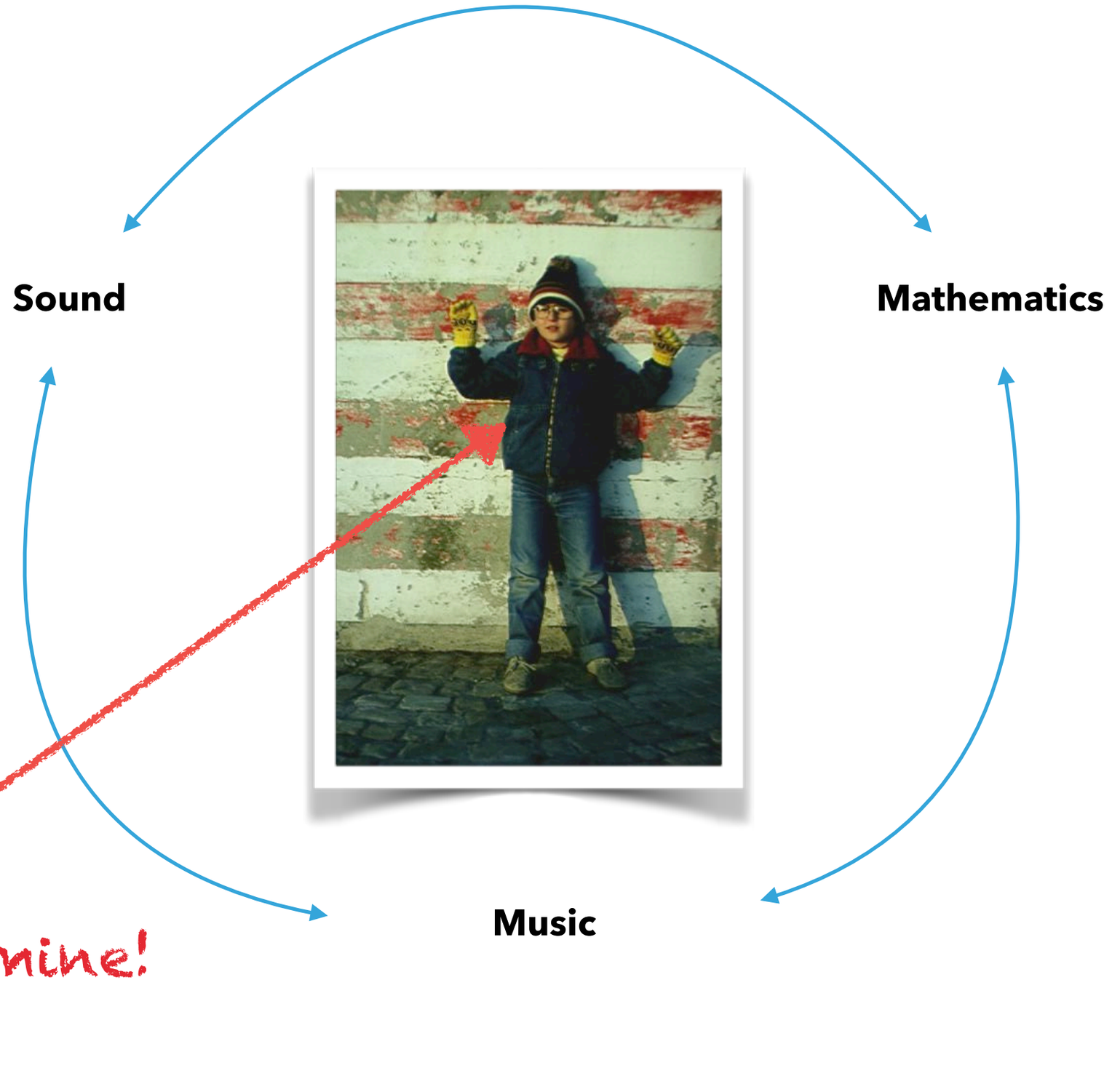
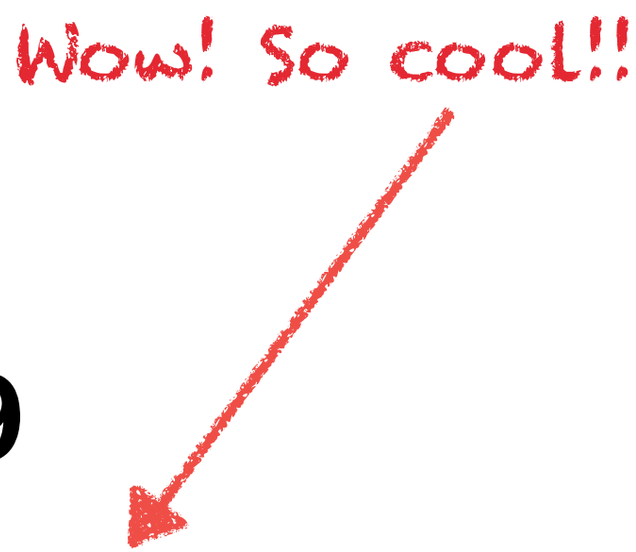
Office hour:
Monday, 3pm-4pm



COURSE



Music 159

Computer programming for music applications

Schedule: M 12:00P-2:59P | McEnerney (CNMAT)

https://berkeley.zoom.us/my/carmine.cella

INTRODUCTION

In 159 we will make a step towards machine creativity. After an overview of advanced analysis and synthesis techniques, such as spectral processing (Unit I), we will study several machine learning methods to generate and transform musical signals (Unit II). By using probability models, statistical learning, logical models and mathematical optimisation we will be able to create new tools to support and enhance musical creation. An example of such tools can be found here: **www.carminecella.com/orchidea**

Music 158 and 159 constitute a sequence in music sciences. The two courses are meant to give to the students the foundation of music signal processing and to bring them towards the frontiers of machine creativity for musical creation. Moreover, these courses will provide very valuable information for composers and will help their musical career.

REQUIREMENTS

Prerequisite:

158a/b or permission (programming practice, linear algebra)

Textbook:

No full books but notes, papers, etc.

All course materials online:

bcourses.berkeley.edu

Computer access:

Personal laptop

Software:

Max/MSP and Python (with packages), audio editor

GRADING

30% attendance and participation

40% assignments

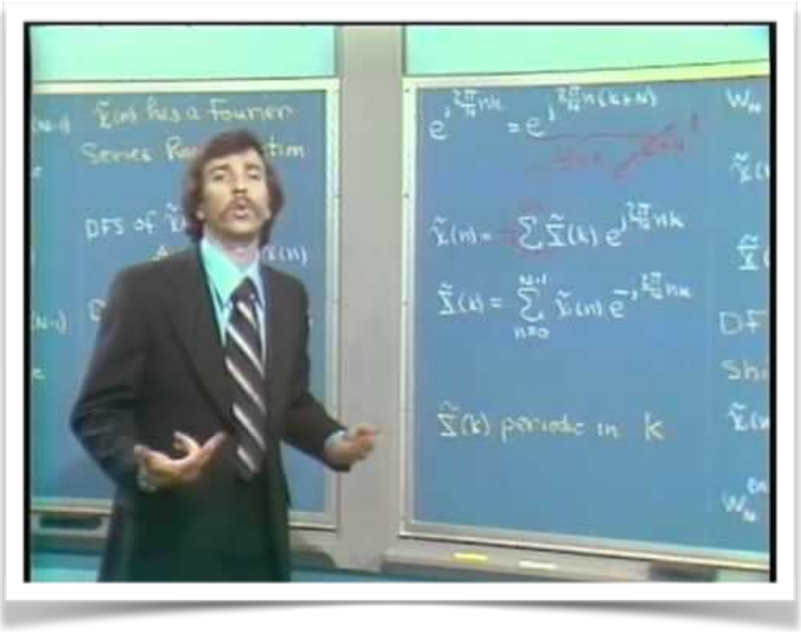
30% final exam

The grade distribution is: 100% -- 90% A; 89% -- 89% B; 79% -- 70% C; 69% -- 60% D; 59% -- 0% F

Plusses are awarded for the top three percent and minuses are reserved for the bottom three percent of each grade distribution above.

STRUCTURE

Unit I: signals and transformations (DSP, spectral processing…)



Do you know them??

Unit II: learning (models for music processing, neural networks..)

SCHEDULE: UNIT I – SIGNALS AND TRANSFORMATIONS

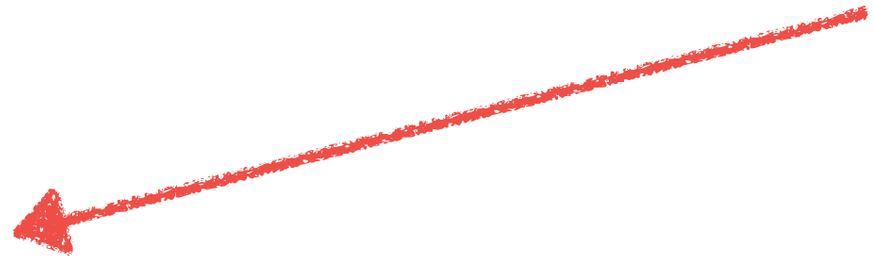
#	Date	Topic	Slides	Readings	Code/examplees
1	1/25	A. Overview of the content; structure of the course. B. Elements of musical acoustics	Yes	[Benson] 1.1-1.7 [Rocchesso] 1.1, 1.2, 1.4 extra: [Dodge] 2.1-2.7	
2	2/1	A. Introduction to musical timbre B. Introduction to digital signals	Yes	(ASSIGNMENT GIVEN)	
3	2/8	Geometric interpretation of signals I: vector spaces and linear combinations; Banach spaces, scalar product and Hilbert spaces; projections and vector reconstruction.	Yes	[Smith] chapter 5, part 1 [Cella2015] 1, 2	
4	2/22	Geometric interpretation of signals II: basis of a vector space; geometric interpretation of sound analysis and synthesis; redundant projective spaces (wavelets and Sobel filters); geometric interpretation of convolution.	Yes	[Smith] chapter 5, part 2 [Cella2015] 3, 4 (ASSIGNMENT GIVEN)	Implementation in Python of feature maps.
5	3/1	Spectral transformations I: spectral delay, convolution-based reverb, reconstruction of impulse responses from sine sweeps.	Yes	[Cella2017a]	Implementation of spectral delay in Max/MSP; implementation in Python of a convolution-based reverb and reconstruction of impulse responses from sine sweeps.
6	3/8	Spectral transformations II: cross-synthesis and spectral freeze.	No	(ASSIGNMENT GIVEN)	Implementation of cross-synthesis and spectral freeze in Max/MSP.

SCHEDULE: UNIT II – LEARNING

#	Date	Topic	Slides	Readings	Code/examples
7	3/15	Introduction to machine learning methods for musical applications: probability and clustering for sound and music representation; supervised vs. unsupervised representations.	No	[Burkov] ch. 1, 2.2-2.4, 3.1, 3.2, 9.1, 9.2 [Cella2016] [Cella2017b] extra: [Crayencour2019]	
8	3/29	Introduction to the theory of sound-types.	Yes	[Cella2013] (ASSIGNMENT GIVEN)	Study of the Python implementation; advanced cross-synthesis with sound-types.
9	4/5	Introduction to mathematical optimisation: NP problems; heuristics and evolutionary approaches; introduction to computer-assisted orchestration (Orchidea).	Yes	[Caetano2020] (ASSIGNMENT GIVEN)	Musical examples (Penderecki, Harvey, Maresz).
10	4/12	Geometrical interpretation of neural networks: projectors and non linearities in the context of musical applications.	TBD	[Cella2020] [Cella2015b] [Burkov] 4.1, 4.2, ch. 6	Musical examples (Ghisi).
11	4/19	**GUEST: J. Gillick** Musical applications of deep learning.			
12	4/26	Neural network design for musical applications: classification of orchestral instruments and sound hybridisation.	Yes	[Lostalen2016 [Gabrielli2018] [Mor2019]	Study of the Python implementation.
13	5/3	RECITATION WEEK.			
14	5/10	**EXAM** Written test/quizzes.			

REFERENCES (1)

Starred items are free!



Books

- [Dodge] R. Dodge, Computer music, 2nd edition, 1997, Schirmer books, NY.
- [Benson]* D. Benson, Music: a mathematical offering, freely available on author's web page.
- [Rocchesso]* D. Rocchesso, Introduction to sound processing, freely available on author's web page.
- [Smith]* J. Smith, The mathematics of the DFT, chapter 5 (freely available on author's web page).
- [Burkov] A. Burkov, The Hundred-page machine learning book.

Lecture notes

- [Cella2015a]* C. E. Cella, A geometric interpretations of signals, 2015, available on www.carminecella.com
- [Cella2017a]* C. E. Cella, On room impulse response measurements with sine sweeps, 2017, available on www.carminecella.com
- [Cella2016]* C. E. Cella, On the multidimensional Haar transform, 2016, available on www.carminecella.com
- [Cella2015b]* C. E. Cella, Logistic regression and artificial neural networks, 2015, available on www.carminecella.com
- [Cella2020]*, C. E. Cella, Notes on the geometrical interpretation of neural networks, 2020, available on www.carminecella.com

REFERENCES (2)

Papers

- [Caetano2020] Imitative Computer-Aided Musical Orchestration with Biologically Inspired Algorithms, HAIM, preprint.
- [Mor2019] Noam Mor, Lior Wolf, Adam Polyak, Yaniv Taigman, A universal music translation network, ICLR 2019.
- [Gillick2019]* Jon Gillick C. E. Cella and David Bamman, Estimating unobserved audio features for targed-based orchestration, ISMIR 2019, Delft, The Netherlands.
- [Crayencour2019]* H. C. Crayencour, C. E. Cella, Learning, probability and logic: towards a unified approach for content-based Music Information Retrieval, Frontiers in Digital Humanities, April 2019.
- [Gabrielli2018]* L. Gabrielli, C. E. Cella, F. Vespertini, D. Droghini, E. Principi and S. Squartini, Deep Learning for Timbre Modification and Transfer: an Evaluation Study, AES 144th, 2018, Milan, Italy.
- [Cella2017b]* C. E. Cella, Machine listening intelligence, International Workshop on Deep learning for music, 2017, Anchorage, ALASKA.
- [Lonstalen2016]* V. Lonstalen, C. E. Cella, Deep convolutional networks on the pitch spiral for musical instrument recognition, ISMIR 2016, New York, USA.
- [Cella2013]* C. E. Cella and J.J. Burred, Advanced sound hybridizations by means of the theory of sound-types, ICMC 2013, Perth, Australia.
- [Cella2011]* C. E. Cella, Sound-types: a new framework for symbolic sound analysis and synthesis, ICMC 2011, Huddersfield, United Kingdom.

SUGGESTIONS

ASSIGNMENTS, EXAM, MAKE-UP POLICY

Assignments will be given after **some** classes and they must be turned in before the next class. They may include small closed-answer questions to be done on bCourses and hands-on projects. There will also be a final, designed as essay-based take-home exams to be written over a 72-hour period.

Assignments and exams must be done individually by each student.
Make-up exams or assignments will only be allowed for students who have a substantiated excuse approved by the instructor before the due date.

Leaving a phone message or sending an e-mail without confirmation is not acceptable.

CHEATING, PLAGIARISM AND ACADEMIC INTEGRITY

Anyone caught cheating on a quiz or exam in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct. To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, see, for example: http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag. html.

Berkeley’s honor code states "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others" (https://teaching.berkeley.edu/berkeley-honor-code). The honor code is a cornerstone of our learning community and of this course. It is your responsibility to know and follow academic integrity policies. I will gladly answer any questions you have.

ACCOMODATIONS FOR STUDENTS WITH DISABILITIES

If you are a student with learning needs that require special accommodation, contact the Disabled Students' Program (https://dsp.berkeley.edu), as soon as possible, to make an appointment to discuss your special needs. Please e-mail me in order to set up a time to discuss your learning needs.

SEXUAL HARASSMENT

The University of California strives to prevent and respond to harassment and discrimination. Engaging in such behavior may result in removal from class or the University. If you are the subject of harassment or discrimination there are resources available to support you. Please contact the Confidential Care Advocate (sa.berkeley.edu/dean/confidential-care-advocate) for non-judgmental, caring assistance with options, rights and guidance through any process you may choose. Survivors of sexual violence may also want to view the following website: survivorsupport.berkeley.edu.

For more information about how the University responds to harassment and discrimination, please visit the Office for the Prevention of Harassment and Discrimination website: ophd.berkeley.edu.

EMERGENCY PROCEDURES

Your emergency evacuation assembly area is **the steps directly across Arch St. leading to the Pacific School of Religion.**
In the event of an emergency please follow instructions from your instructor and CNMAT staff.
Take note of emergency procedures posted in your classroom. If the fire alarm is sounding, exit the building immediately. In the event of an earthquake, duck when possible and hold in place, covering your head with your arms, a binder or your laptop. Then exit the building when the shaking stops.

EMERGENCY SERVICES:

- UC Police and all emergencies number from campus phones: **911**
- UC Police and all emergencies number from cell phones: **(510) 642-3333**
- UC Police non-emergency number: **(510) 642-6760**

RESTROOM ACCESS:
Restrooms at 1750 Arch Street are available to all genders.