Doctoral Dissertation
Report of Progress
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Motivational question:

How can we improve the design of electronic musical instruments?

The answer is a general hypothesis:

Understanding the relationships between the movement of the human body and music.

This follows the Embodied Music Cognition train of thought.

Two research questions arise:

1. How does the human body move with music?

   The Answer is a model.

2. How the modelling of human bodily movement to music could be applied to the design of novel electronic musical instruments?

Hence the title of the dissertation:

Mimetic Relationships between Bodily Movement and Musical Structure: Measurement and Application

The dissertation consists of three parts, each yielding at least one scholarly article:

1- Theory

2- Measurement

3- Application

1- Theory

Bodily movement induced by music *corresponds* to the sound heard.

Music → Bodily movement

Watch these videos:

https://www.youtube.com/watch?v=Um6y_IQGU8s
https://www.youtube.com/watch?v=rlbDezIy-bo
https://www.youtube.com/watch?v=dMH0bHeiRNg
https://www.youtube.com/watch?v=2DU31dRGmAI
https://www.youtube.com/watch?v=kFKV_70EIw0
https://www.youtube.com/watch?v=4t1NWH6G1f0

1- Theory

Bodily movement induced by music *corresponds* to the sound heard.

Music → Bodily movement

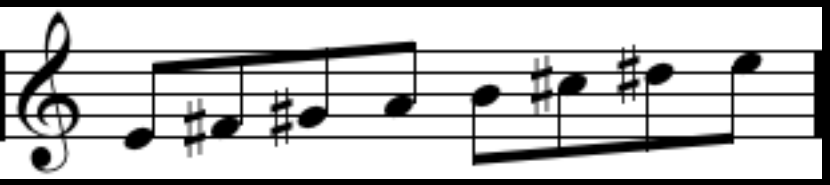
Bodily movement to produce music *corresponds* to the sound produced.

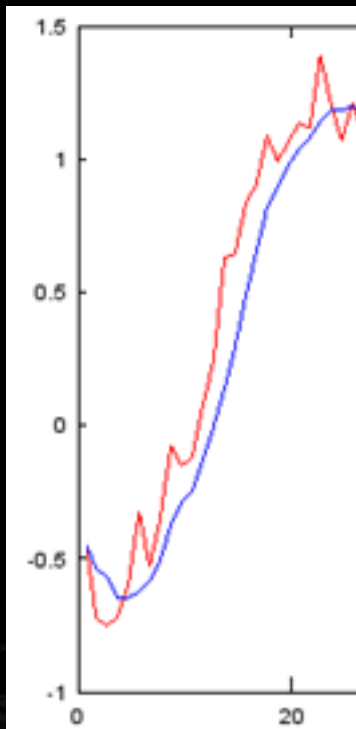
Bodily movement → Music

1- Theory

This phenomenon is called

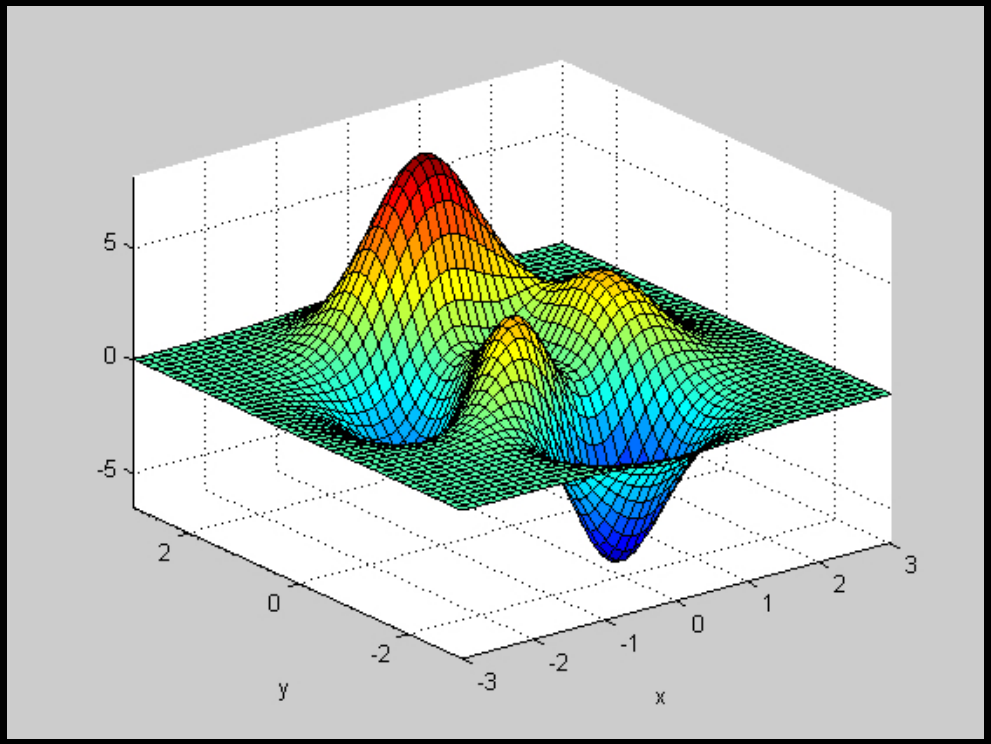
Musical Gesture





1- Theory

Musical Gesture has been formalised with tools of Topology (Mazzola & Andreatta, 2007). One of its properties is proximity. For example, the direction of the movement of hands over the piano keyboard has a direct correspondence with the pitch of the sound. In practice, the observation of one variable measured from a gesture could summarise to a fair extent several variables of the gesture.



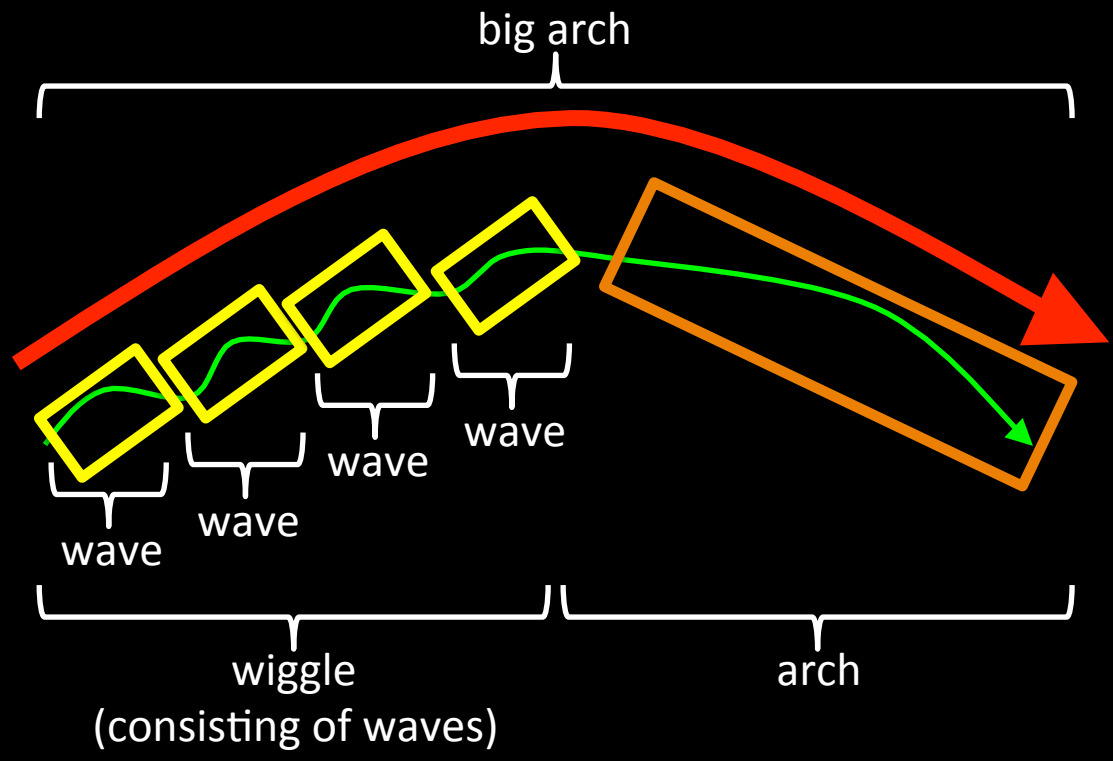
1- Theory

The hypothesis of gesture chunking by Co-Articulation (Godøy, 2011) says that the grouping of bodily gestures into meaningful structures depends on the music that goes along with the bodily gesture.

The figure to the right shows a trajectory, for example the hand of a person dancing.

This trajectory can be decomposed in units at different time-scales:

- short: wave
- medium: wiggle and arch
- large: big arch



1- Theory

Cartesian and Enactive Model of Musical Interaction

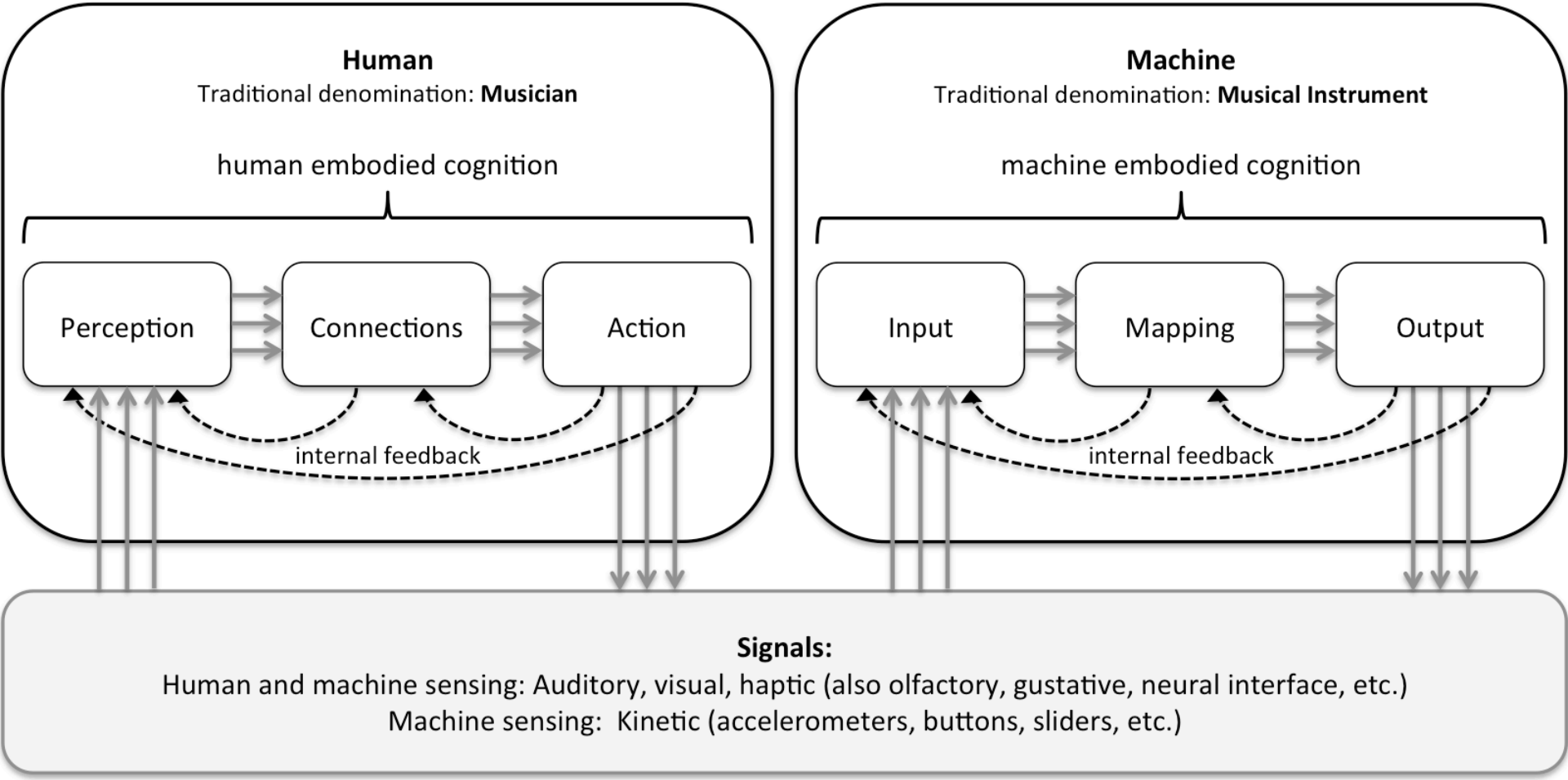
signals carrying gestures

Musical Instrument	Musician	Sandwich Model (Hurley, 2002, p. 401)
Control	Perception	
Mapping	Cognition	
Sound Production	Action	

1- Theory

A better model of Musical Interaction

(Mendoza & Thompson, in press)



2- Measurement

of

Musical Gestures

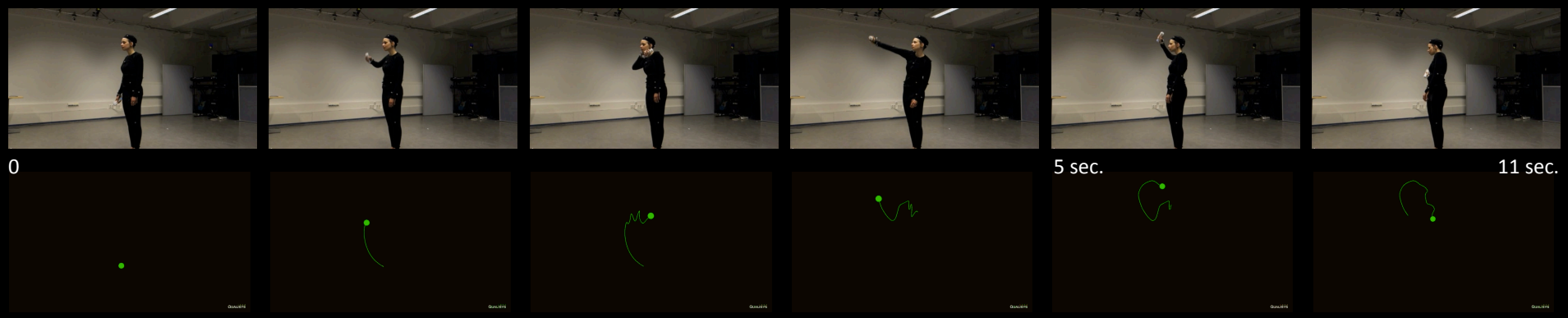
2- Measurement

2.1- Multimodal Data Recording

Sound Tracing: a “Single-Point” approach

This person was asked to *dance with her right hand* to the music she was presented with, while holding a Wiimote. Data was captured from the Wiimote and from the optical motion capture .

Video



Optical Motion Capture (only one marker at the wrist is shown)

2- Measurement

2.2- Ground Truth

Segmentation: People are asked to annotate where and how gestures are.

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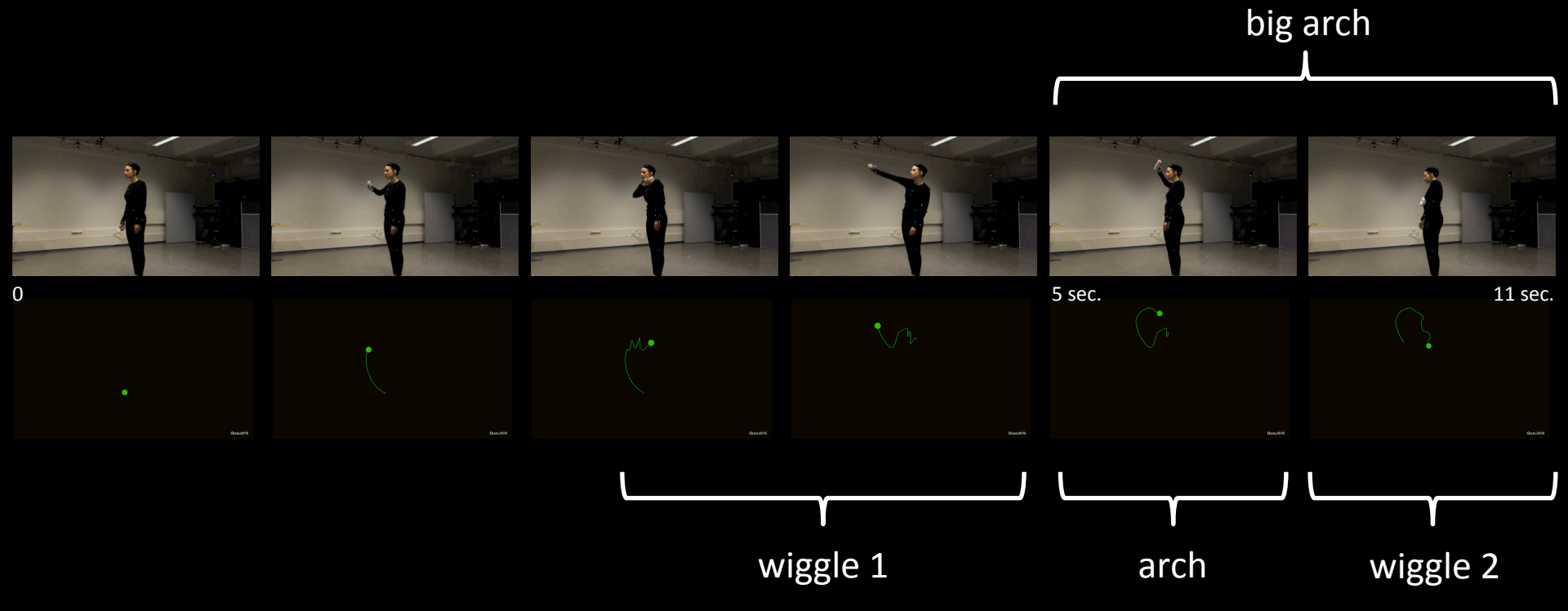
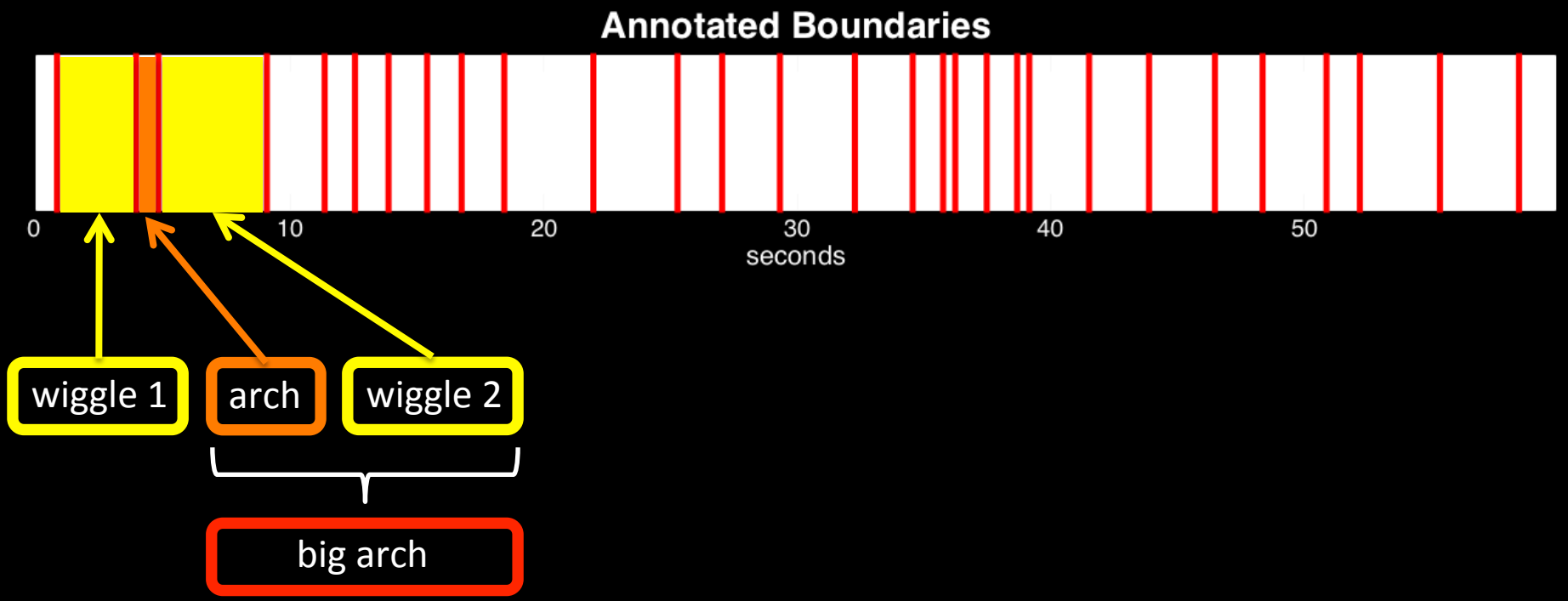


2- Measurement

2.2- Ground Truth

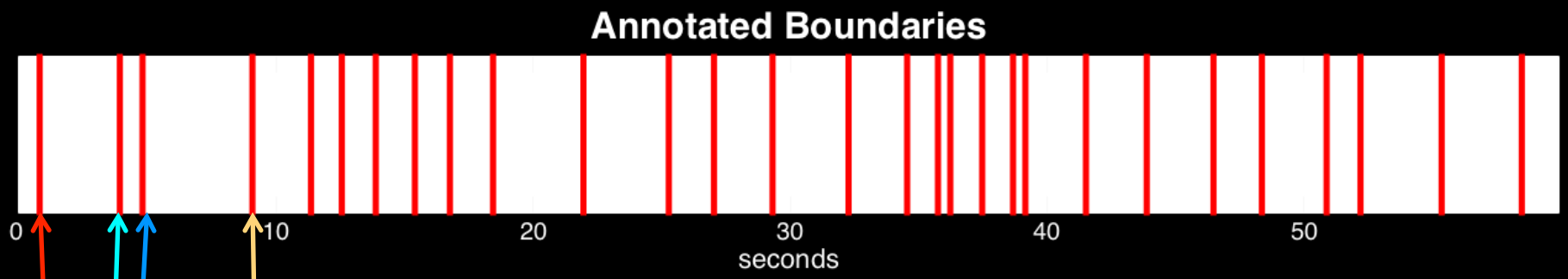
Segmentation: Human annotation of where and how gestures are.



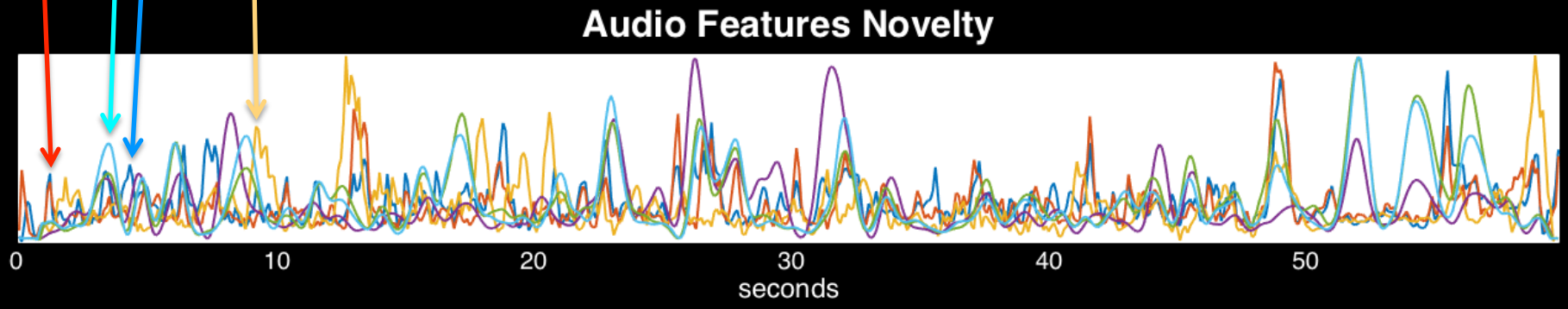
2- Measurement

2.2- Ground Truth

Perceived boundaries may correspond to changes (novelty)
of musical sound characteristics (computed audio features from digital audio)
such as energy, tonality or peridiocity.



etc.



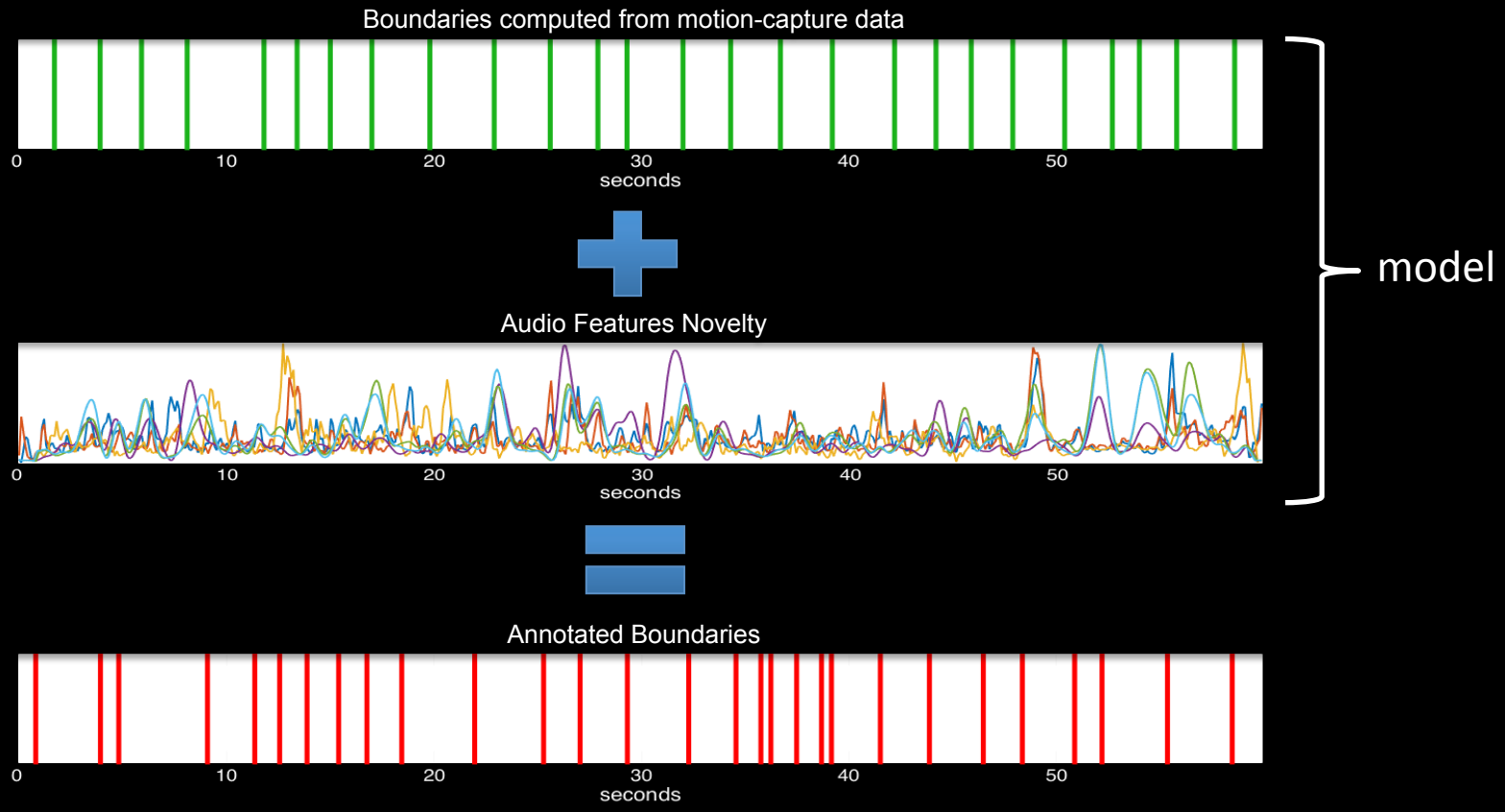
2- Measurement

2.3- Automation

To produce generalisable results it is necessary to make a big-scale experiment, which involves annotation of many hours of video. This is costly and therefore it is reasonable to automate the segmentation task. Automated segmentation can be performed by an algorithm processing the motion-capture signal.

2- Measurement

Consistent with the co-articulation hypothesis, the algorithm should predict perceived (annotated) gesture boundaries by using novelty of audio features to group boundaries computed from motion-capture data.



3- Application

3.1- Build a Digital Musical Instrument into which later the Automatic Recognition System will be Implemented.

3.2- Evaluate user experience to inform the instrument's improvement (Qualitative exploration study).

Watch this video:
http://users.jyu.fi/~juigmend/video/Mimetic_Relationships_Music_Gesture_SHORT_LQ.mp4

3- Application

3.1- Build a Digital Musical Instrument into which later the Automatic Recognition System will be Implemented.

3.2- Evaluate user experience to inform the instrument's improvement (Qualitative exploration study).

3.3- Implement the Automatic Gesture Recognition System into a Digital Musical Instrument.

3.4- Evaluate user experience to inform the instrument's improvement (Qualitative exploration study).

Publications as of November 2016

1- Theory:

- “Review of New Perspectives in Music and Gesture” (Thompson & Mendoza, 2014)

- “Gestural Agency in Human-Machine Musical Interaction ” (Mendoza & Thompson, in press)