



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA



Berkeley
UNIVERSITY OF CALIFORNIA

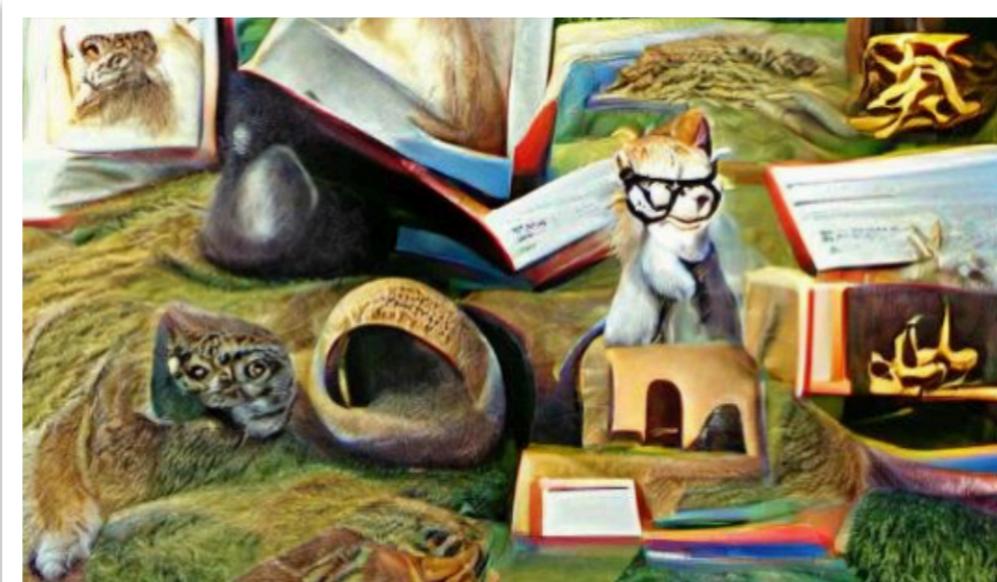
CARMINE-EMANUELE CELLA

ARTISTIC RESEARCH AND (COMPUTATIONAL) CREATIVITY

AN INTRODUCTION

ON ARTISTIC RESEARCH

WHAT IS ARTISTIC RESEARCH? (1/2)



"KeefyKat" by Keith Roberson

“I create art which explores technologies, like virtual art and artificial intelligence, and demonstrate their potential as artistic mediums and for new kinds of expression,”

Keith Roberson (FSU)

WHAT IS ARTISTIC RESEARCH? (2/2)

- The term *artistic research* is an umbrella term that covers an eclectic array of methodological and epistemological approaches
- The key elements that unify this diverse body of work are: it is **research**; and one or more **art** forms or processes are involved in the doing of the research
- How art is involved varies enormously

WHAT IS ARTISTIC RESEARCH? (2/2)

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Research in the arts serves as a **dynamic, multidimensional creative landscape** for exploration, artistic expression, and innovation

BACH, FUGUE C MINOR, WTC VOL. 2 (EXCERPT)



BACH, FUGUE C MINOR, WTC VOL. 2 (EXCERPT)



BACH'S EXAMPLE

RELATIONAL COMPLEXITY



RELATIONAL COMPLEXITY

SUBJECT (theme)



RELATIONAL COMPLEXITY

SUBJECT (theme)

5
1 2 3 2 1
3 2 3 1 5

DILATED SUBJECT

RELATIONAL COMPLEXITY

SUBJECT (theme)

A musical score from Bach's Example, featuring two staves of music. The top staff is in common time (indicated by 'C') and the bottom staff is in common time (indicated by 'C'). The music consists of eighth and sixteenth notes. Three specific melodic segments are highlighted with red boxes:

- SUBJECT (theme):** A box highlights the first measure of the top staff, which consists of three eighth notes followed by a sixteenth note.
- DILATED SUBJECT:** A box highlights the second measure of the top staff, which consists of three eighth notes followed by a sixteenth note. This measure is identical to the subject but stretched in time.
- INVERTED SUBJECT:** A box highlights the third measure of the top staff, which consists of three eighth notes followed by a sixteenth note. The pitch of each note is inverted compared to the original subject.

DILATED SUBJECT

INVERTED SUBJECT

RELATIONAL COMPLEXITY

SUBJECT (theme)



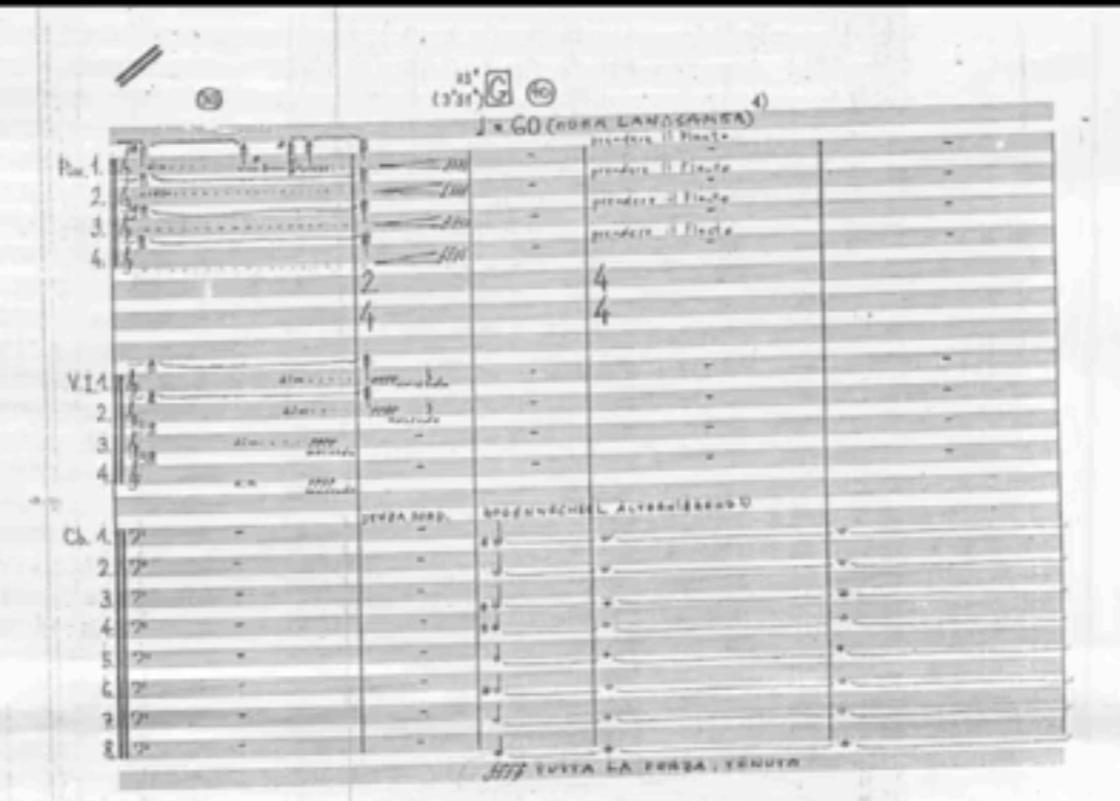
Multi-scale hierarchical relationships

LIGETI, ATMOSPHÈRES (EXCERPT)



1) or slower
2) alternating change of bow

LIGETI, ATMOSPHÈRES (EXCERPT)



A NEW TYPE OF COMPLEXITY

Melodies → Streams

A NEW TYPE OF COMPLEXITY

Melodies → Streams

Rhythm → Density

A NEW TYPE OF COMPLEXITY

Melodies → Streams

Rhythm → Density

Chords → Textures

A NEW TYPE OF COMPLEXITY

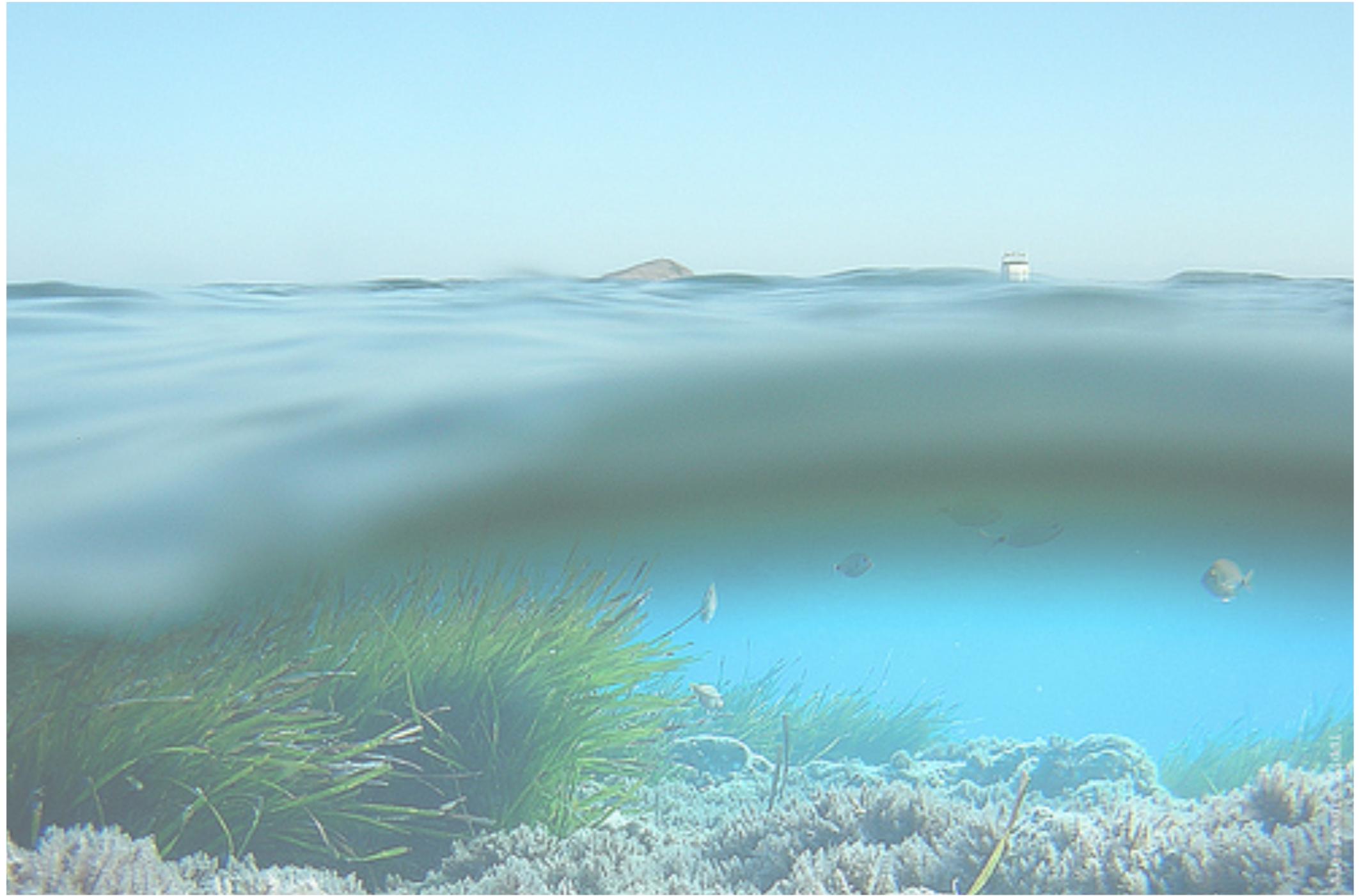
Melodies → Streams

Rhythm → Density

Chords → Textures

Symbols → Sounds

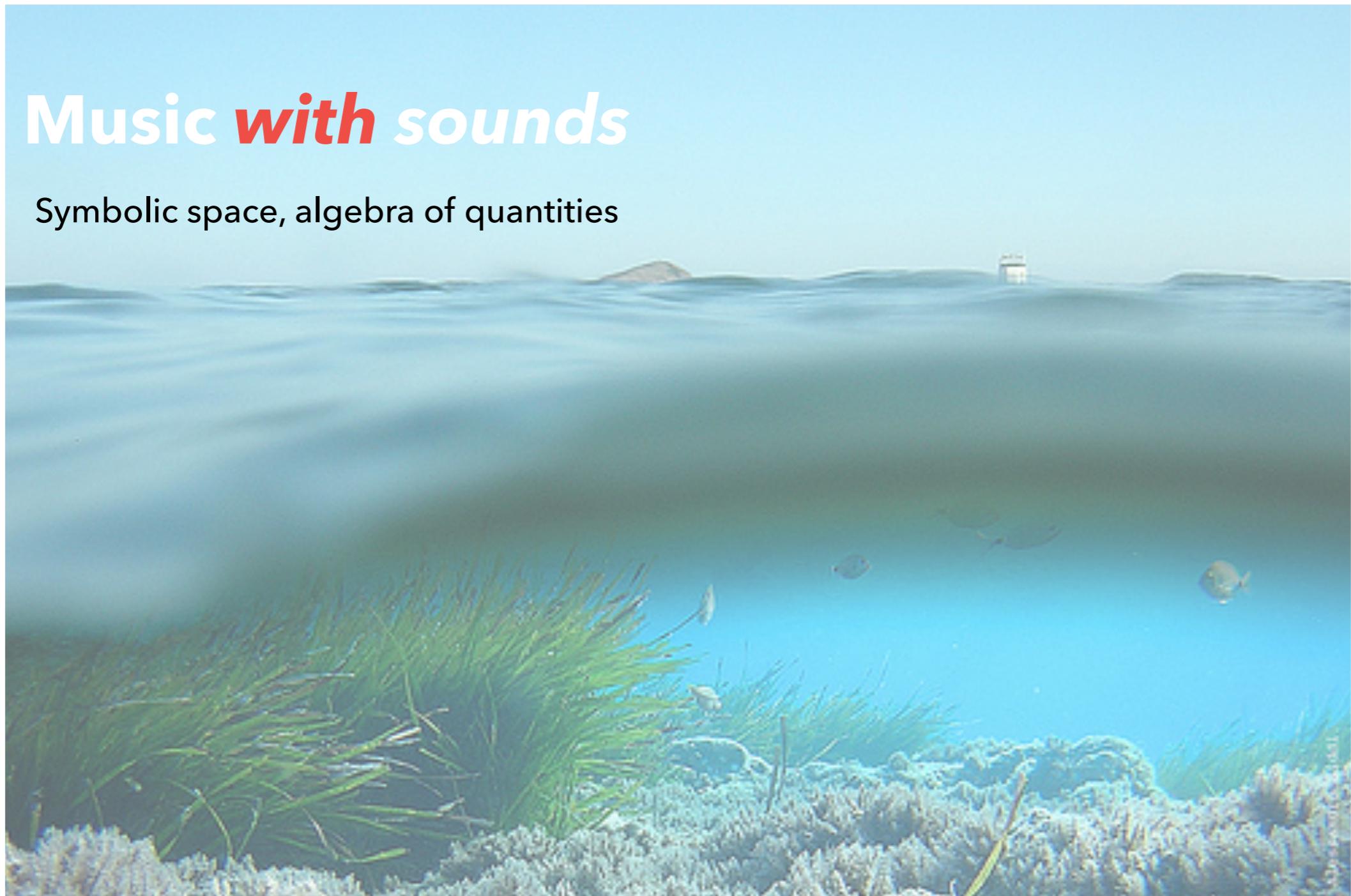
IS MUSIC LIKE THE SEA?



IS MUSIC LIKE THE SEA?

Music **with** sounds

Symbolic space, algebra of quantities



IS MUSIC LIKE THE SEA?



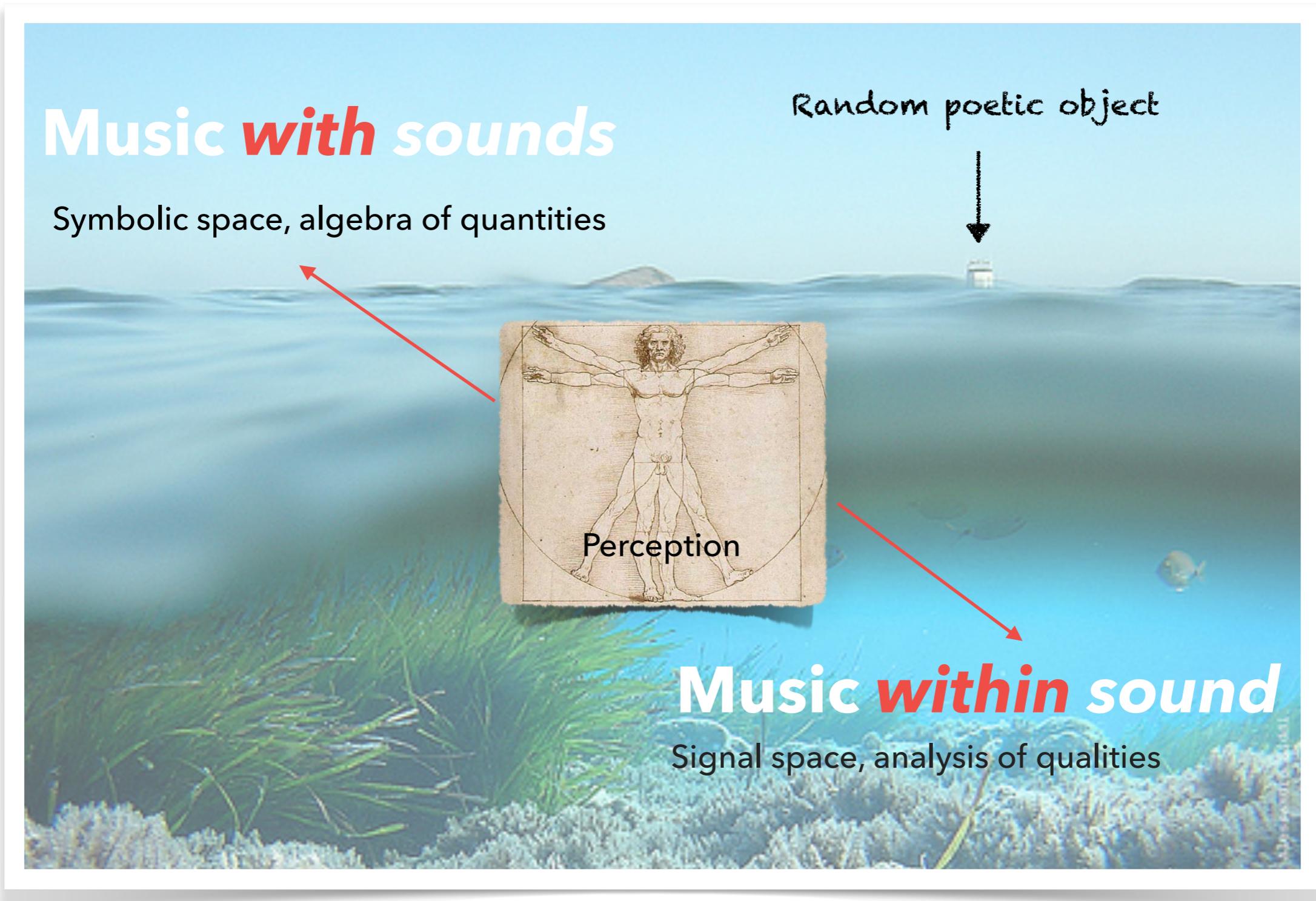
Music *with* sounds

Symbolic space, algebra of quantities

Music *within* sound

Signal space, analysis of qualities

IS MUSIC LIKE THE SEA?



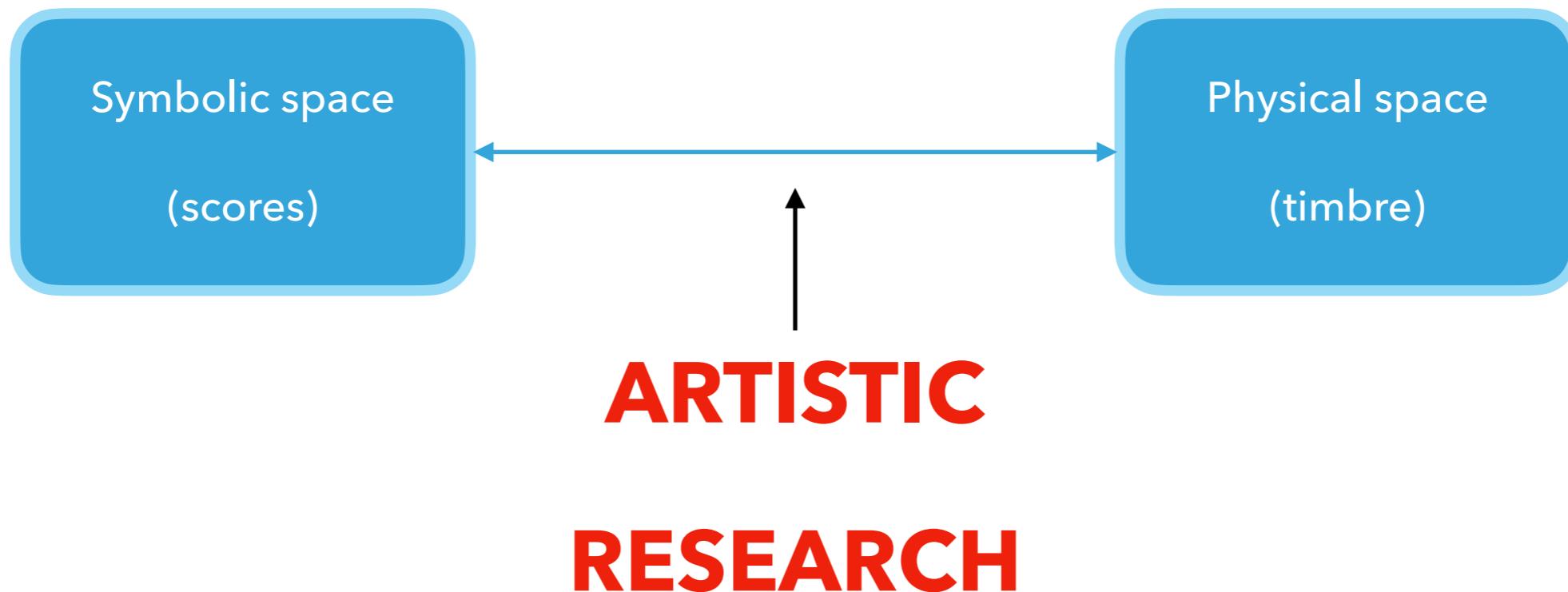
MY DEFINITION OF ARTISTIC RESEARCH

Which connections can we make between
the symbolic space and the signal space?



MY DEFINITION OF ARTISTIC RESEARCH

Which connections can we make between
the symbolic space and the signal space?



CAN COMPOSERS THINK IN SOUNDS?



- What is the mental model of an artist during the creative process?
- Can we use mathematical or computational models to support/foster/discover this mental model?

ON (COMPUTATIONAL) CREATIVITY

WHAT IS CREATIVITY?

- giving a precise definition of this concept is not a trivial task
- general idea is that it relates to the ability that some human individuals possess to create something that did not exist before
- “creations” start from concepts that already existed, or at least that could already have existed, but that nobody had already explicitly linked in a fixed product. This kind of “novel linkage”

Dali, The persistence of memory

clocks had been painted before,
and everybody has experienced
that things can melt, but
nobody had yet linked these two
concepts in a painting



DALL-E-2

TEXT DESCRIPTION

An astronaut Teddy bears A bowl of soup

that is a portal to another dimension that looks like a monster as a planet in the universe

as digital art in the style of Basquiat drawn on a cave wall



DALL-E 2



<https://openai.com/dall-e-2/>

DALL-E-2

TEXT DESCRIPTION

An astronaut **Teddy bears** A bowl of
soup

mixing sparkling chemicals as mad
scientists **shopping for**
groceries working on new AI research

in the style of ukiyo-e as a one-line
drawing **in ancient Egypt**



DALL-E 2



<https://openai.com/dall-e-2/>

DEEP DREAM



Prior
attempts
at AI-
generated
synthetic
images

ROBBIE BARRAT



Open source GAN
software on Github



CAN COMPUTERS BE CREATIVE??

“Computers can’t create anything. For creation requires, minimally, originating something. But computers originate nothing; they merely do that which we order them, via programs, to do.”

Lovelace (1842).

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Alan Turing, responded to Lady Lovelace’s objection pointing out that she had no real experience in programming, while we now know that a computer can often surprise us by doing the exact opposite of what we intended, until a program is thoroughly checked for bugs (Turing, 1950)

CREATIVITY = ERROR?

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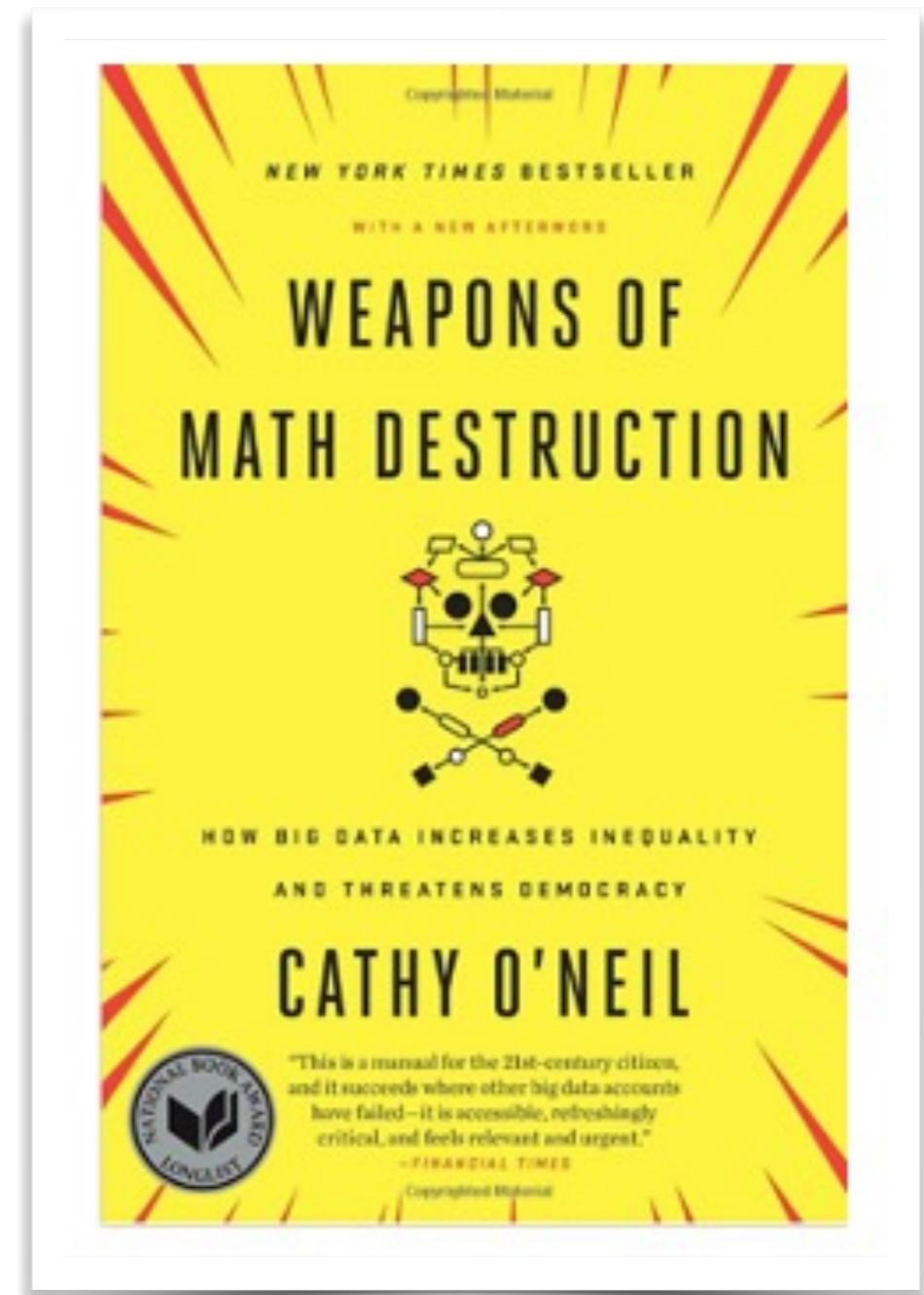
CREATIVITY = ERROR?



LARGER IMPACTS OF AI



AI generated identities



INDUSTRIAL REVOLUTIONS: NEW SKILLS

1. Simple physical labor



INDUSTRIAL REVOLUTIONS: NEW SKILLS

1. **Simple** physical labor



2. **Complex** physical labor



INDUSTRIAL REVOLUTIONS: NEW SKILLS

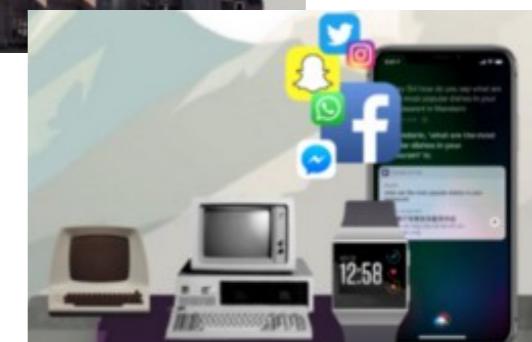
1. **Simple** physical labor



2. **Complex** physical labor



3. **Simple** intellectual tasks
(planning, scheduling ,etc.)



INDUSTRIAL REVOLUTIONS: NEW SKILLS

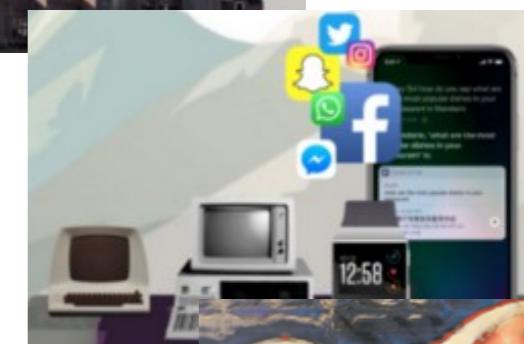
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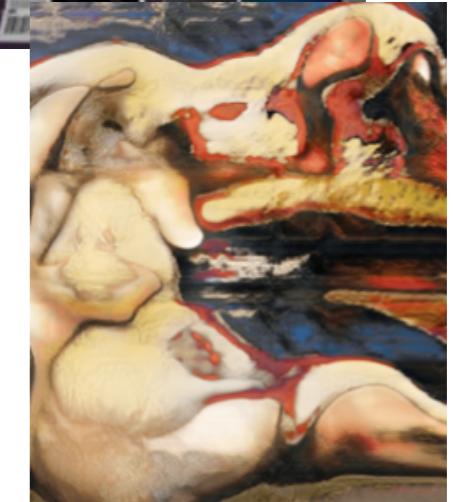
2. **Complex** physical labor

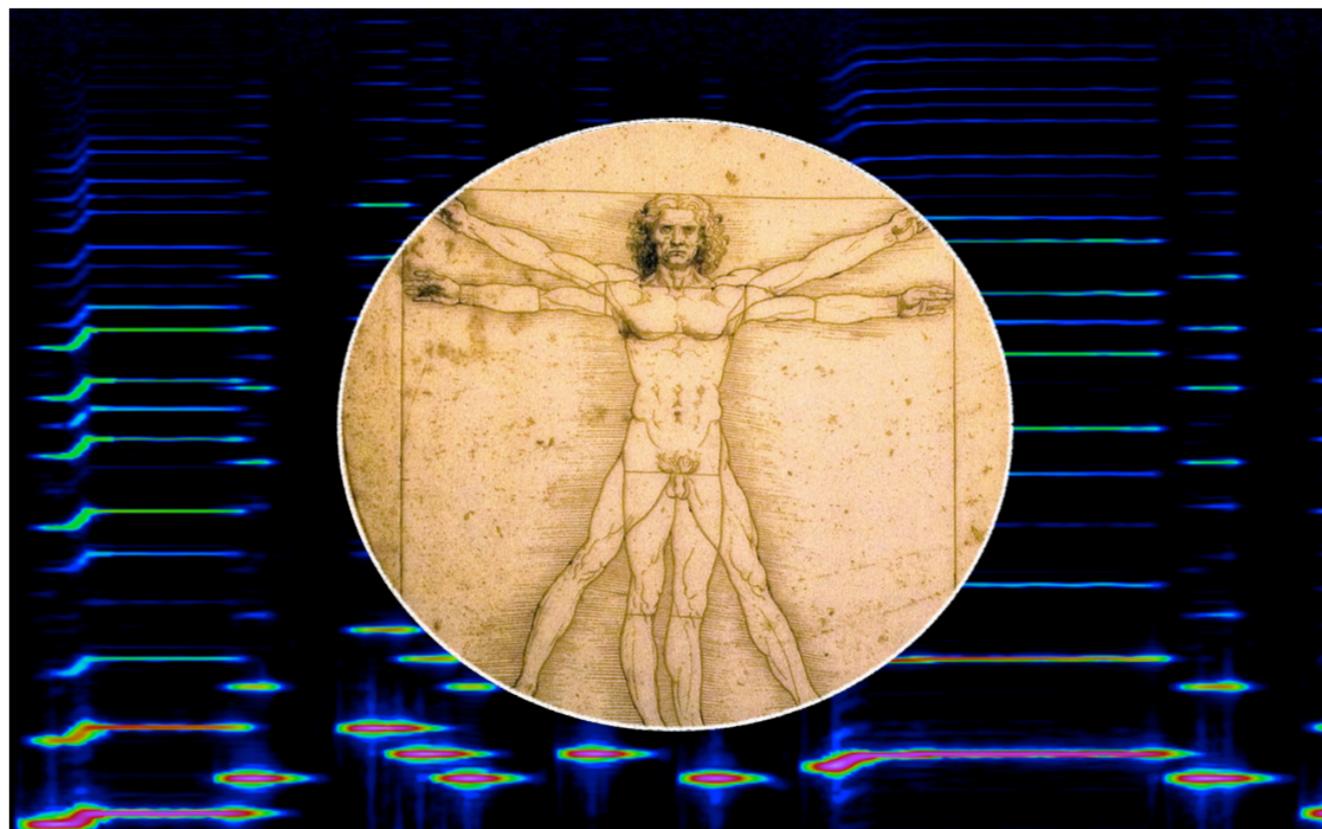


3. **Simple** intellectual tasks
(planning, scheduling ,etc.)



4. **Complex** intellectual tasks
(game playing, artistic
creation, etc.)

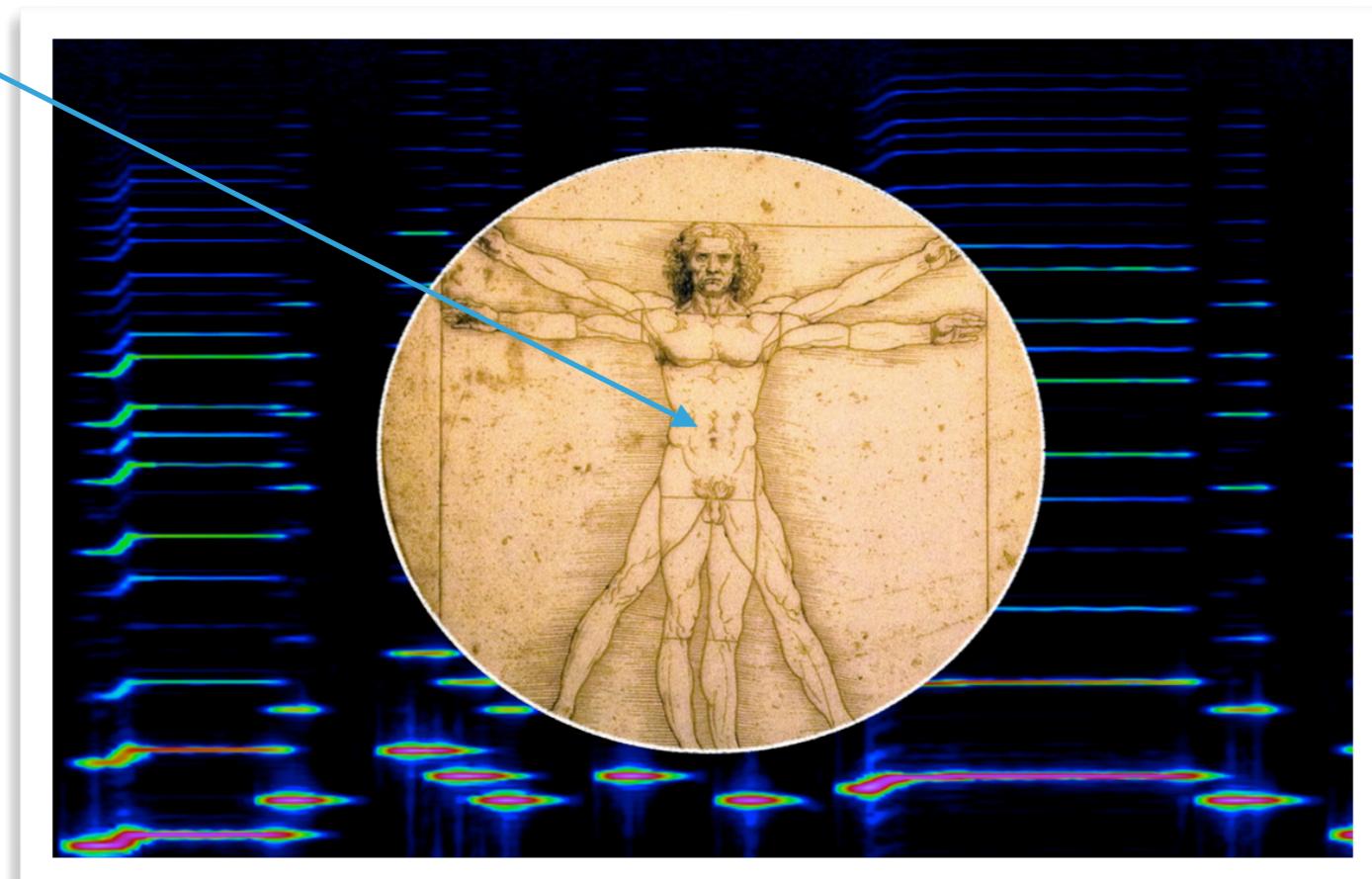




What's next?

(what makes us...human?)

Emotions?

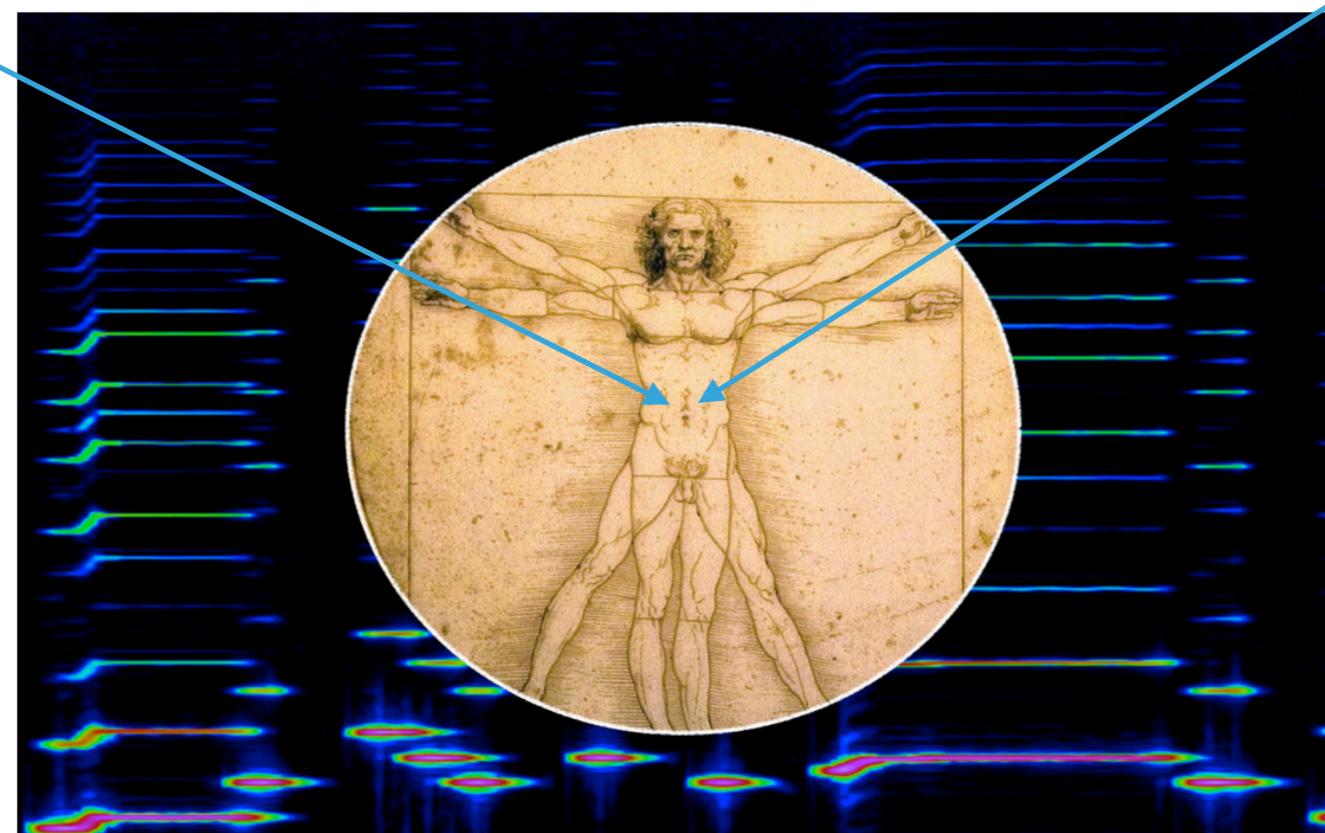


What's next?

(what makes us...human?)

Emotions?

Genetics?

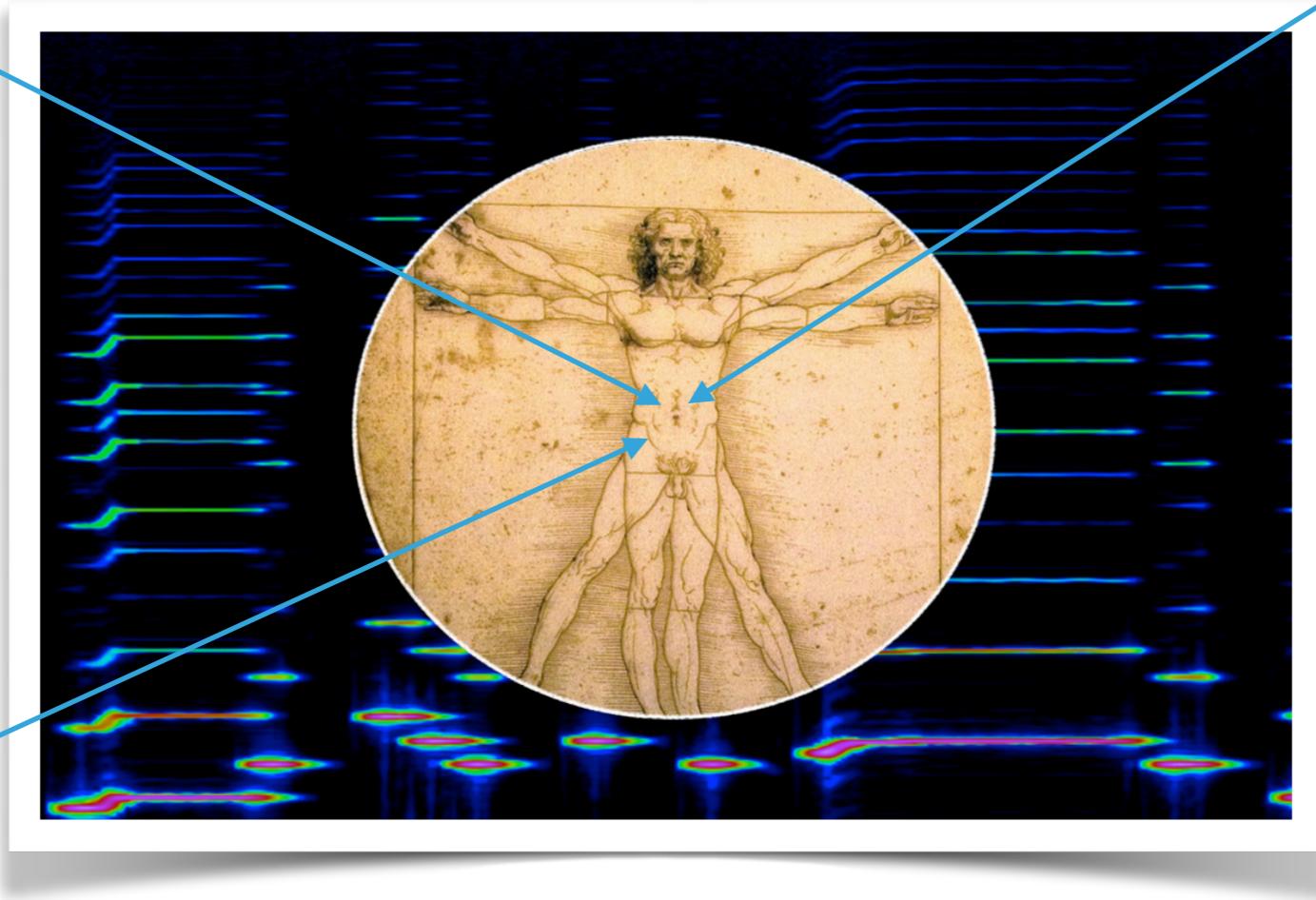


What's next?

(what makes us...human?)

Emotions?

Genetics?



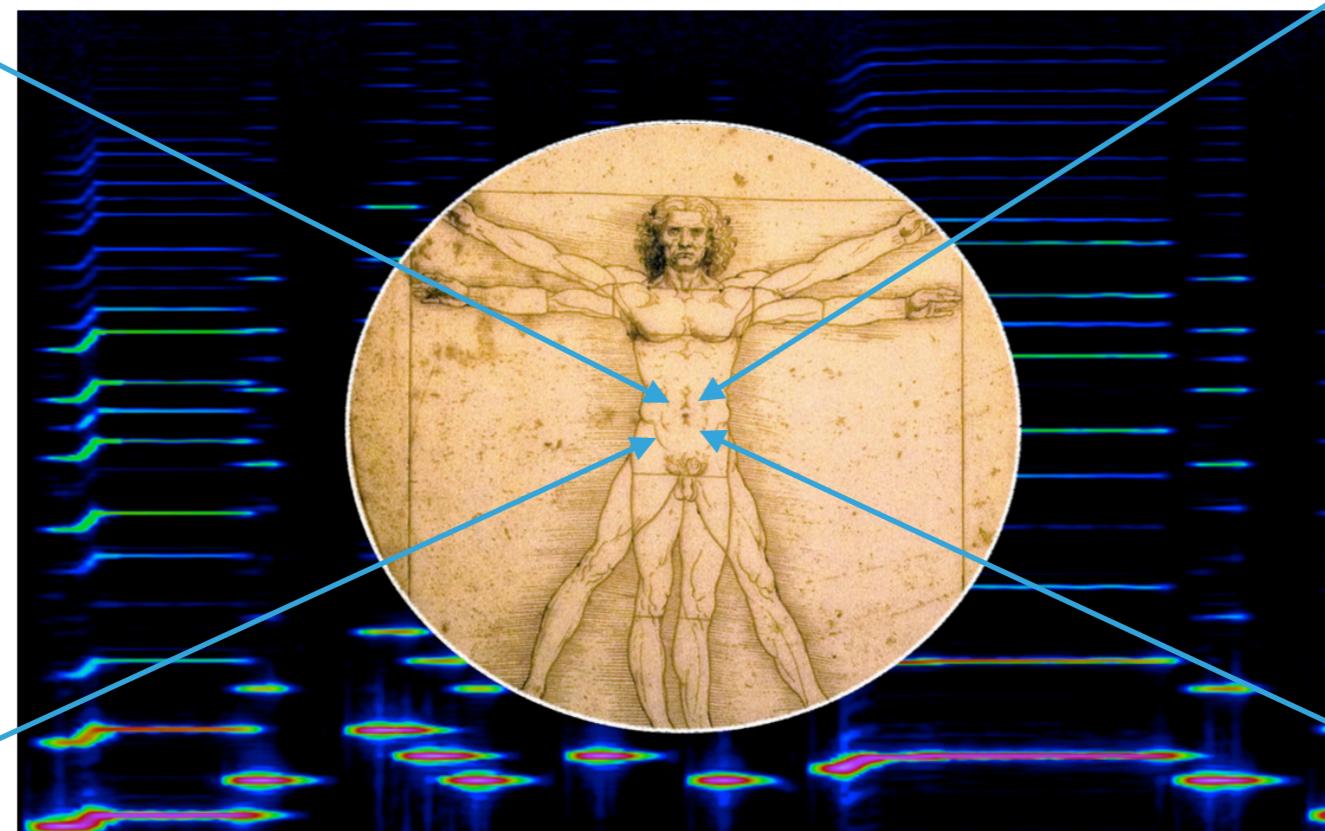
Culture?

What's next?

(what makes us...human?)

Emotions?

Genetics?



Culture?

Relationships?

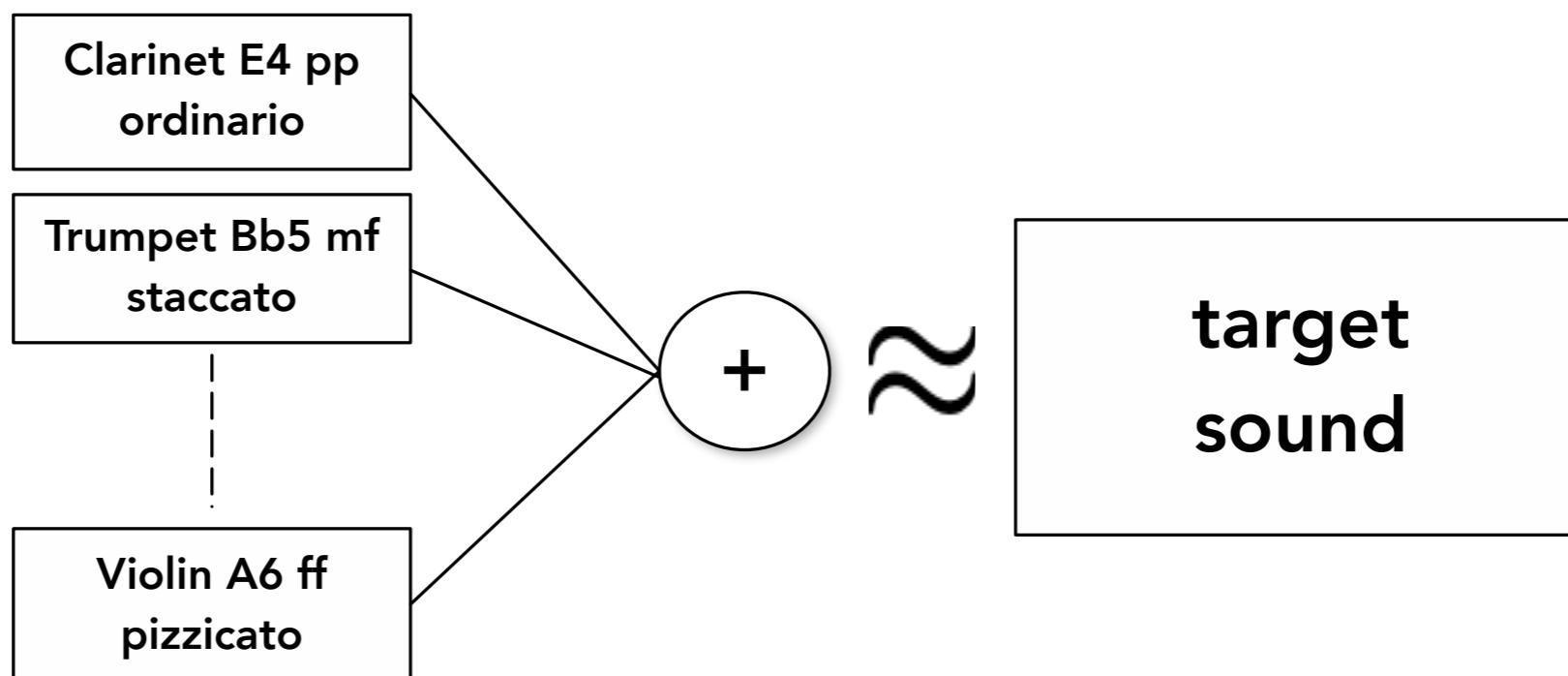
What's next?

(what makes us...human?)

AN EXAMPLE: ASSISTED ORCHESTRATION

A PRELIMINARY DEFINITION

The process of searching for the best combinations of orchestral sounds to match a target sound under specified metric and constraints.



ORCHESTRATION: PROJECTION

Muovendo $\text{♩} = 78$

103

A musical score page showing seven staves of music for an orchestra. The instruments are Picc., Fl., Ob., Eng. horn, Cl., B. Cl., and Bass. The tempo is Muovendo $\text{♩} = 78$ and the dynamic is 103 . The score includes various musical markings such as trills, slurs, and dynamics like ff, sfff, and simile. Measure numbers 6, 6, 6, 3, 3, 3, and 3 are indicated above the staves.

Picc.

Fl.

Ob.

Eng. horn

Cl.

B. Cl.

Bass

ORCHESTRATION: PROJECTION

Muovendo $\text{♩} = 78$

103

The musical score shows six staves of music for an orchestra. The instruments are Picc. (Piccolo), Fl. (Flute), Ob. (Oboe), Eng. horn, Cl. (Clarinet), and B. Cl. (Bass Clarinet). The score includes dynamic markings such as *ff*, *fff*, *tr.*, *simile*, and *dim.*. Measure numbers 7 and 8 are indicated at the top. The tempo is marked as $\text{♩} = 78$.

PROJECTION

Signal space
(timbre)

ORCHESTRATION: INDUCTION?

Signal space
(timbre)

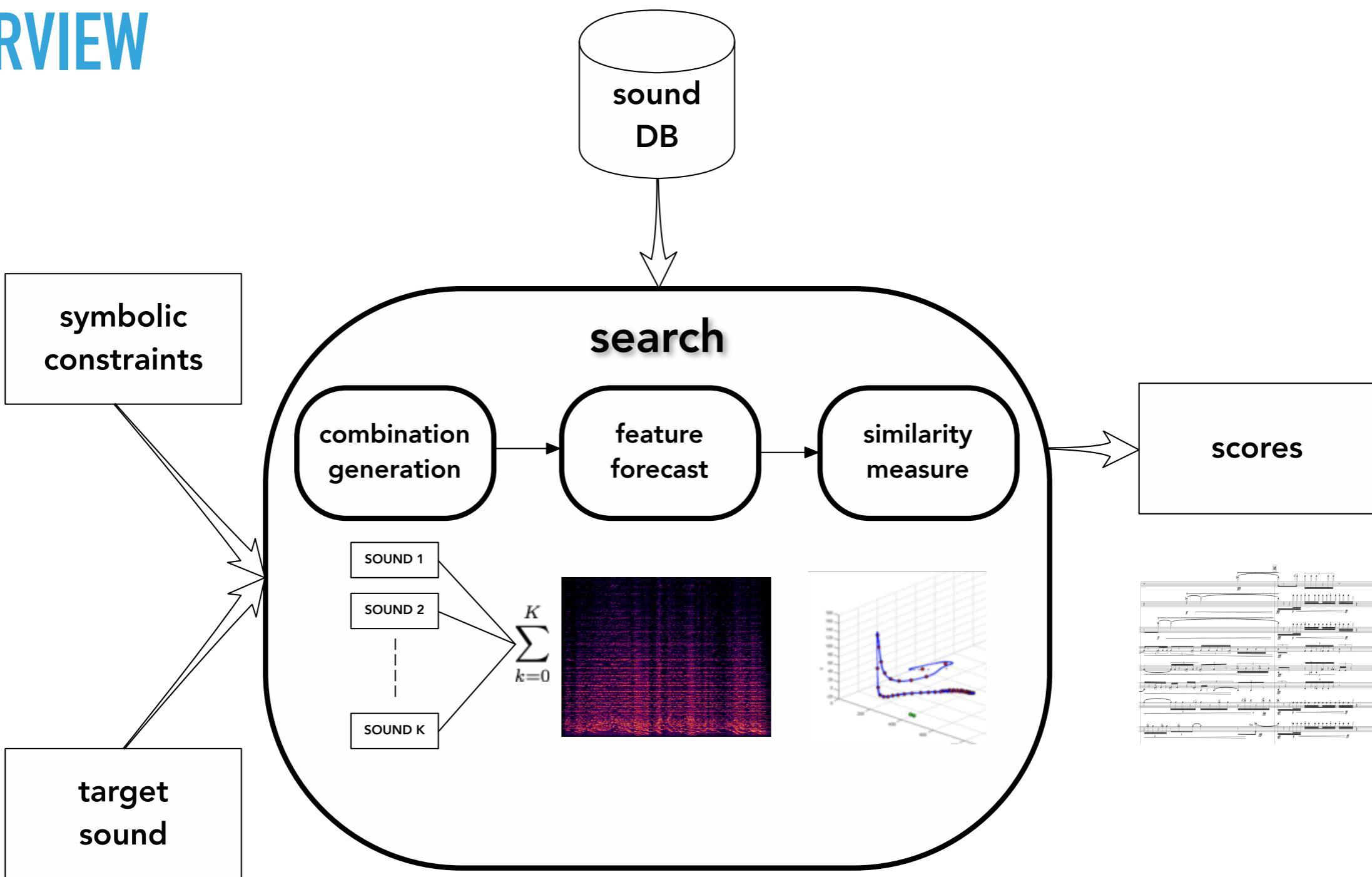
ORCHESTRATION: INDUCTION?

A musical score for orchestra, showing ten staves of music. The instruments listed from top to bottom are Flute (Fl), Oboe (Ob), Clarinet (Cl), Bassoon (Bn), Horn (Hn), Trombone (Tp), Tuba (Tbn), Violin (Vn), Viola (Va), and Cello/Bass (Cb). Each staff includes a clef, key signature, and dynamic markings. For example, the Flute starts at forte (ff) and ends at nonvibrato (ff); the Bassoon starts at piano (pp) and ends at ff; the Violin starts at ff and ends at ff.

?

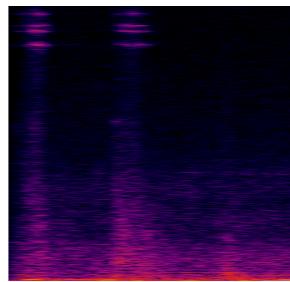
Signal space
(timbre)

OVERVIEW

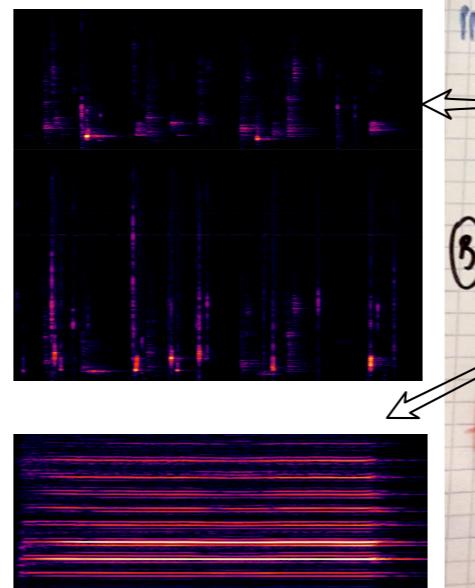


C. E. CELLA, STADES D'OMBRE, STADES DE LUMIÈRE (2018)

Target sound



Orchidea solution



Real orchestration
(longer excerpt)



**Stades d'ombre,
stades de lumière**

For Eb

Carmine-Emanuele Cella (2018)

FULL SCORE

Section C (Grave = 48)

Flute: harmonic tremolo, pp.

Oboe: mf senza crescere, ppp.

Clarinet in Bb: p senza crescere.

Bassoon: ppp.

Horn in F: opening and closing with hand, ppp senza crescere, harmon mute.

Trumpet in Bb: ppp, straight mute.

Trombone: irregular movements with superball, ppp.

Percussion: TAM TAM, irregular movements with hands on the strings in the lower region, strike strings with hands, l.v., pp.

Piano: irregular movements with hands on the strings in the lower region, strike strings with hands, l.v., pp, pp.

Violin I (Grave = 48)

Violin II: increasing vibrato speed, p express.

Viola: on the bridge, ppp.

Violoncello: mute, lead mute, increasing vibrato speed, pizz., pp.

Contrabass: on the bridge, ppp senza crescere, mp express.

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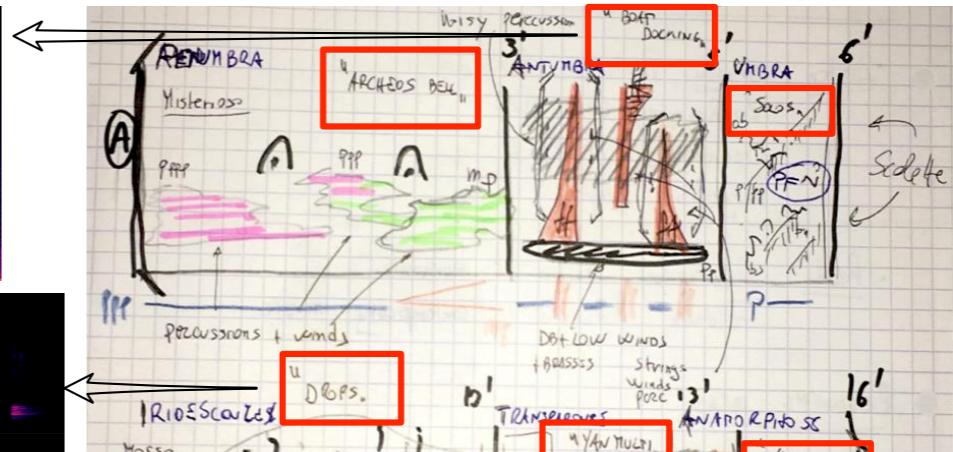
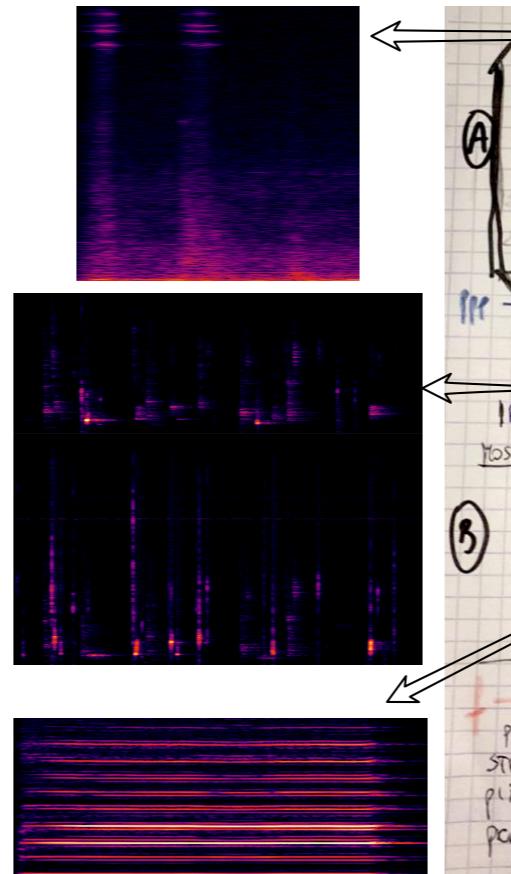
C. E. CELLA, STADES D'OMBRE, STADES DE LUMIÈRE (2018)

Target sound

Orchidea solution

Real orchestration

(longer excerpt)



FULL SCORE

Stades d'ombre, stades de lumière

For Eli

Carmine-Emanuele Cella (2018)

C **Grave** ♩ = 48

C **Grave** ♩ = 48

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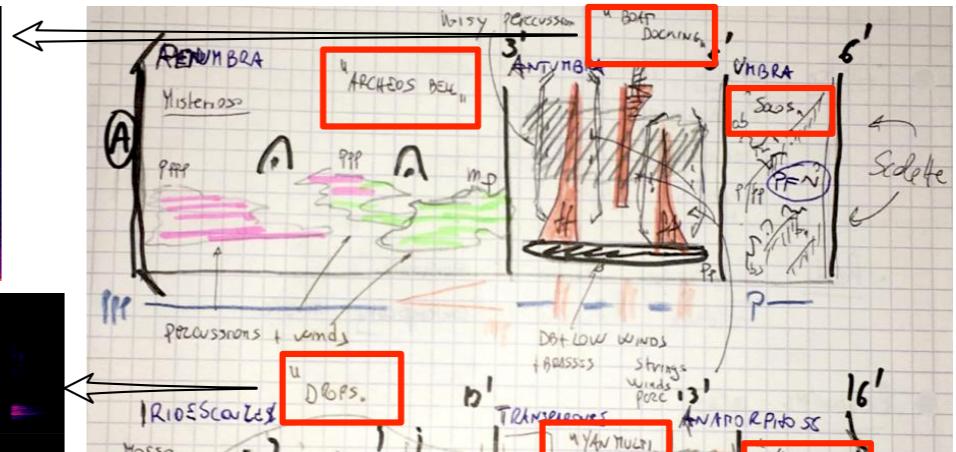
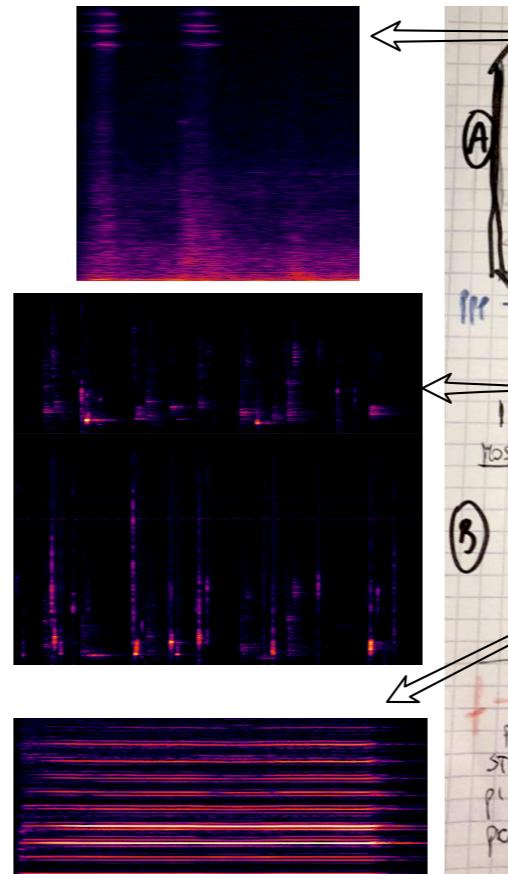
C. E. CELLA, STADES D'OMBRE, STADES DE LUMIÈRE (2018)

Target sound

Orchidea solution

Real orchestration

(longer excerpt)



FULL SCORE

Stades d'ombre, stades de lumière

For Eli

Carmine-Emanuele Cella (2018)

C **Grave**, = 48

Flute

Oboe

Clarinet in B \flat

Bassoon

Horn in F

Trumpet in B \flat

Trombone

Percussion

Piano

C **Grave**, = 48

Violin I

Violin II

Viola

Visioncello

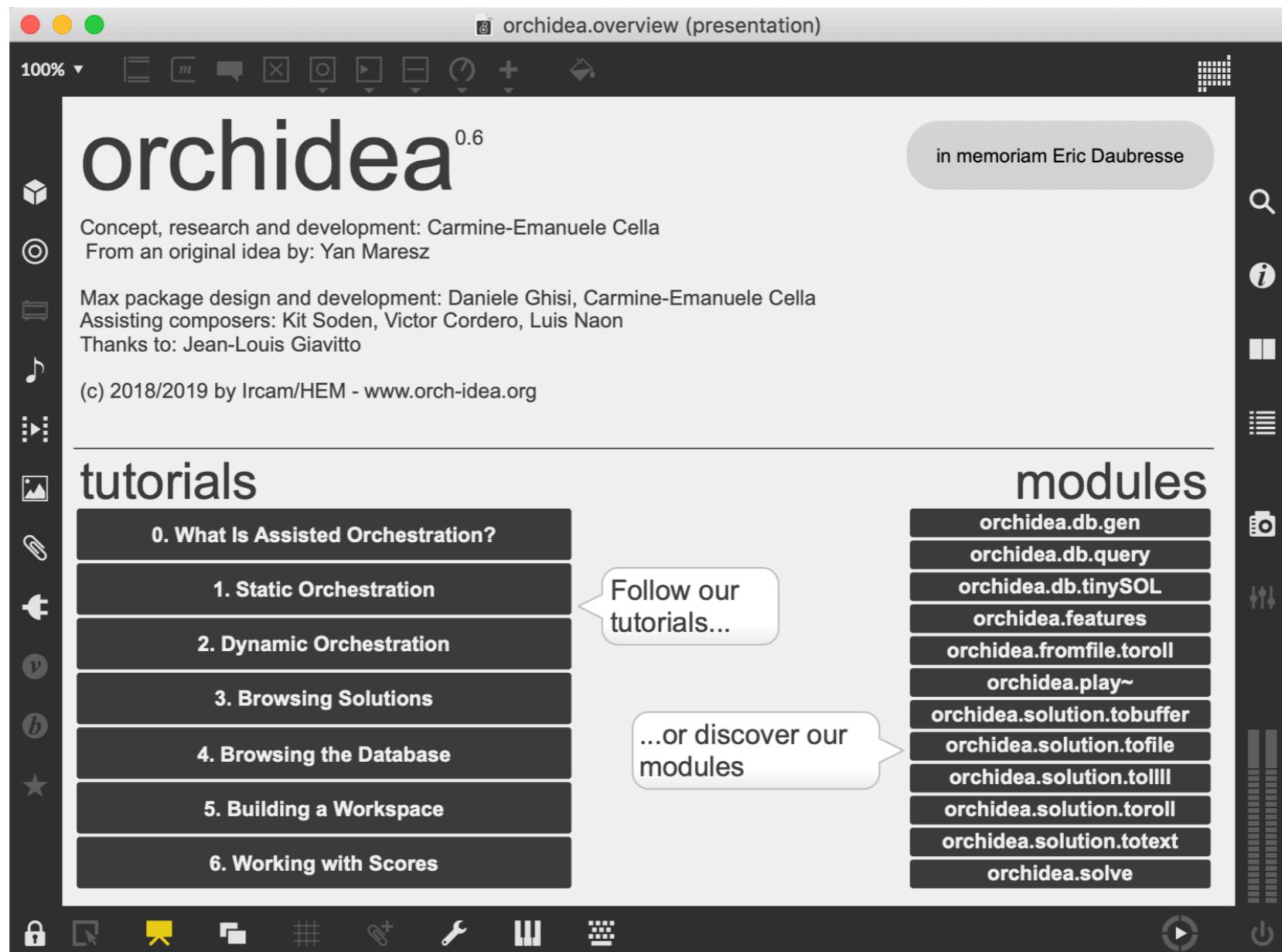
Contrabass

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ORCHIDEA MAX PACKAGE

Carmine-Emanuele Cella, Daniele Ghisi



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THANK YOU!!!



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