Berkeley
UNIVERSITY OF CALIFORNIA

CNMAT

CARMINE-EMANUELE CELLA

MUSIC 159
SYLLABUS –SPRING 2020

INSTRUCTOR

Carmine-Emanuele Cella
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PhD musical composition
PhD applied mathematics

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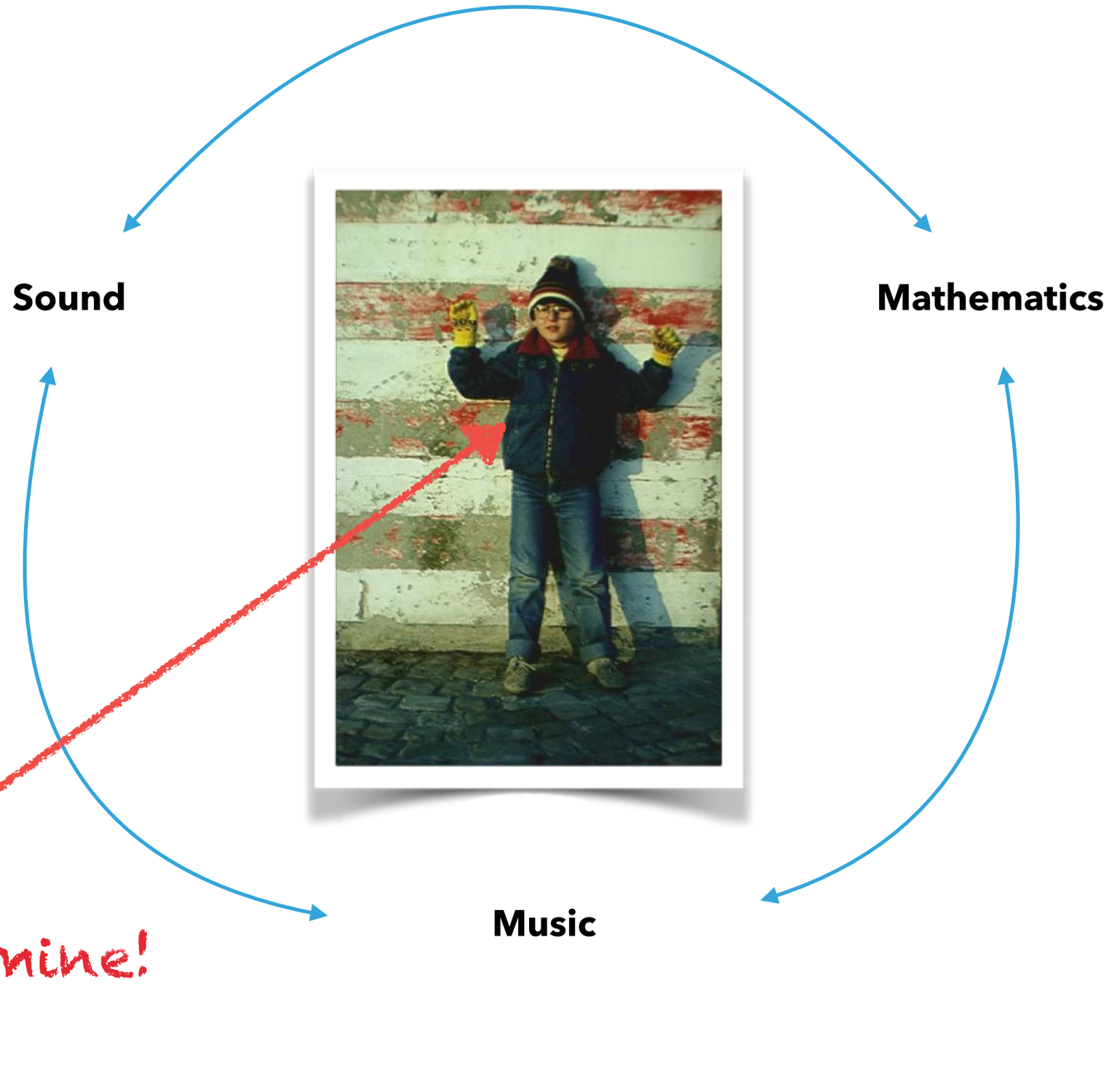
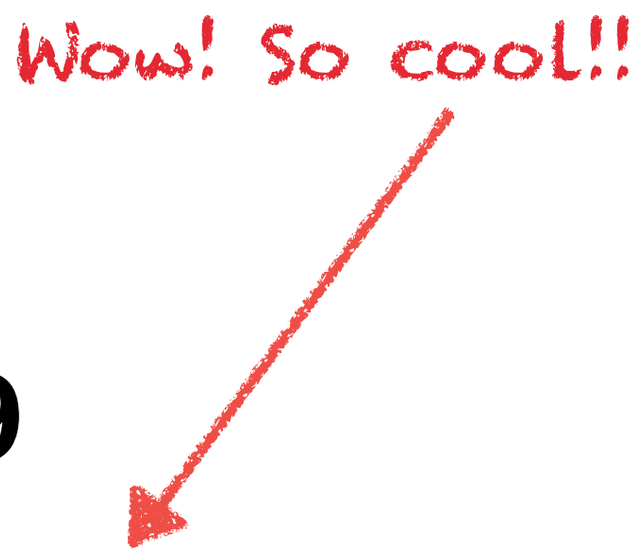
Office hour:
Monday, 3pm-4pm



COURSE



Music 159

Computer programming for music applications

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

(…in sequence with Music 158b)

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 158b 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

20% mid-term assignment

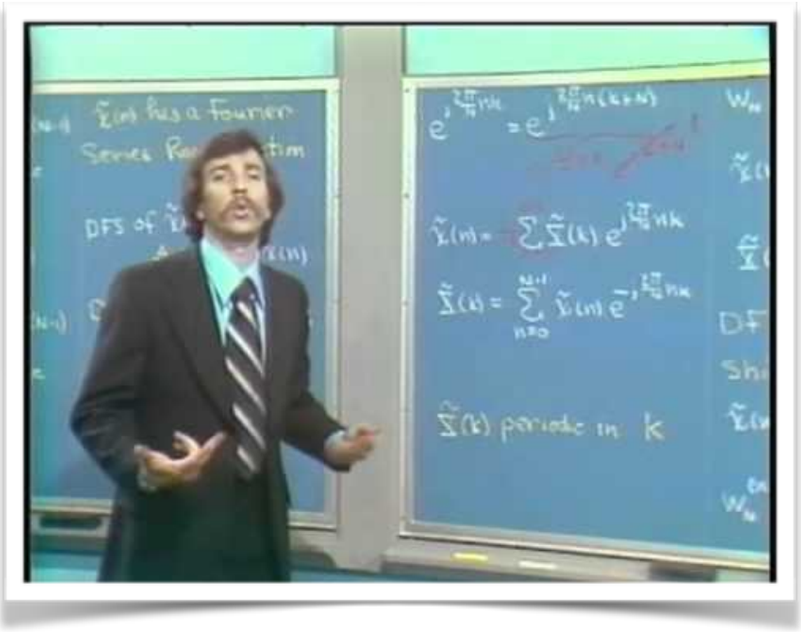
50% final exam

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	1/27	A. Overview of the content; structure of the course. B. Elements of musical acoustics and digital signals (sound waves, harmonic series, sampling theorem).	Yes	[Benson] 1.1-1.7 [Rocchesso] 1.1, 1.2, 1.4 extra: [Dodge] 2.1-2.7	
2	2/3	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	
3	2/10	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	Implementation in Python of feature maps.
4	2/24	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.
5	2/28	Spectral transformations II: cross-synthesis and spectral freeze.	No	(ASSIGNMENT GIVEN)	Implementation of cross-synthesis and spectral freeze in Max/MSP.
6	3/2	**GUEST: D. Ghisi** Corpus-based musical composition.			

SCHEDULE: UNIT II – LEARNING

#	Date	Topic	Slides	Readings	Code/examples
7	3/9	Introduction to machine learning methods for musical applications: probability and clustering for sound and music representation; supervised vs. unsupervised representations.	TBD	[Burkov] ch. 1, 2.2-2.4, 3.1, 3.2, 9.1, 9.2 [Cella2016] [Cella2017b] [Crayencour2019] (ASSIGNMENT DUE DATE)	
8	3/16	Introduction to the theory of sound-types.	Yes	[Cella2013]	Study of the Python implementation; advanced cross-synthesis with sound-types.
9	3/30	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).
10	4/6	**GUEST: J. Gillick** Musical applications of deep learning.			
11	4/13	Introduction to mathematical optimisation: NP problems; heuristics and evolutionary approaches; introduction to computer-assisted orchestration (Orchidea).	Yes	[Caetano2020]	Musical examples (Penderecki, Harvey, Maresz).
12	4/20	Neural network design for musical applications I: classification of orchestral instruments.	Yes	[Lostalen2016]	Study of the Python implementation.
13	4/27	Neural network design for musical applications II: sound hybridisation.	Yes	[Gabrielli2018] [Mor2019]	
14	5/4	RECITATION WEEK.			
15	5/11	**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.
- [Muller] M. Muller, Fundamentals of music processing.
- [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

POLICIES

COURSE ENVIRONMENT

Names/Pronouns

You deserve to be addressed in the manner you prefer. To guarantee that I address you properly, you are welcome to tell me your pronoun(s) and/or preferred name at any time, either in person or via email.

Diversity

We embrace diversity of age, background, beliefs, ethnicity, gender, gender identity, gender expression, national origin, religious affiliation, sexual orientation, and other visible and non-visible categories. I do not tolerate discrimination.

Accessibility

I want you to succeed in this course.
Contact me if you have special circumstances. I will find resources for you.

Title IX

You deserve a community free from discrimination, sexual harassment, a hostile environment, sexual assault, domestic violence, dating violence, and stalking. If you experience or know of a Title IX violation, you have many options for support and/or reporting

Academic Integrity

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.

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.