



{ CONSERVATORIO  
ROSSINI

hem

Haute école de musique  
Genève - Neuchâtel



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA



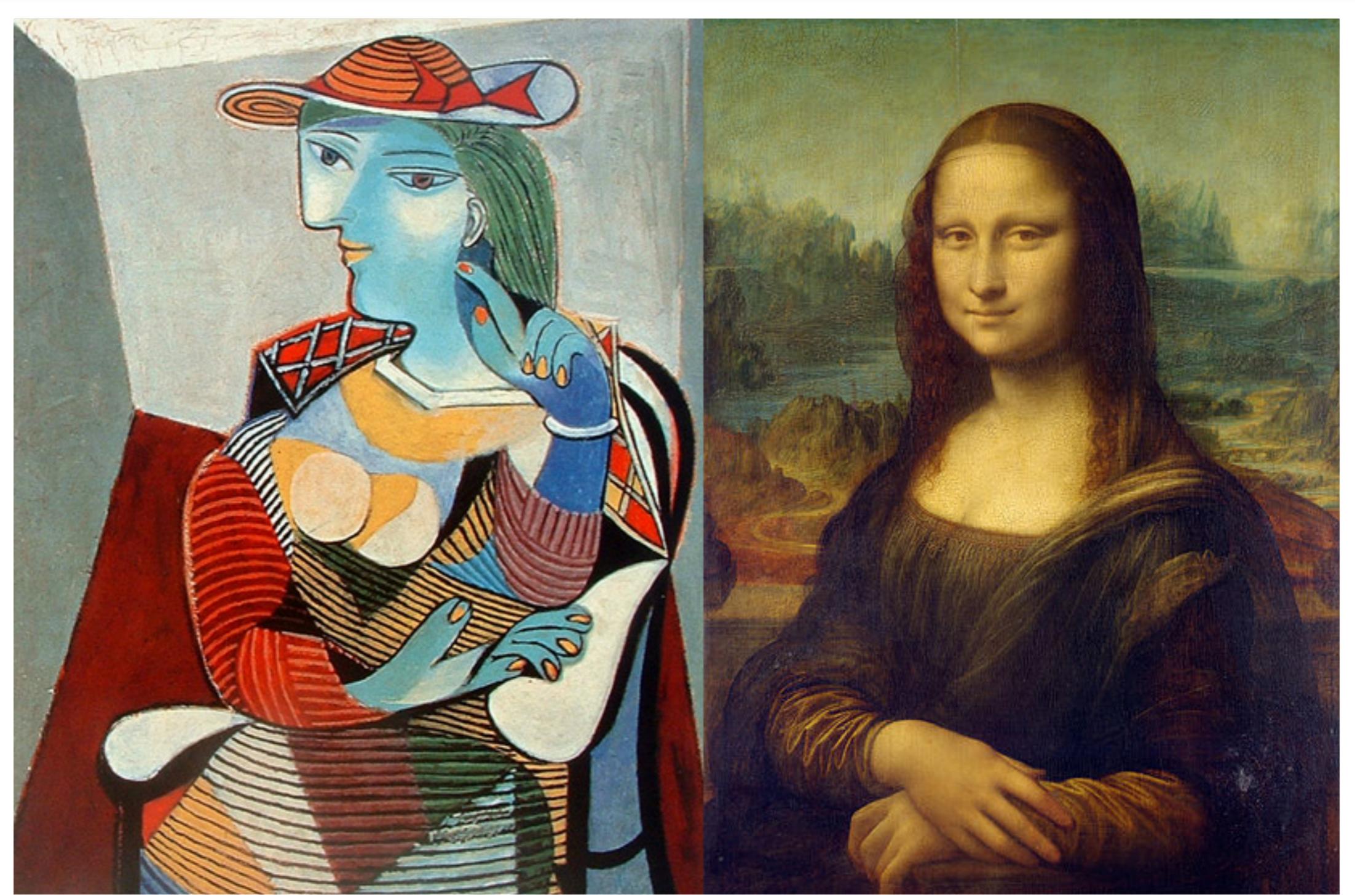
Berkeley  
UNIVERSITY OF CALIFORNIA

CARMINE-EMANUELE CELLA

PLAYING THE WORLD!

AN INTRODUCTION TO AUGMENTED INSTRUMENTS

## KATHARSIS AND MIMESIS



# FROM PHYSICAL MODELLING TO CREATIVE MODELLING

**Physical modelling**  
**synthesis**

Accurate

Real sounds (almost)



**Physically inspired**  
**synthesis**

Expressive

*Plausible* sounds



## PHYSICAL MODELLING

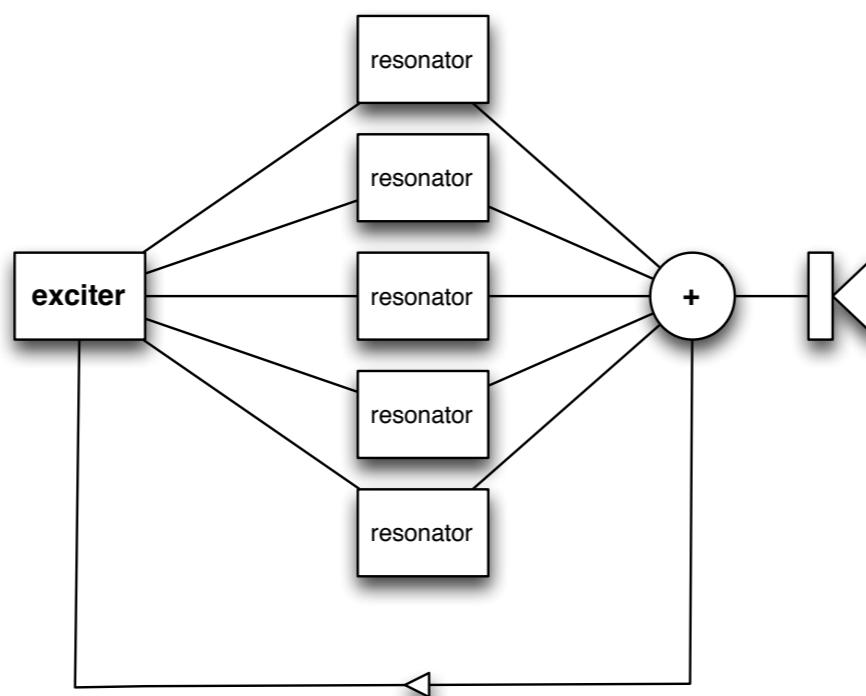
- Physical modelling synthesis generates sounds by copying the **mechanical system under vibration** and not by copying the sound itself

## PHYSICAL MODELLING

- Physical modelling synthesis generates sounds by copying the **mechanical system under vibration** and not by copying the sound itself
- It is based on the solutions of the wave equation:  $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ .

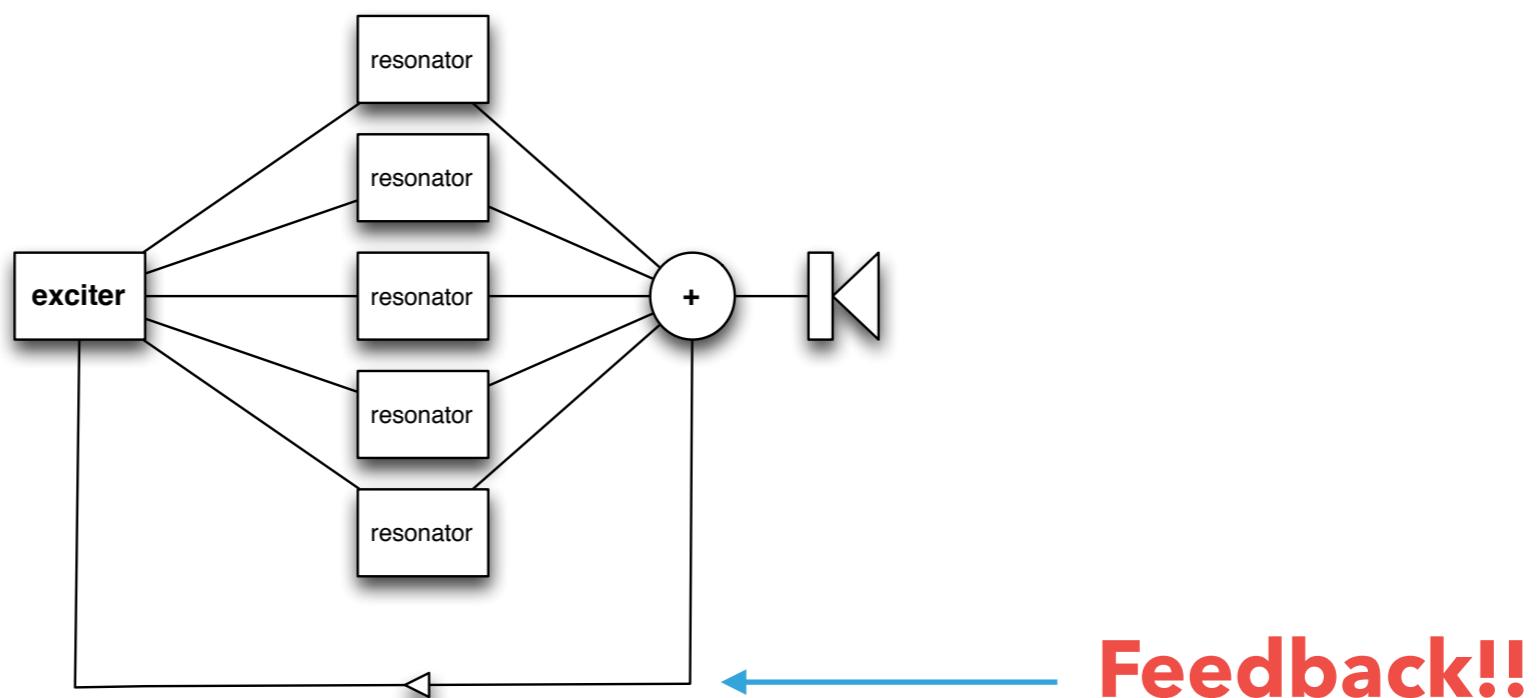
## PHYSICAL MODELLING

- Physical modelling synthesis generates sounds by copying the **mechanical system under vibration** and not by copying the sound itself
- It is based on the solutions of the wave equation:  $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ .
- A simplification is represented by the **exciter-resonator** system



## PHYSICAL MODELLING

- Physical modelling synthesis generates sounds by copying the **mechanical system under vibration** and not by copying the sound itself
- It is based on the solutions of the wave equation:  $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ .
- A simplification is represented by the **exciter-resonator** system



## A CREATIVE APPROACH

- The simulation of a real vibrating object by means of modal synthesis (for example a musical instrument) can be a difficult task

## A CREATIVE APPROACH

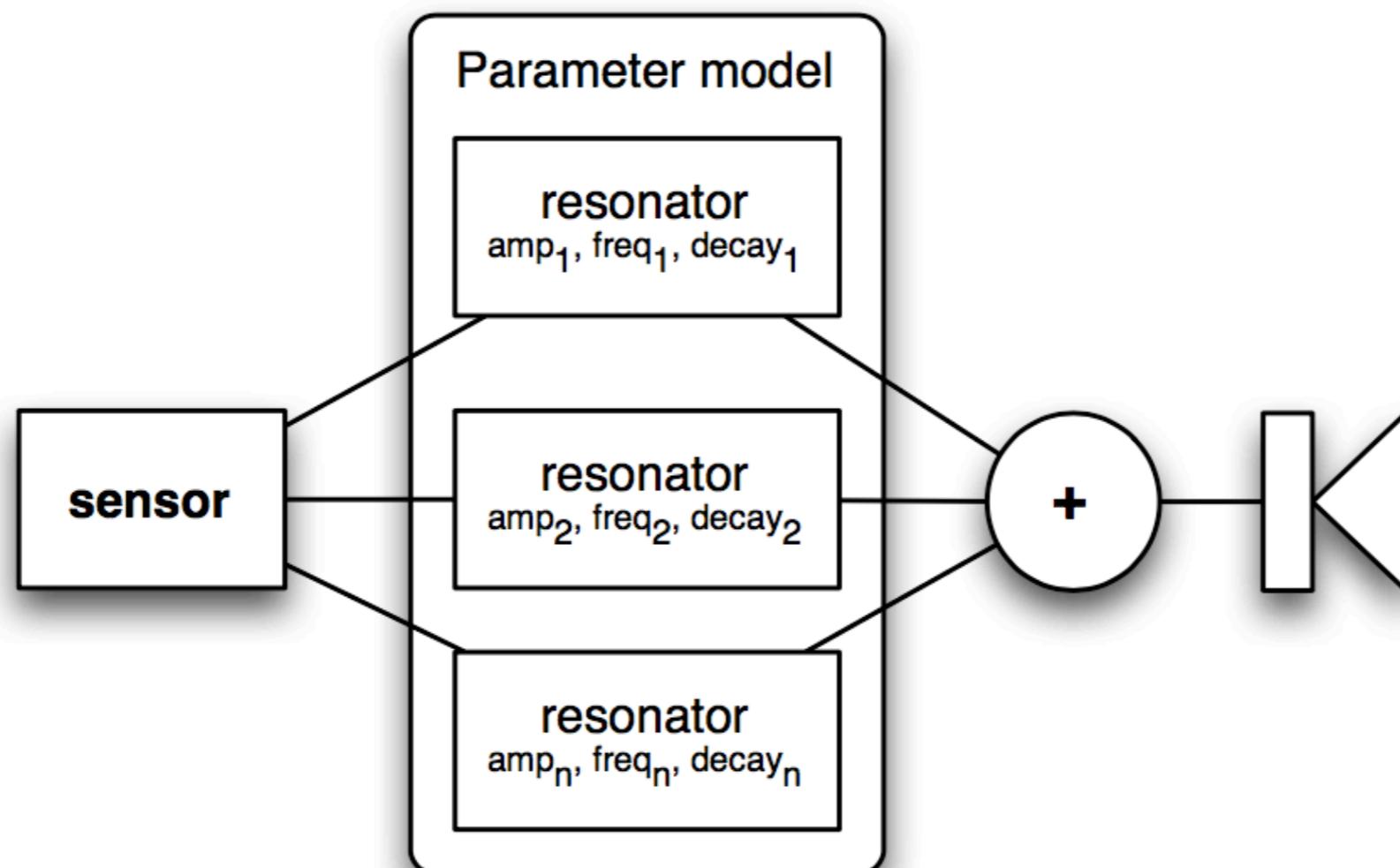
- The simulation of a real vibrating object by means of modal synthesis (for example a musical instrument) can be a difficult task
- The simulation of quasi-physical instruments can be an interesting creative activity

## A CREATIVE APPROACH

- The simulation of a real vibrating object by means of modal synthesis (for example a musical instrument) can be a difficult task
- The simulation of quasi-physical instruments can be an interesting creative activity
- **Physically inspired** synthesis is variant of modal synthesis that generates sounds with special *physical* characteristics without modelling real vibrating objects

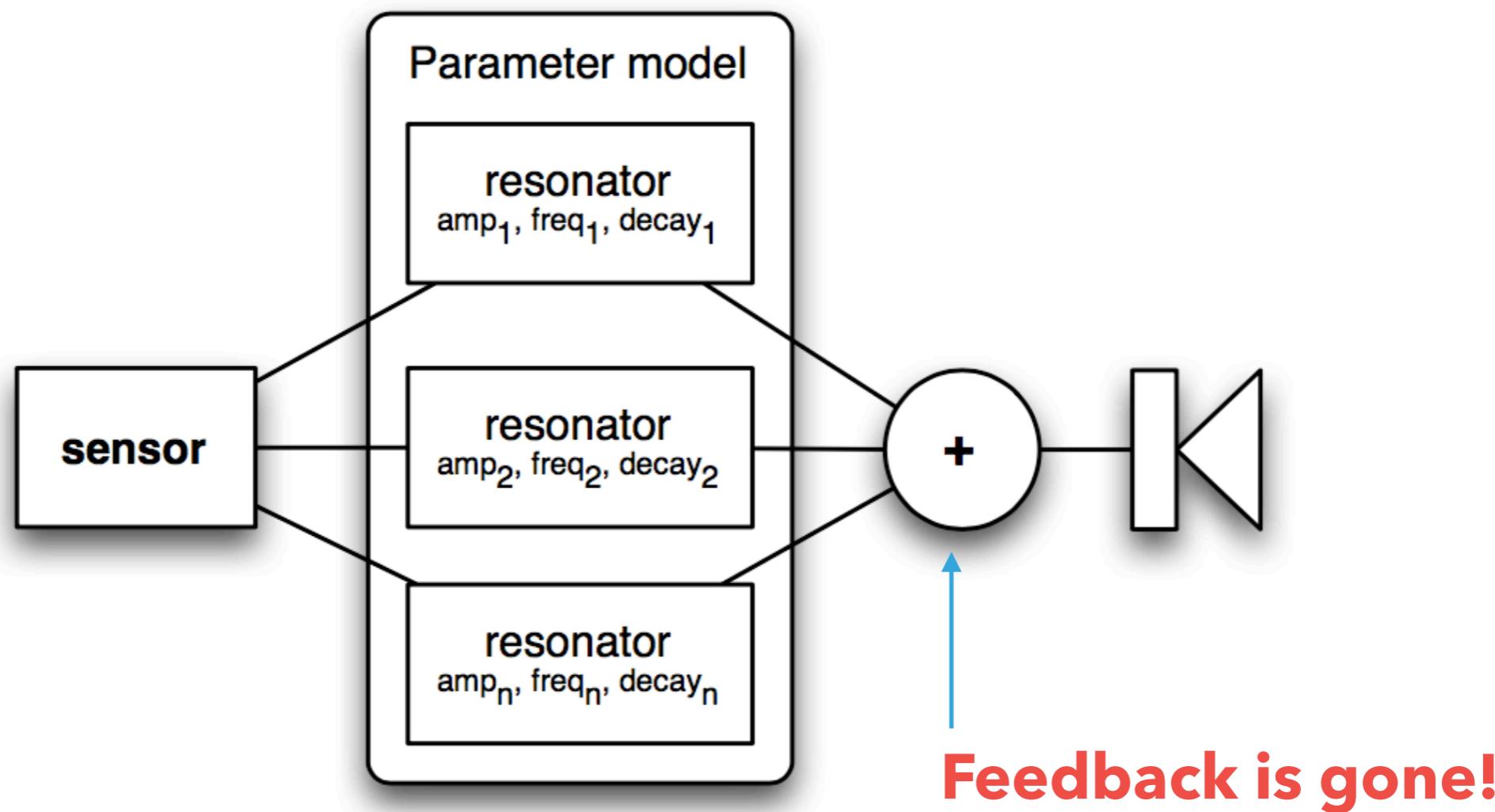
## PARAMETER MODELS

In physically inspired synthesis, the feedback between the exciter and the resonators is replaced by a **parameter model** and the excitation is provided by a **sensor**

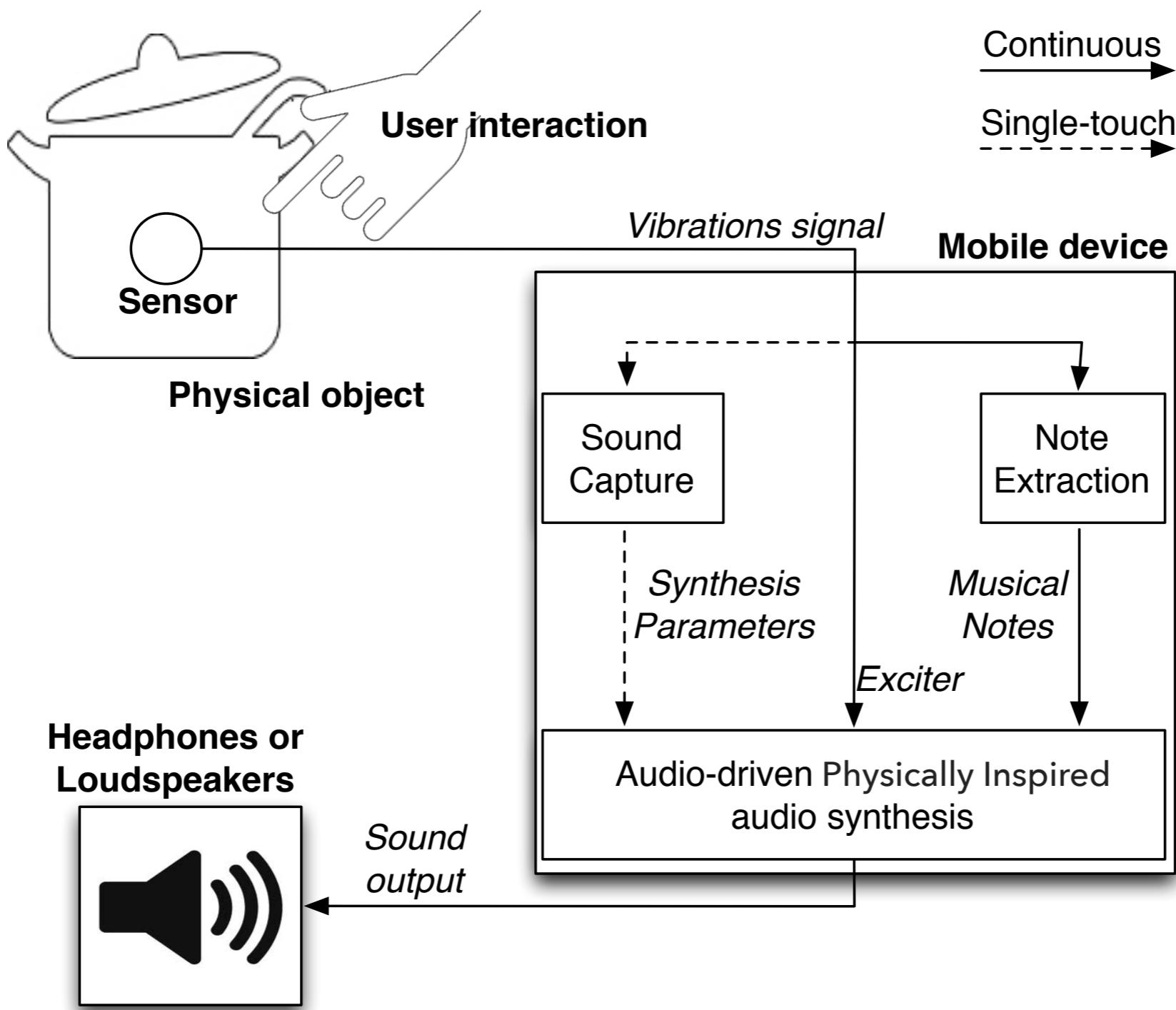


## PARAMETER MODELS

In physically inspired synthesis, the feedback between the exciter and the resonators is replaced by a **parameter model** and the excitation is provided by a **sensor**



# CAN WE SONIFY THE WORLD?

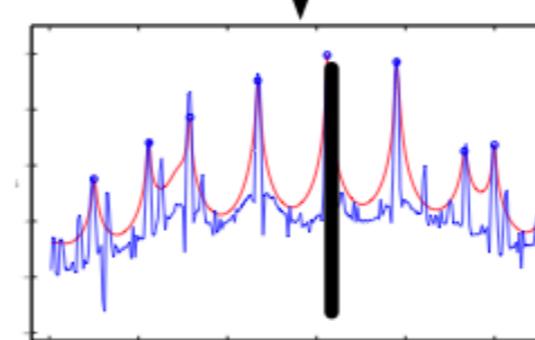
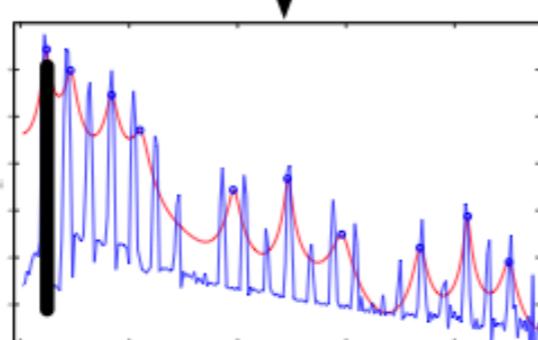


## GESTURE MAPPING

low-frequency gesture



high-frequency gesture



Mapping



# SMART PERCUSSIONS (AND STUPID COMPOSER)

CARMINE-EMANUELE CELLA  
**INSIDE-OUT**

FOR SMART PERCUSSIONS (AND STUPID COMPOSER)

# SMART PERCUSSIONS (AND STUPID COMPOSER)

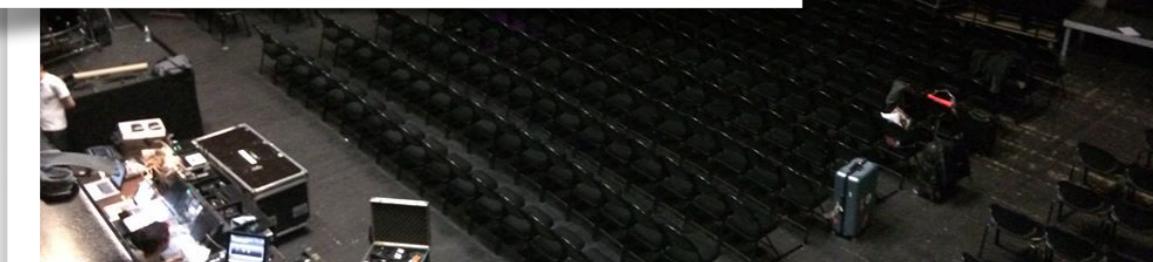
CARMINE-EMANUELE CELLA  
**INSIDE-OUT**

FOR SMART PERCUSSIONS (AND STUPID COMPOSER)

## PRODUCTIONS

---

# LES ESPACES PHYSIQUES (2017-2022)



### SUMMARY

- Modelling reality means choosing an *abstraction* level (mimesis and katharsis)

### SUMMARY

- Modelling reality means choosing an *abstraction* level (mimesis and katharsis)
- Physical modelling synthesis is a flexible framework to model the acoustic behaviours of physical objects

# SUMMARY

- Modelling reality means choosing an *abstraction* level (mimesis and katharsis)
- Physical modelling synthesis is a flexible framework to model the acoustic behaviours of physical objects
- Physically inspired synthesis expands this possibility by creating *plausible* sounds by means of sensors and parameter models

# SUMMARY

- Modelling reality means choosing an *abstraction* level (mimesis and katharsis)
- Physical modelling synthesis is a flexible framework to model the acoustic behaviours of physical objects
- Physically inspired synthesis expands this possibility by creating *plausible* sounds by means of sensors and parameter models
- Gesture recognition is the key step to create a system for **augmented reality**

## GITHUB REPOSITORY OF THIS LECTURE

[https://github.com/CarmineCella/HEMU\\_Jan\\_2024](https://github.com/CarmineCella/HEMU_Jan_2024)

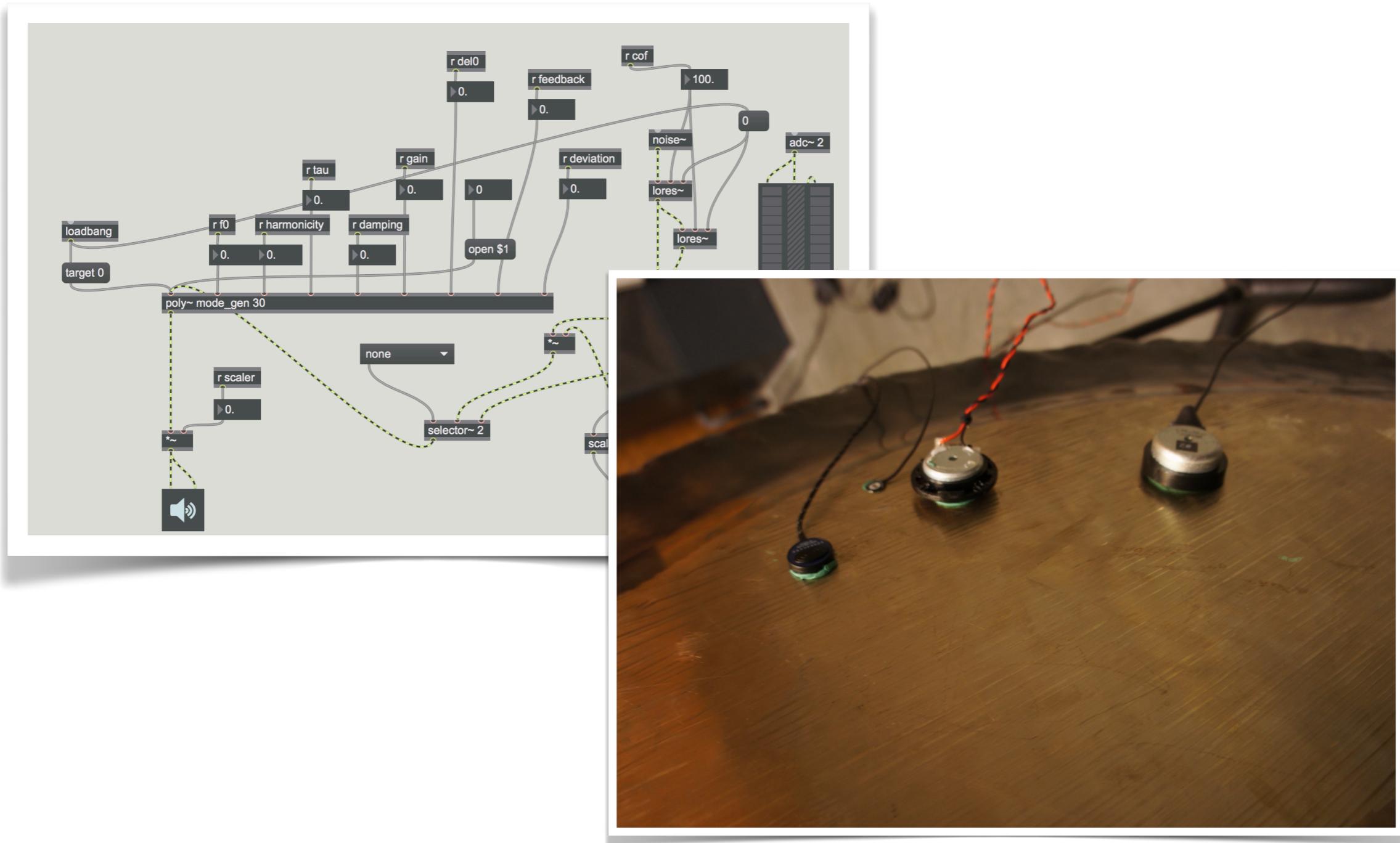
## SELECTED REFERENCES

- C. E. Cella, Generalized series for spectral design, 2013
- C. E. Cella, On physically inspired synthesis of sound, 2012
- C. E. Cella, Les espaces physiques (2017-2022), <https://www.youtube.com/watch?v=ZaaYmDhl5N8&t=823s>

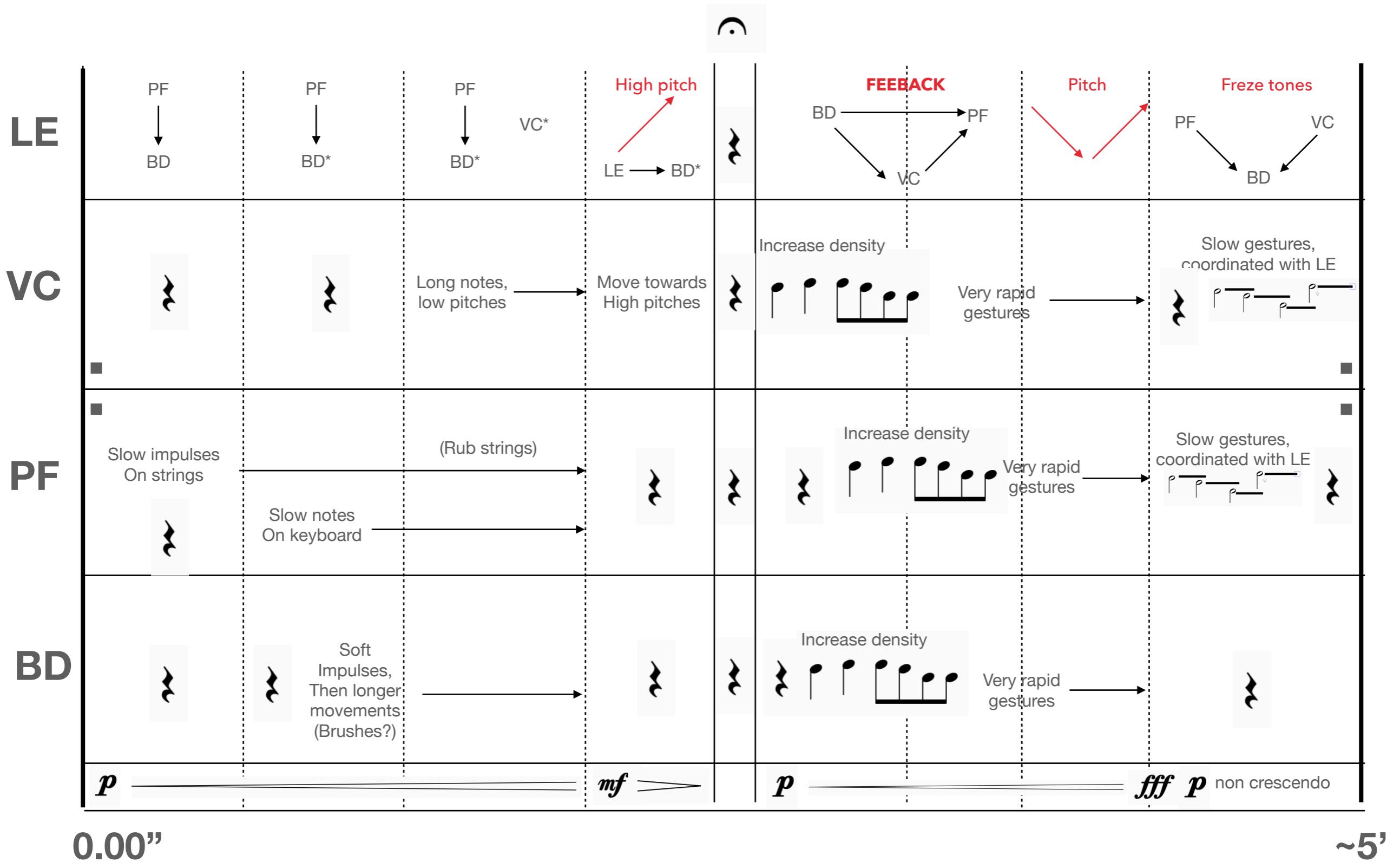
# A FULL MODEL IN ACTION

---

## LET'S GO LIVE!



# PSEUDO-SCORE



## PSEUDO-SCORE (HAND-WRITTEN)

