MuTAnt team

Jean-Louis Giavitto

Programming Cyber-Temporal Musical Systems

subsuming the event-driven and time-driven models

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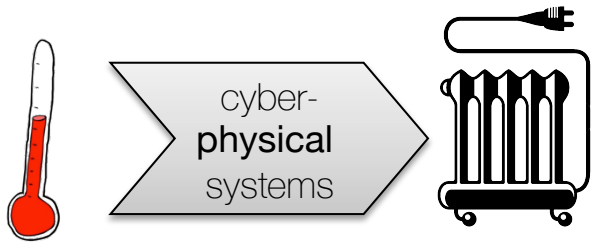
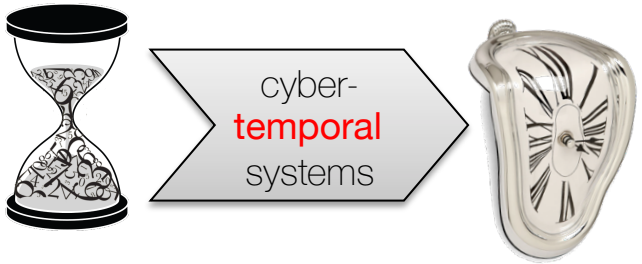
Notion of

CYBER-TEMPORAL SYSTEMS

Cyber-temporal systems:
computing time in real-time

- *from:* physical entities
  monitored by algorithms
- *to:* temporal relationships
  sensed and produced by algorithms
- *example:* interactive music systems
  Antescofo

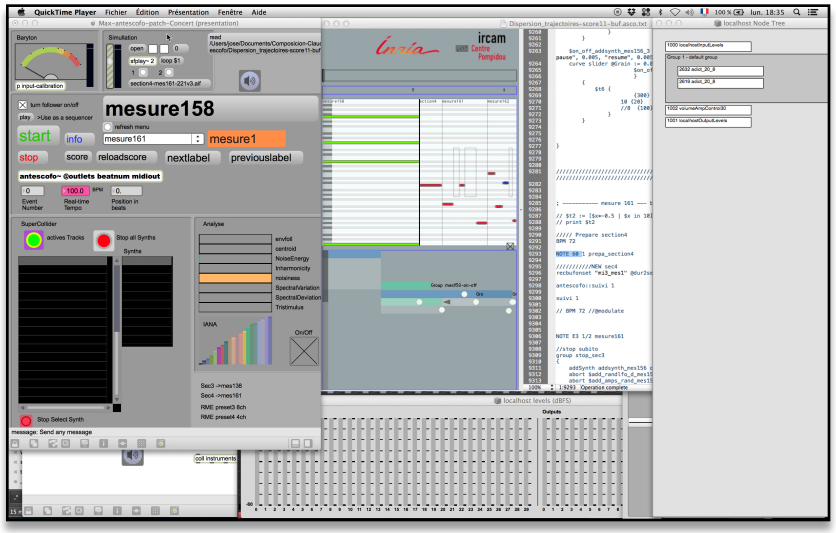


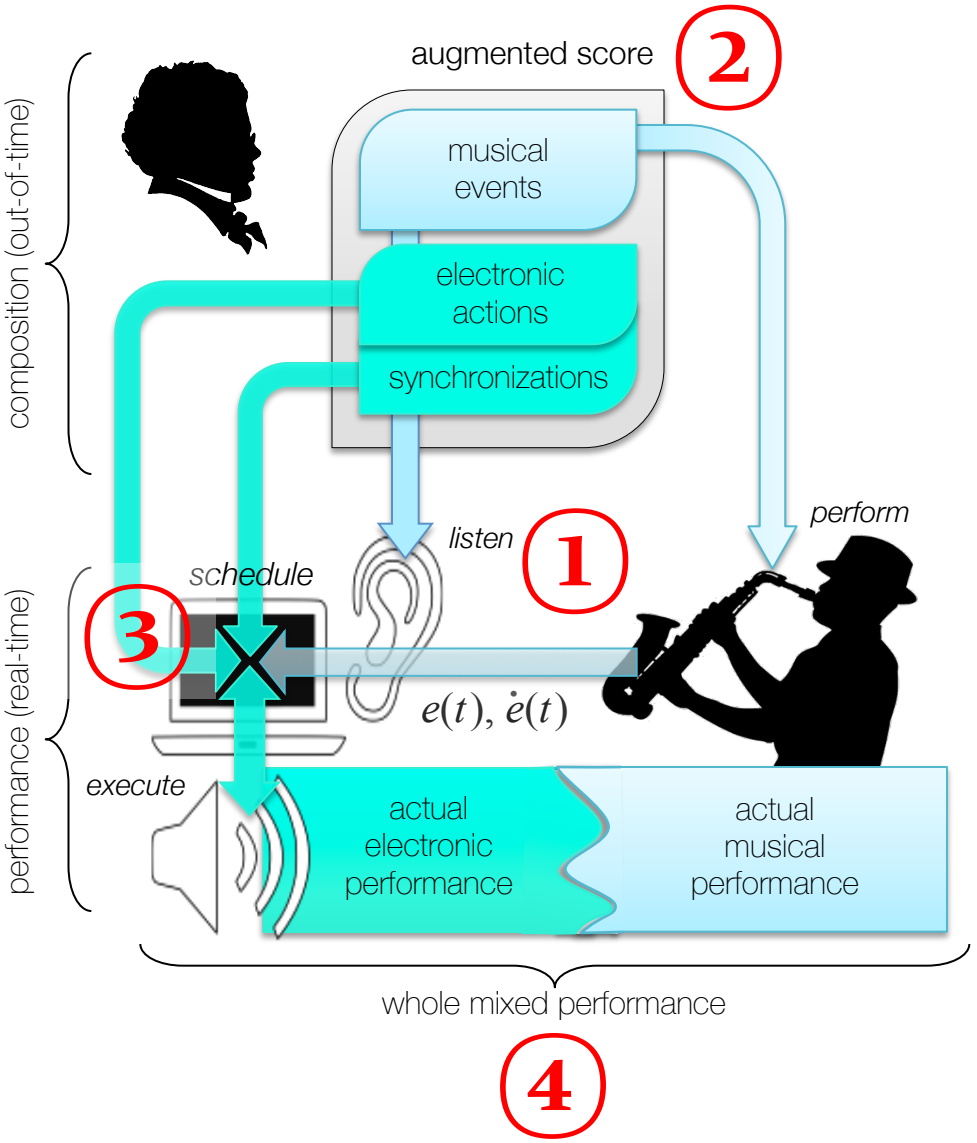


- notion**S** of TIME:
  - multiple times: deferred time, real-time
  - multiple models of time: event-driven, time-driven
  - multiple scales: from audio (0.02 *ms*) to control (*hours*)
  - time programmability: time is a denotable entity

reactive, strongly timed language + score following

Antescofo





A "Language Approach"

Authoring time:
- composition
- computing time

Author (composer)

write

Authoring time
in real-time

« read »

« eval »

« print »

Analysis

Perception

interactive scenario
open score, virtual
score…

Action

writer
pretty-printing

reader
parsing

Acquisition

interactive piece
mixed music,
time-art,
…

Production

Synthesis,
rendering

interact

Musicans
(& audience)

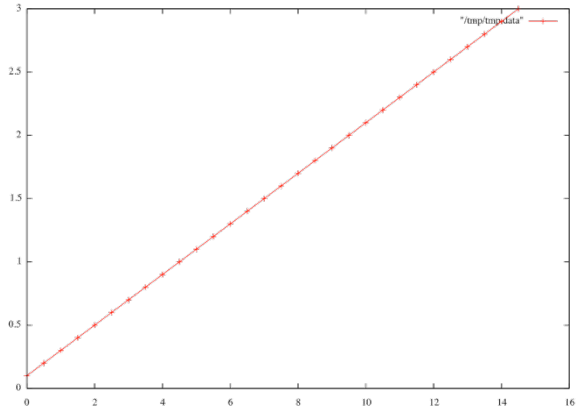
authoring interaction :
- performance
- computing in real-time

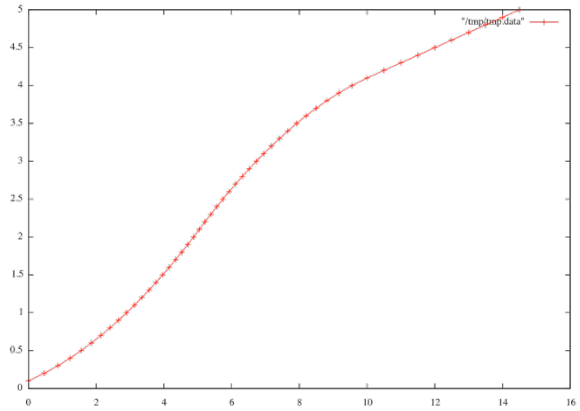
Programming

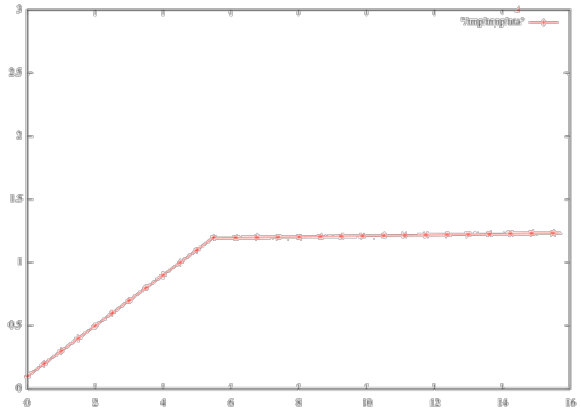
② TEMPORAL SCENARIOS

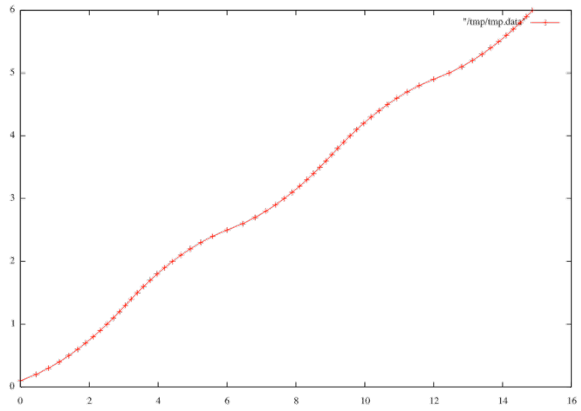
Strongly timed

- **event-driven system**
  - event from the listening machine
  - logical event
    - predicates on variables
    - begining or end of a computation (continuation)
  - introspective event
- **time-driven: computing with duration**
  - delay
  - continuous actions
  - relative time
    (dynamic) tempo
  - synchronization
    tempo + event

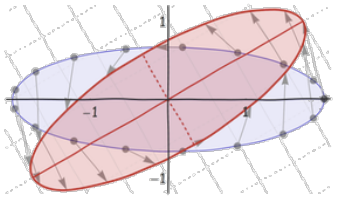






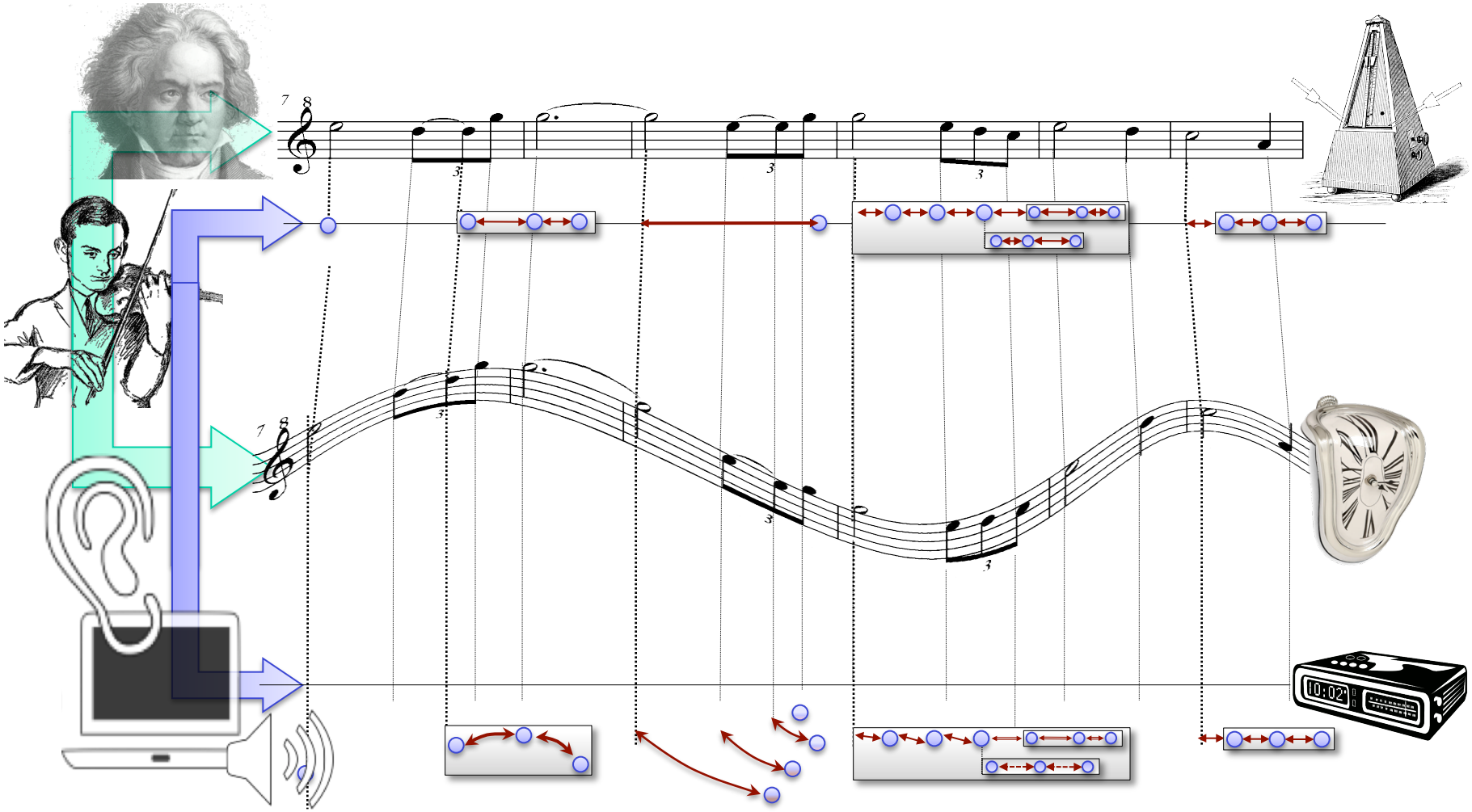


Strongly timed

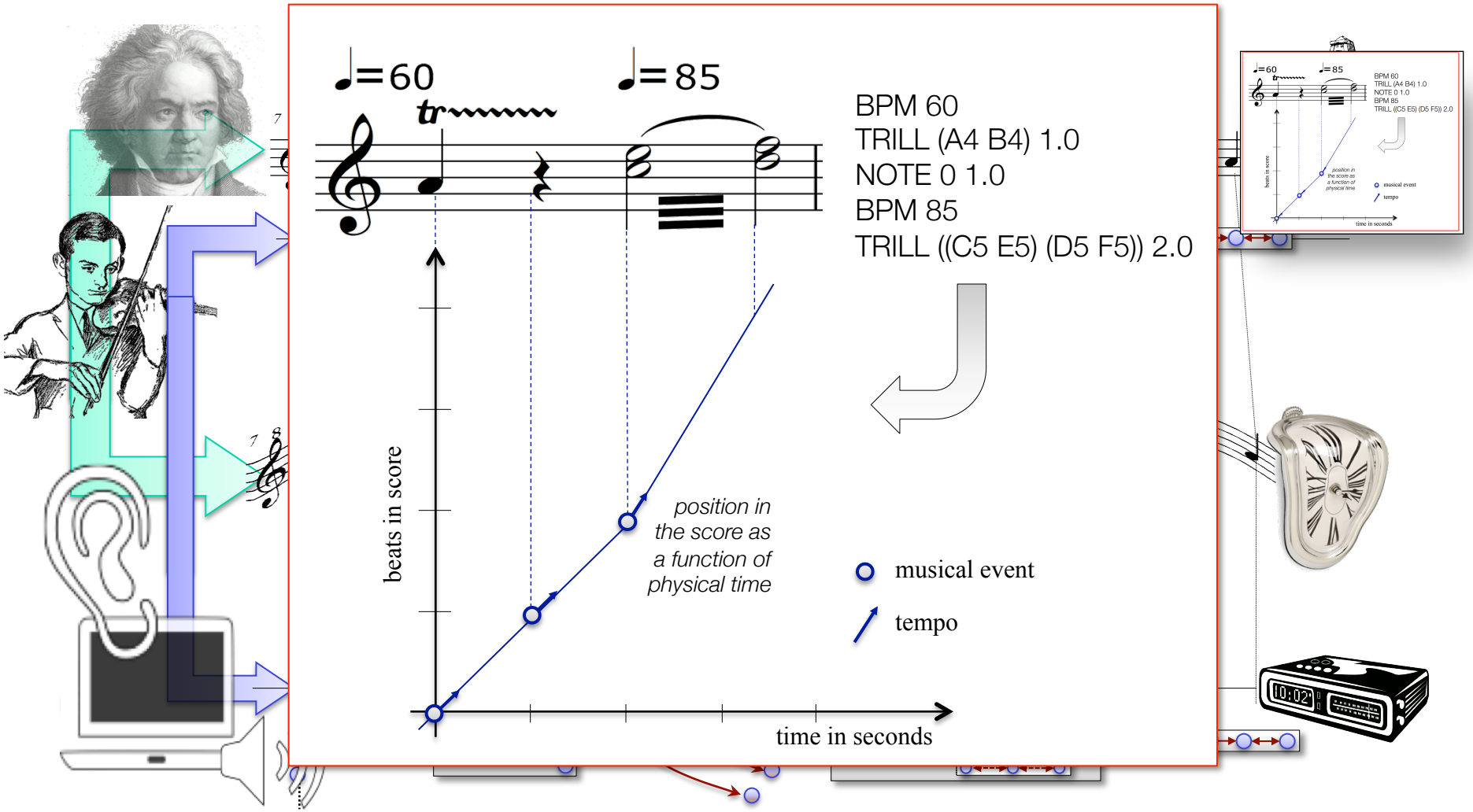


- time transformations are for Antescofo
  what changes of coordinates are for postscript…
- BUT
  - time is only spent in real-time
  - time is causal
    (I don't know the transformation in the future)
  - the transformation comes from the environment
    (synchronization)
  - transformations are not necessarily *newtonian*
    (when human is in-the-loop position ≠ ∫ tempo)

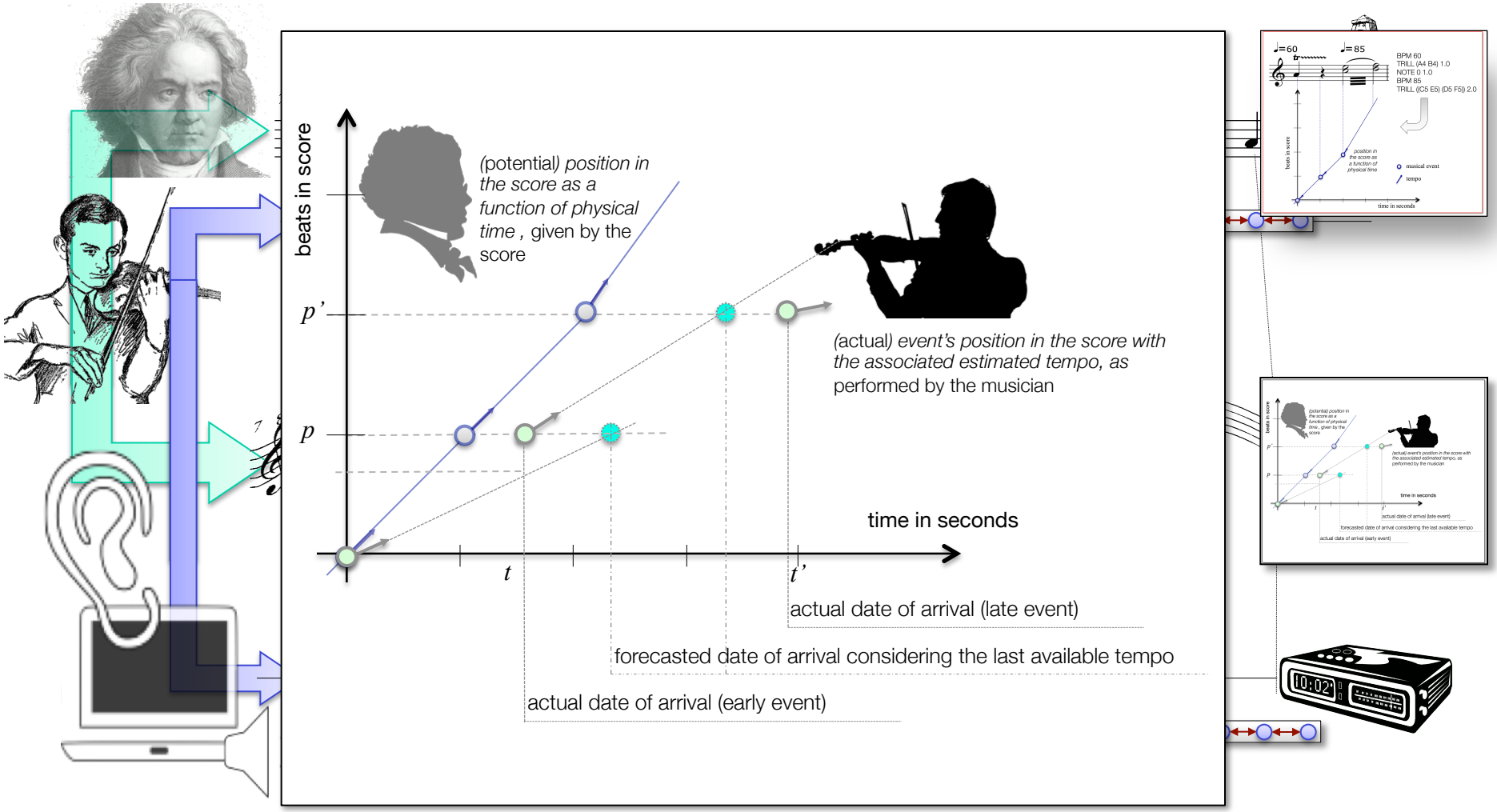
The Multiples Times of Temporal Scenarios



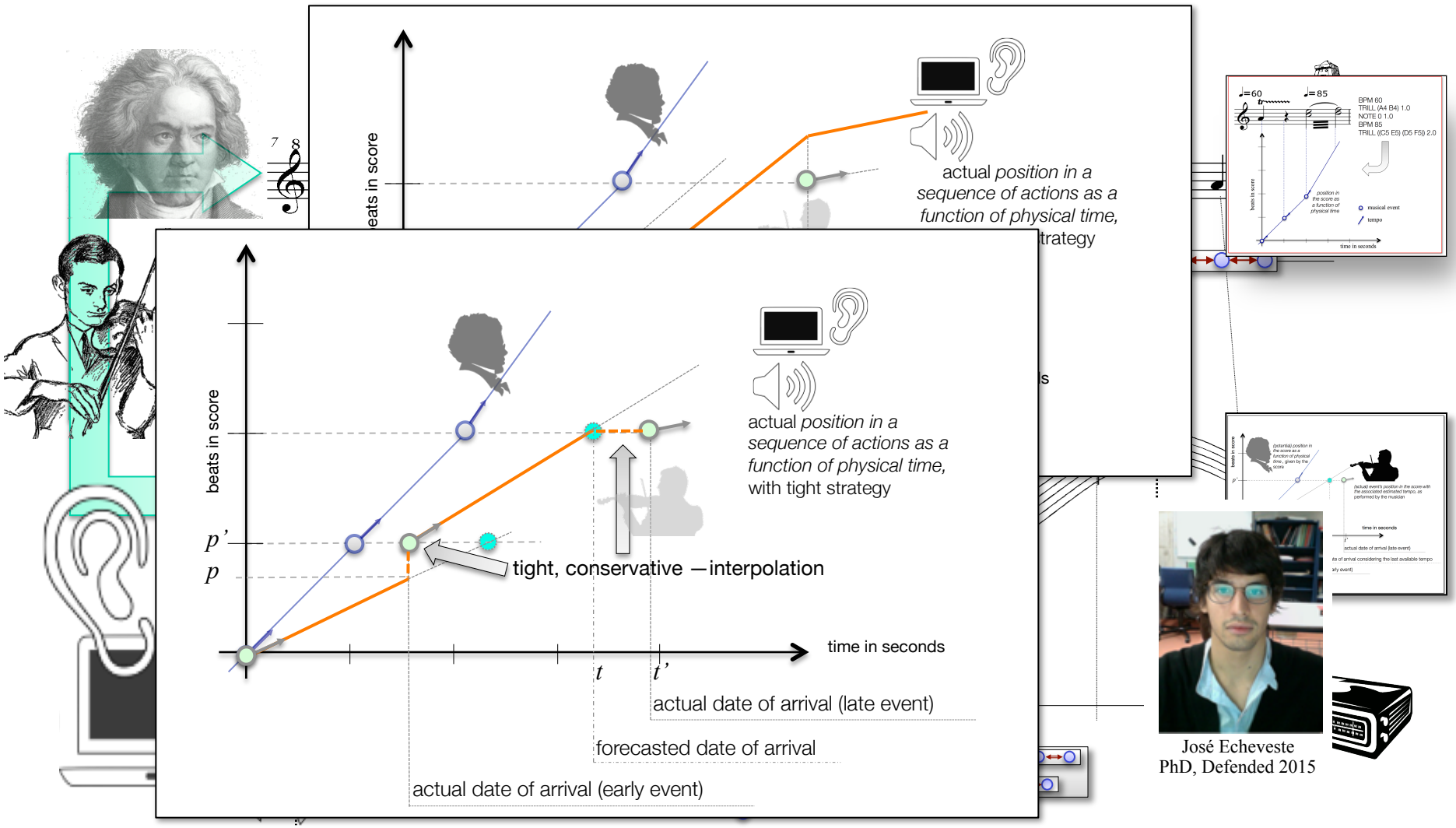
Time-time diagrams



Time-time diagrams



Time-time diagrams



José Echeveste
PhD, Defended 2015

Dynamic Target

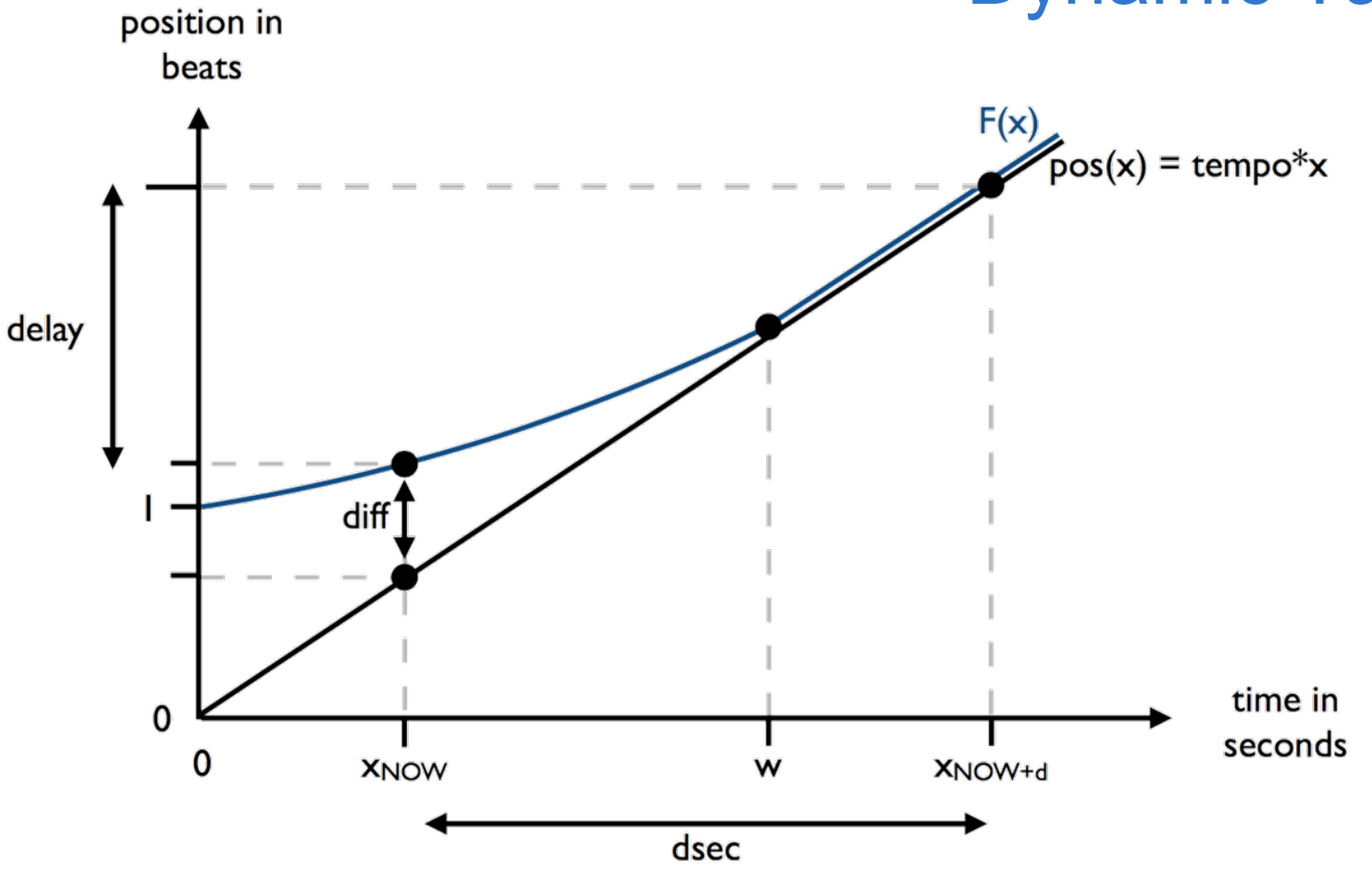
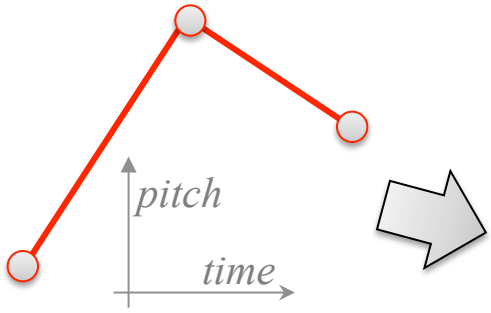


Fig. 10. Method used to compute a duration $dsec$ in seconds corresponding to a delay $delay$ in beats with a dynamic target $[w]$ and with a initial difference of position $diff = \tau.beatPos - position$. Function F represents the position in τ as a function of time x. It is made of two parts: a part G where the $\tau.tempo$ changes linearly until it becomes equal to $tempo$. From this time, F evolve as pos, with $\tau.tempo = tempo$ (a constant). Function G is the part of the parabola that goes from $x = 0$ to $x = w$. Because the origin is translated w.r.t. the origin of the physical time, the date x_{NOW} of the current instant is localized on the X axis by looking at the point which achieve the current difference $diff$.

Open Score in Antescofo

- real-time matching of temporal pattern

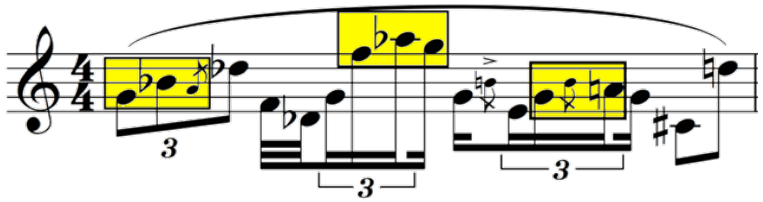


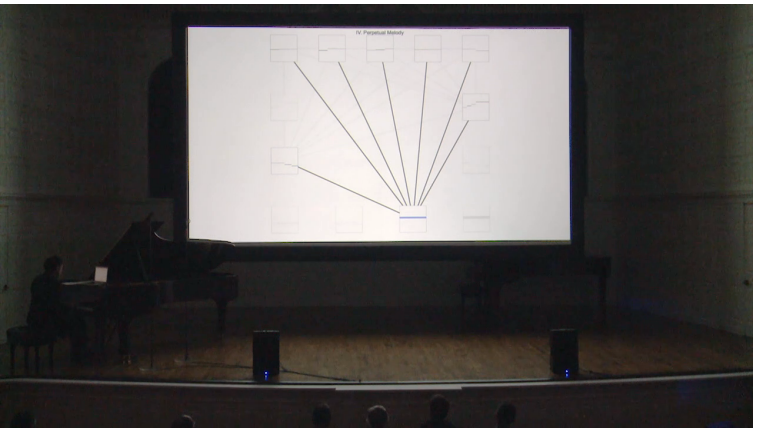
specification
(including durational properties)

```
pattern P
{
   @local $x , $y , $z
   NOTE $x
   before [0.5]
   NOTE $y where $x < $y
   before [0.5]
   NOTE $z where ($y>$z) & ($z>$x)
}
```

Real-Time Matching of Antescofo Temporal Patterns, Jean-Louis Giavitto, José Echeveste, ACM PPDP 2014, 2014.

compilation
&
on-the-fly matching



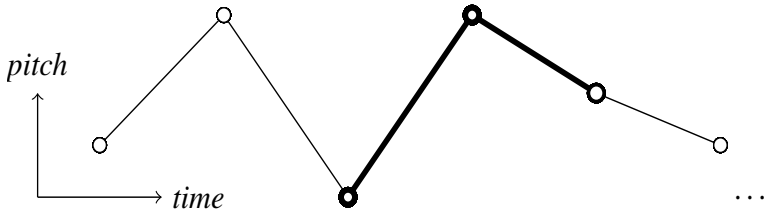


- dynamic non-deterministic score

Jason Freeman (GeorgiaTech) *Shadows,* 2015.

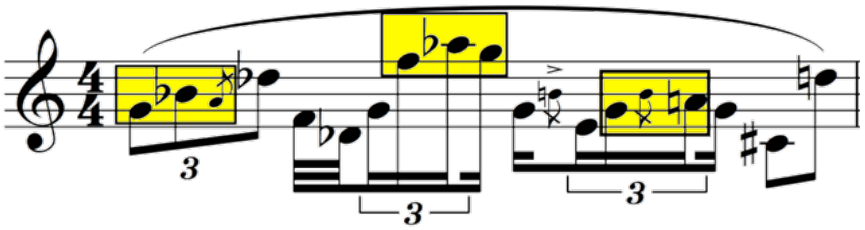
Real-Time Matching a Temporal Pattern

Real-Time Matching of Antescofo Temporal Patterns,
J.-L. Giavitto, J. Echeveste,
ACM PPDP 2014, 2014.



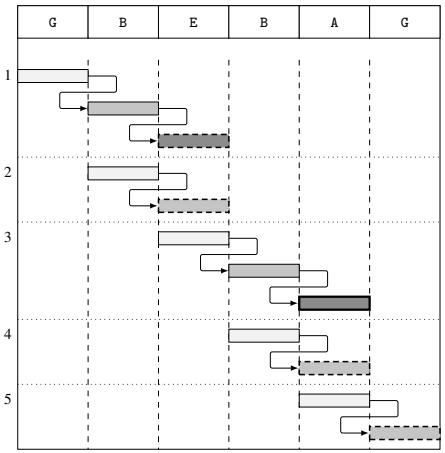

```
pattern P
{
   @local $x , $y , $z
   NOTE $x
   before [0.5]
   NOTE $y where $x < $y
   before [0.5]
   NOTE $z where ($y>$z) & ($z>$x)
}
```

compilation & on-the-fly matching




```
1  whenever ($PITCH) {
2    @local $x
3    $x := $PITCH
4    whenever ($PITCH > $x) {
5      @local $y
6      $y := $PITCH
7      whenever ($PITCH<$y & $PITCH>$x) {
8        @local $z
9        $z := $PITCH
10       a
11     } during [1#]
12   } during[1#]
13 }
```

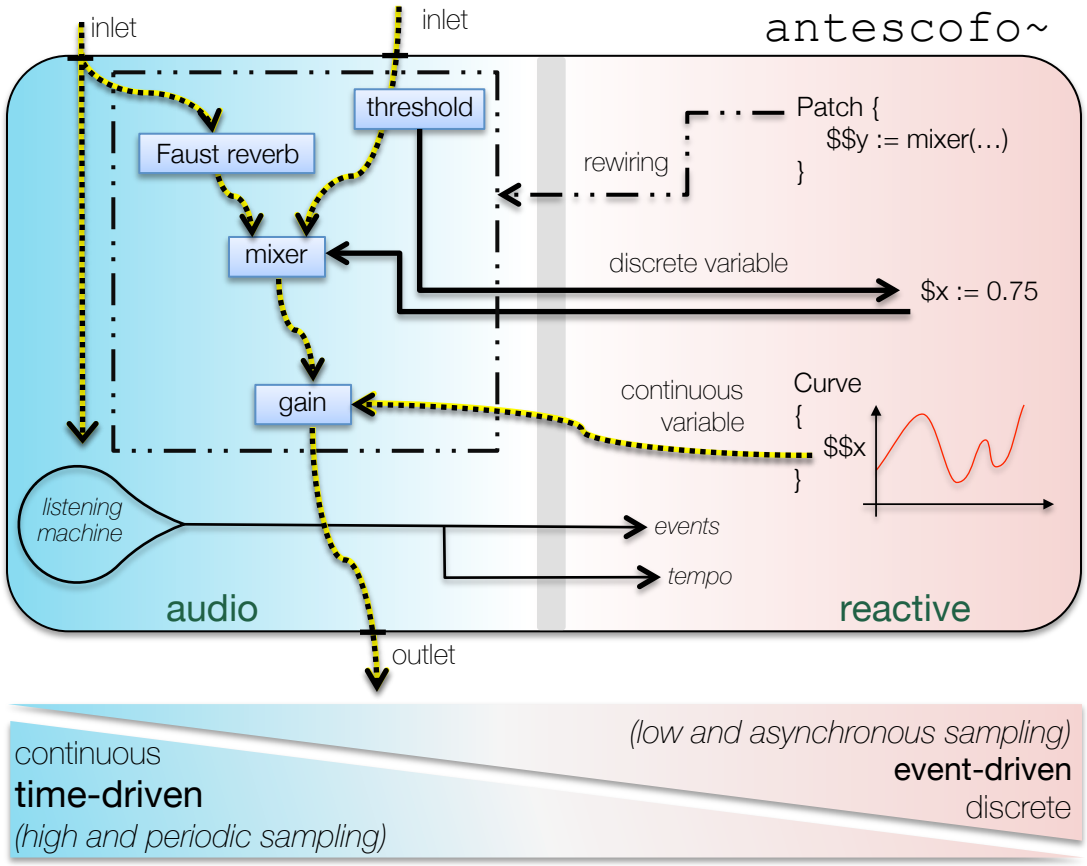
temporal patterns

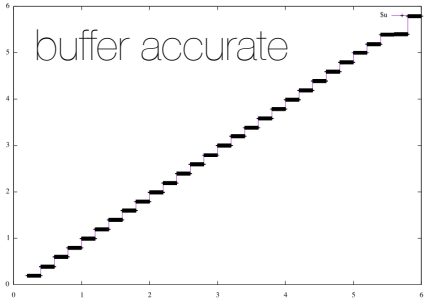


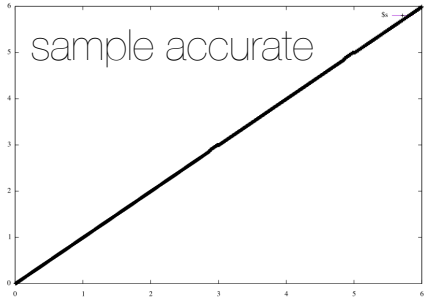
③ REAL-TIME SCHEDULING

Embedding audio in Antescofo

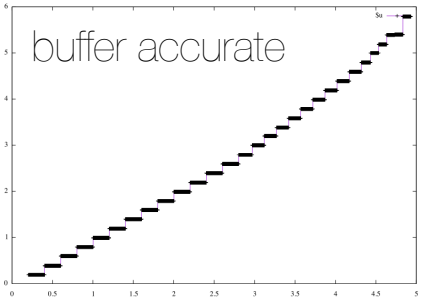
- audio effects written in FAUST + specifics (FFT)
- compiled on-the-fly
- 40% cpu improvement on the remake of *Antheme2*
- new hybrid scheduling
- sample accurate for curve → audio
- sample accurate for audio → control
- buffer accurate elsewhere

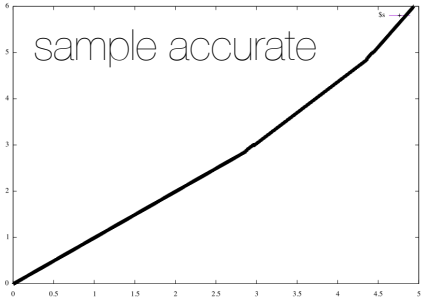






relative time

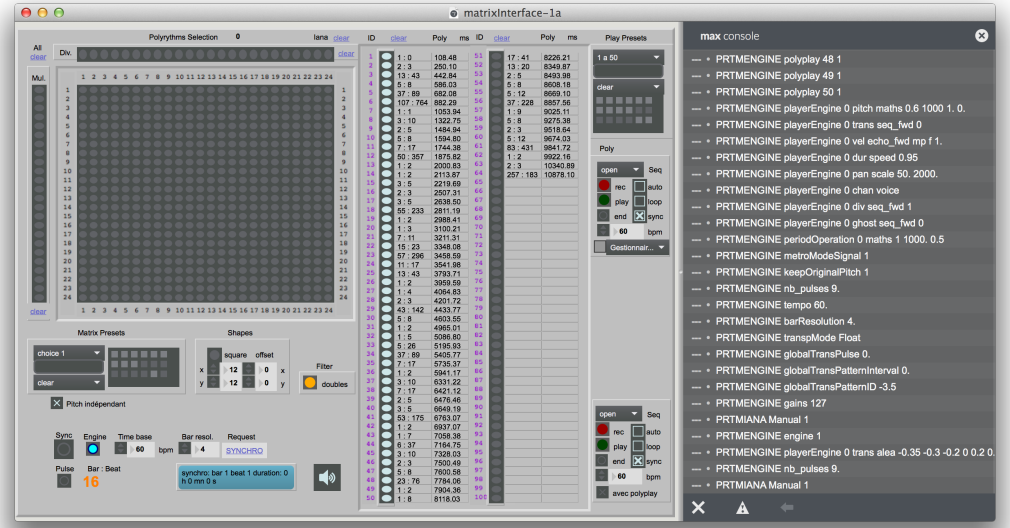


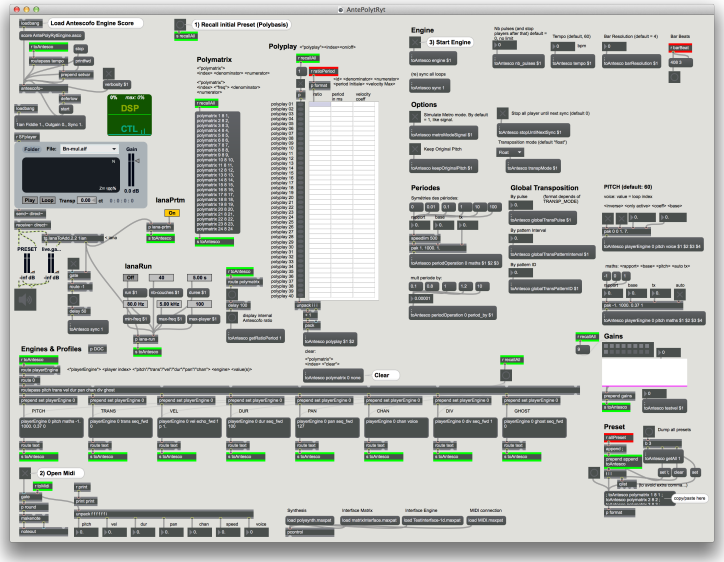


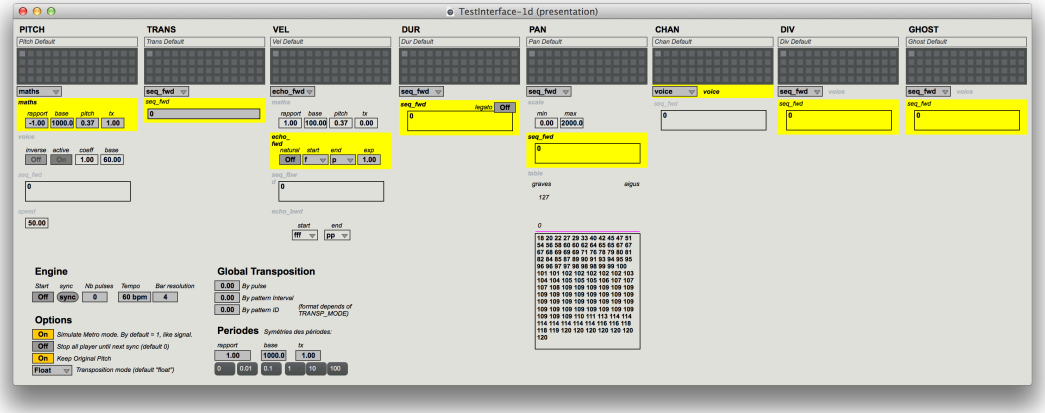
physical time

④ ARTISTIC APPLICATIONS

Yan Maresz *Polyrythmic machine* in Antescofo

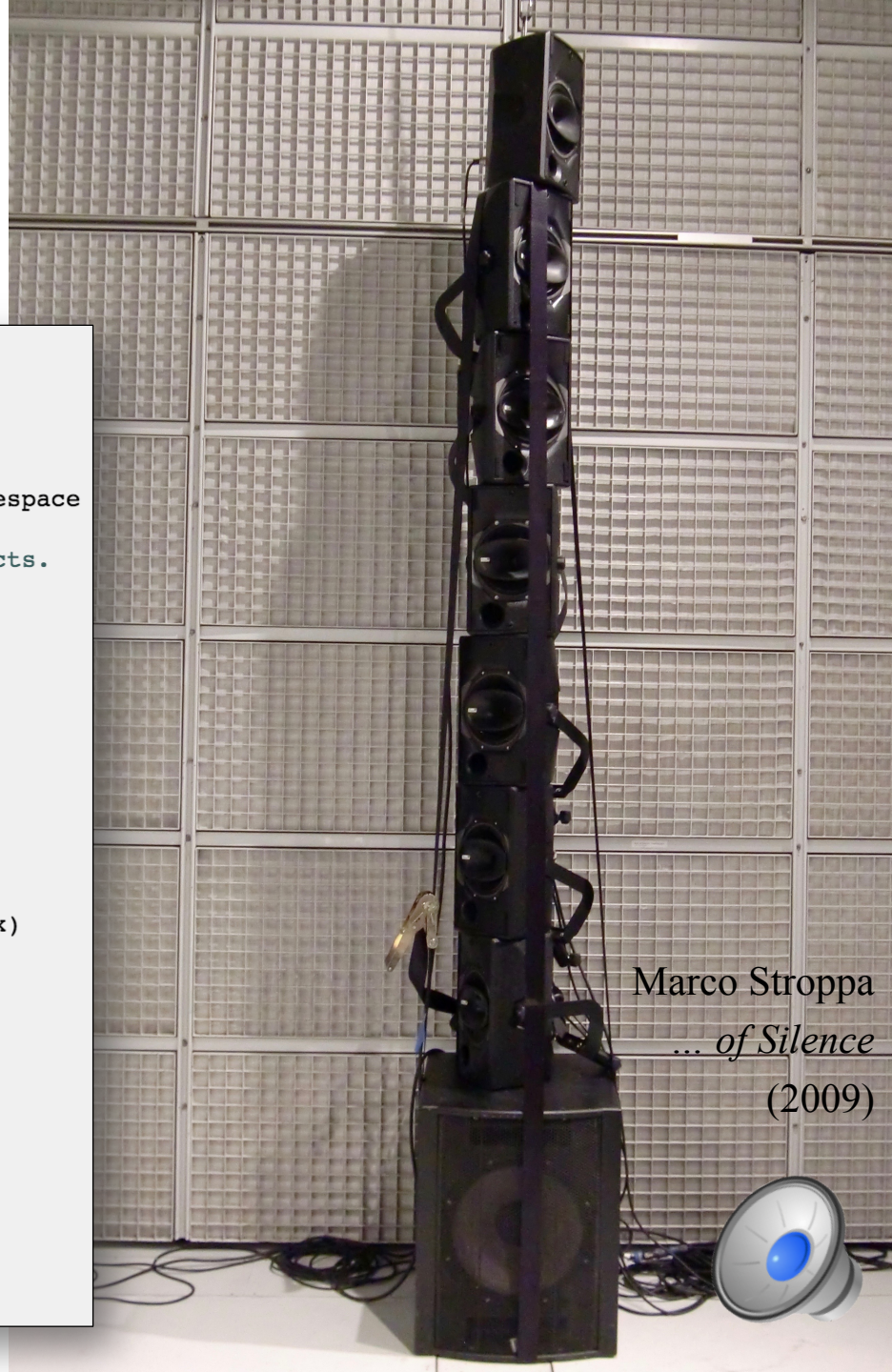




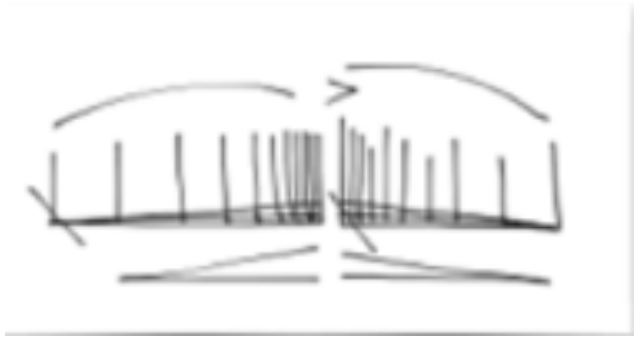


Marco Stroppa
Antescofo library for totem control

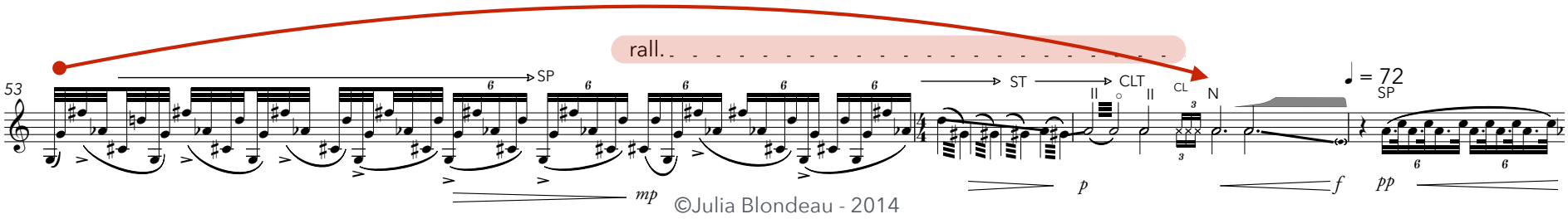
```
; SOURCE Object Definition

@obj_def source($idn, $npoints, $namespace)
{
    ; local state
    @local $coordinates, $idnum, $last_action, $prefix_namespace

    ; A broadcasted signal to all instances of source objects.
    @broadcast reset()  { abort $last_action }

    // …

    ; igoto method will create a curve that goes
    ; from $coordinates to $destination in $dur time
    @proc_def igoto($destination, $dur, $itp)
    {
        curve FlyingEngine   @Grain := 0.05s,
          @Action := {
              $coordinates := $x
              @command($prefix_namespace+$idnum+"-spat") ($x)
          }
        {
            $x
            {
                        { ($coordinates) } @type $itp
                $dur    { ($initlevels($destination)) }
            }
        }
    }

    // …
}
```



Julia Blondeau
Phrasé



```
NOTE D4 1/6 mes52

Curve tempCouchT3 @grain := 1/12
    { $tempCouchT3
        {       { ($RT_TEMPO-5) } @type "cubic"
            2   { ($RT_TEMPO+40) }
            1/3 { ($RT_TEMPO-40) }
            1/2 { ($RT_TEMPO+30) }
            1/2 { ($RT_TEMPO-15) }
            1/2 { ($RT_TEMPO+20) }
            1/2 { ($RT_TEMPO-15) }
            3/2 { ($RT_TEMPO+20) } @type "cubic"
            7/3 { ($RT_TEMPO+60) }
        }
    }

GROUP CoucheT3 @target {mes53,sync53,mes54,sync54_1,sync54_2,sync54_3,mes57}
    @tempo := $tempCouchT3
    {
        ::SPAT_lissaj3("SPAT7",1.5,12,0)
        curve ampexplo @grain := 0.05s
            {$ampexplo
                {       { 0.08 } @type "cubic"
                    2   { 0.19 } @type "cubic_out"
                    2   { 0.09 }
                    2   { 0.23 }
                    2   { 0.09 }
                    3   { 0.05 }
                }
            }

        ::ASCOtoCS_points("i33",1/8,$ampexplo,0.9,62)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,87)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,91)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,67)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,73)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,98)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,92)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.6,103)

        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.9,102)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.9,84)
        1/8 ::ASCOtoCS_points("i11",1/8,$ampexplo,0.9,73)
```



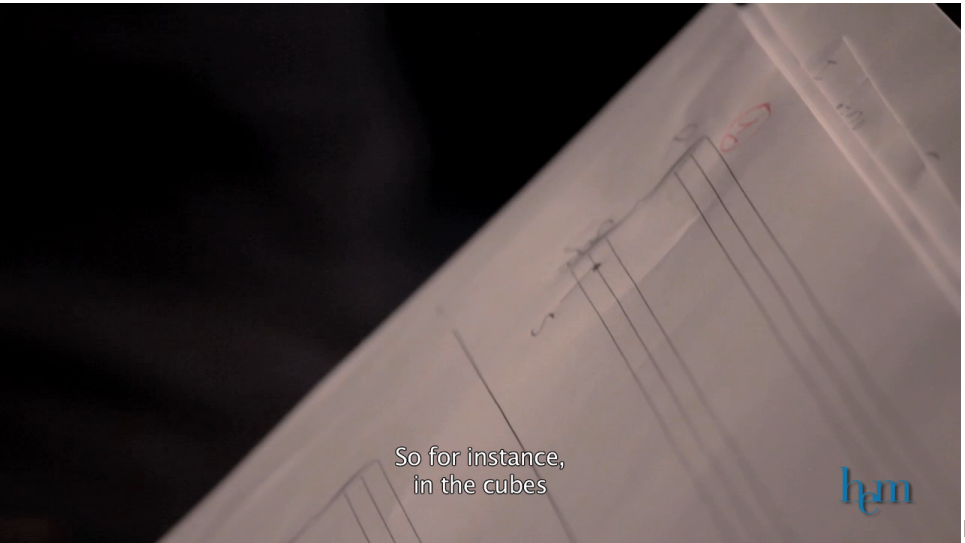
José-Miguel Fernandez
gesture-driven synthesis

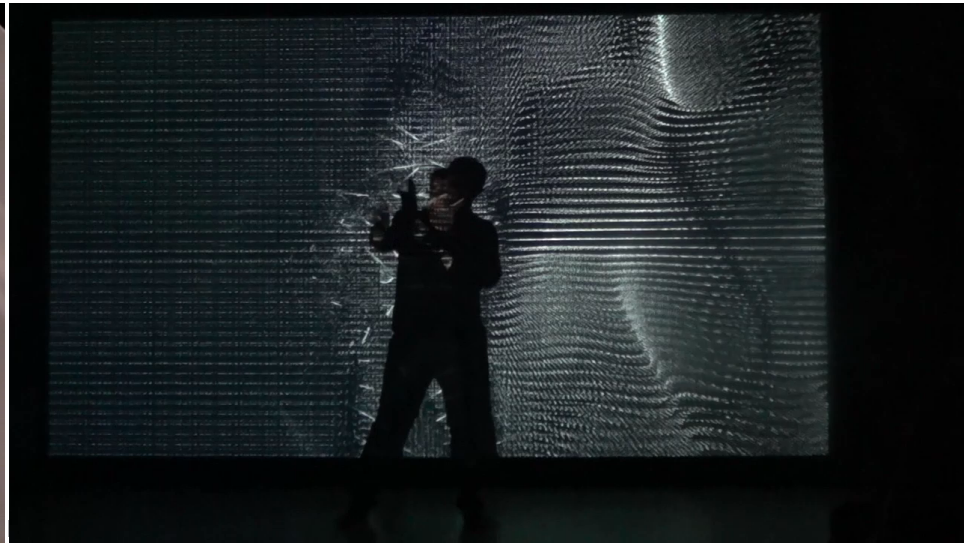
OSC *or* setvar

GeKiPe (Gest Kinect Percussion),
Philippe Spiesser (percu),
Alexander Vert (composition),
Jose Miguel Fernandez (RIM)

Haute école de musique
Genève

Hypersphère, Jose Miguel Fernandez,
séance de travail IRCAM 26/2/16





PERSPECTIVES

Perspectives

The Augmented Score

- temporal scope as denotable value
- musical gesture
- embedding composer specific languages (idiosyncrasy)
- abstraction
- durative *vs* continuous computations

Next Generation of IMS

- offline and online score analysis
- offline and online score scheduling
- real-time score execution at sample accuracy
- extensible-, distributed-architectures for interactive music systems (ex.: VST, RTAS, audio plugins)

Digital Preservation

- compilation

Beyond Music

- cyber-temporal systems: exploring other highly timed interactive scenarios (**Robotics**, Domotics)
- Programming with Perceptual Concepts
- other sensing devices/listening machines