

Dynamic Language for Musician-Computer Interaction

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<http://repmus.ircam.fr/mutant>





Departments

- R&D (9 teams)
- Production & Diffusion
- Educational & Cultural Outreach
- Multimedia Library
- Research/Creativity Interfaces



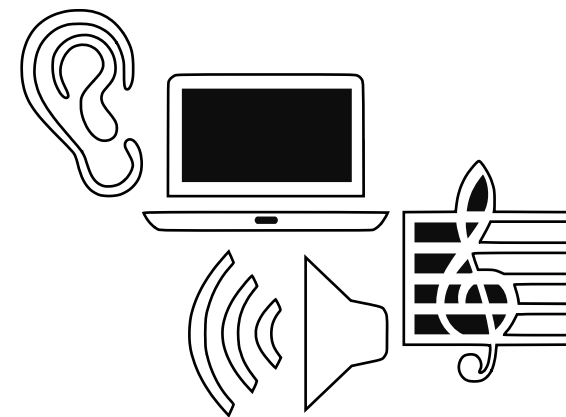
> 180 collaborators

- ~ 65 researchers
- 20 PhD students
- 20 Composition students
- 15 invited scholars
- 25 internships
- Composers, Artists, etc.

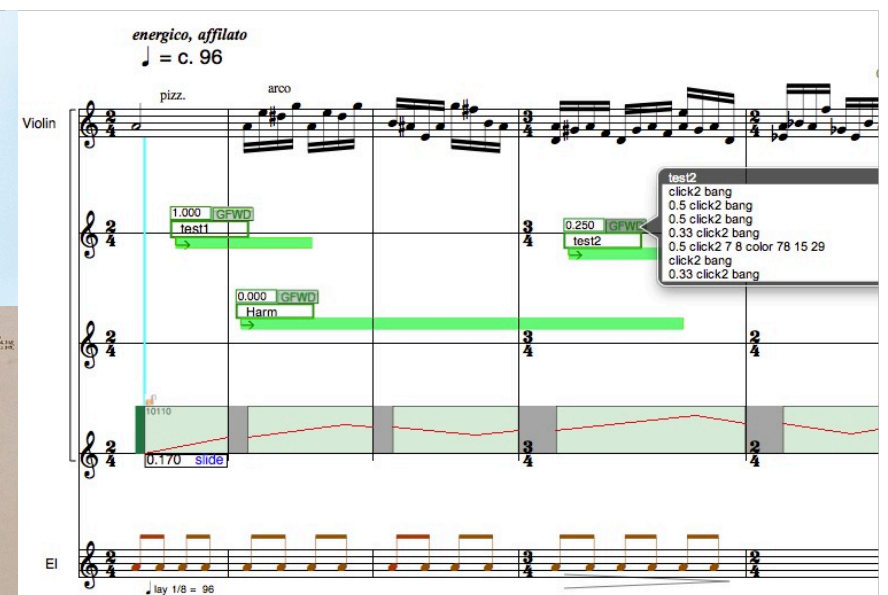
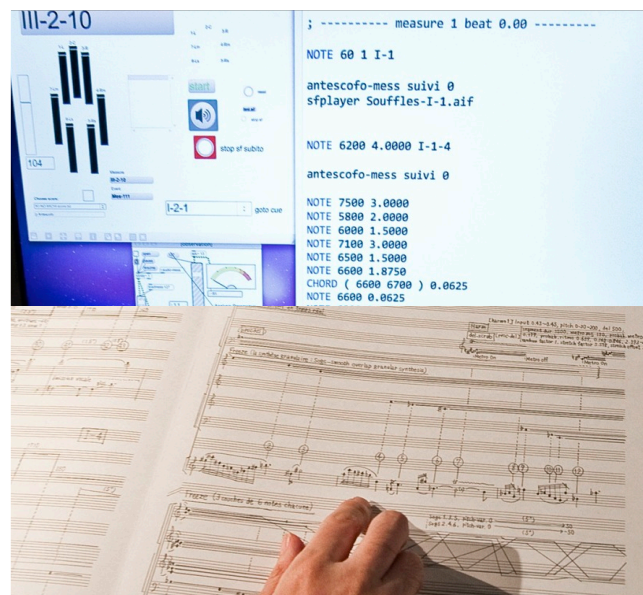
Mixed Music



Interpretation / Realtime

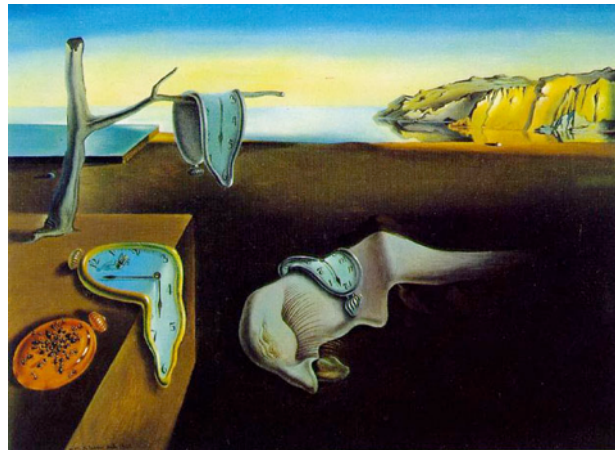


Composing / Programming



Musical Times

- Elastic time

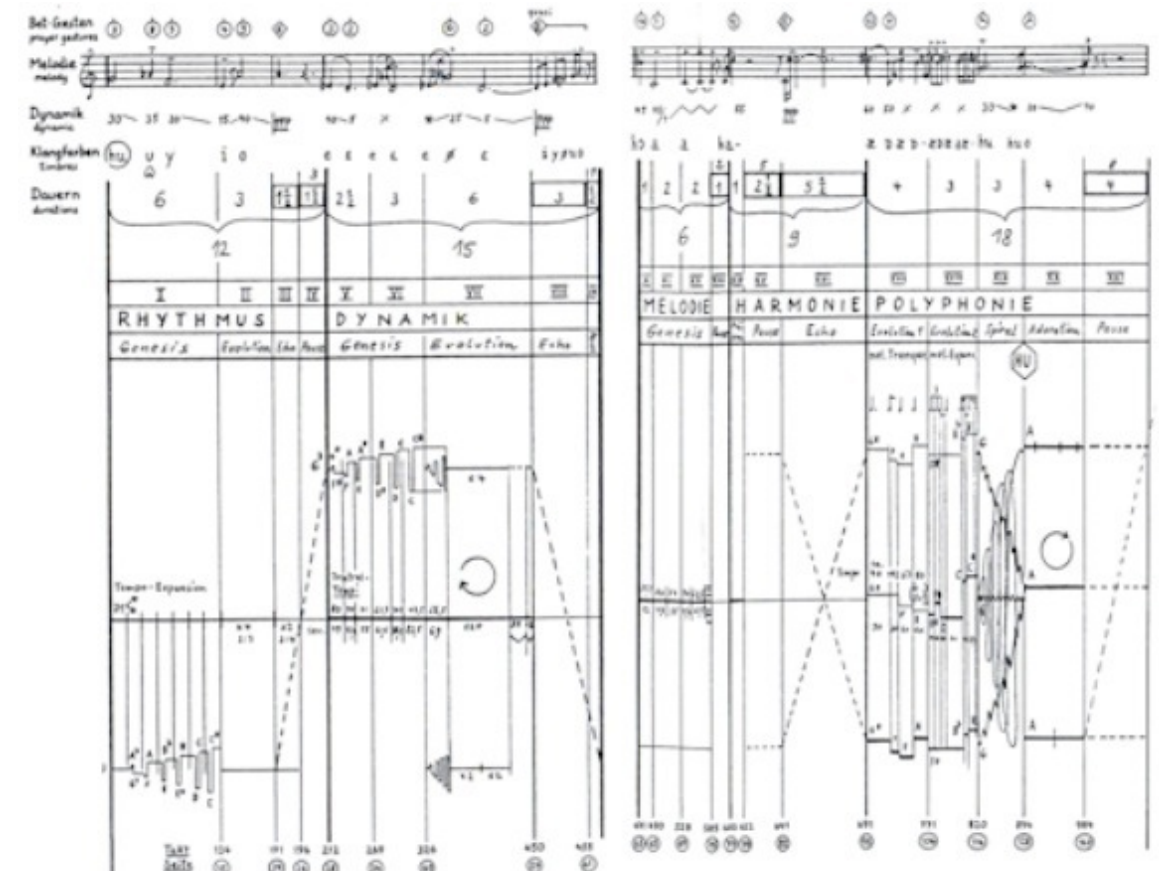
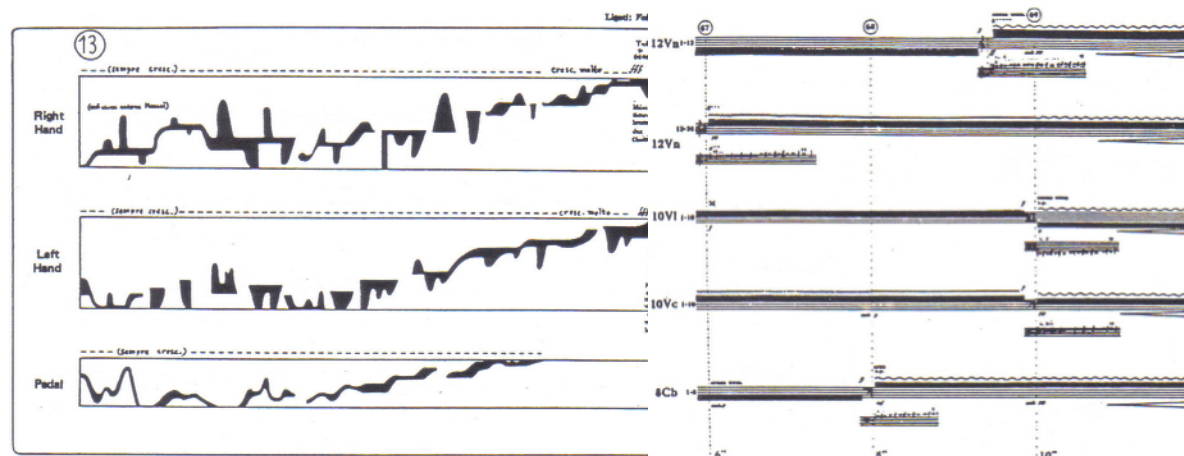


Fuga IV a 5 voci

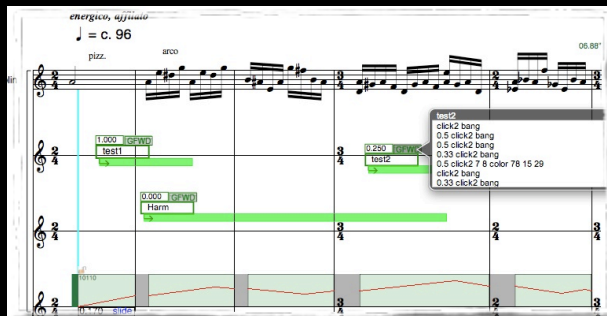
Johann Sebastian Bach (1685–1750)
BWV 849



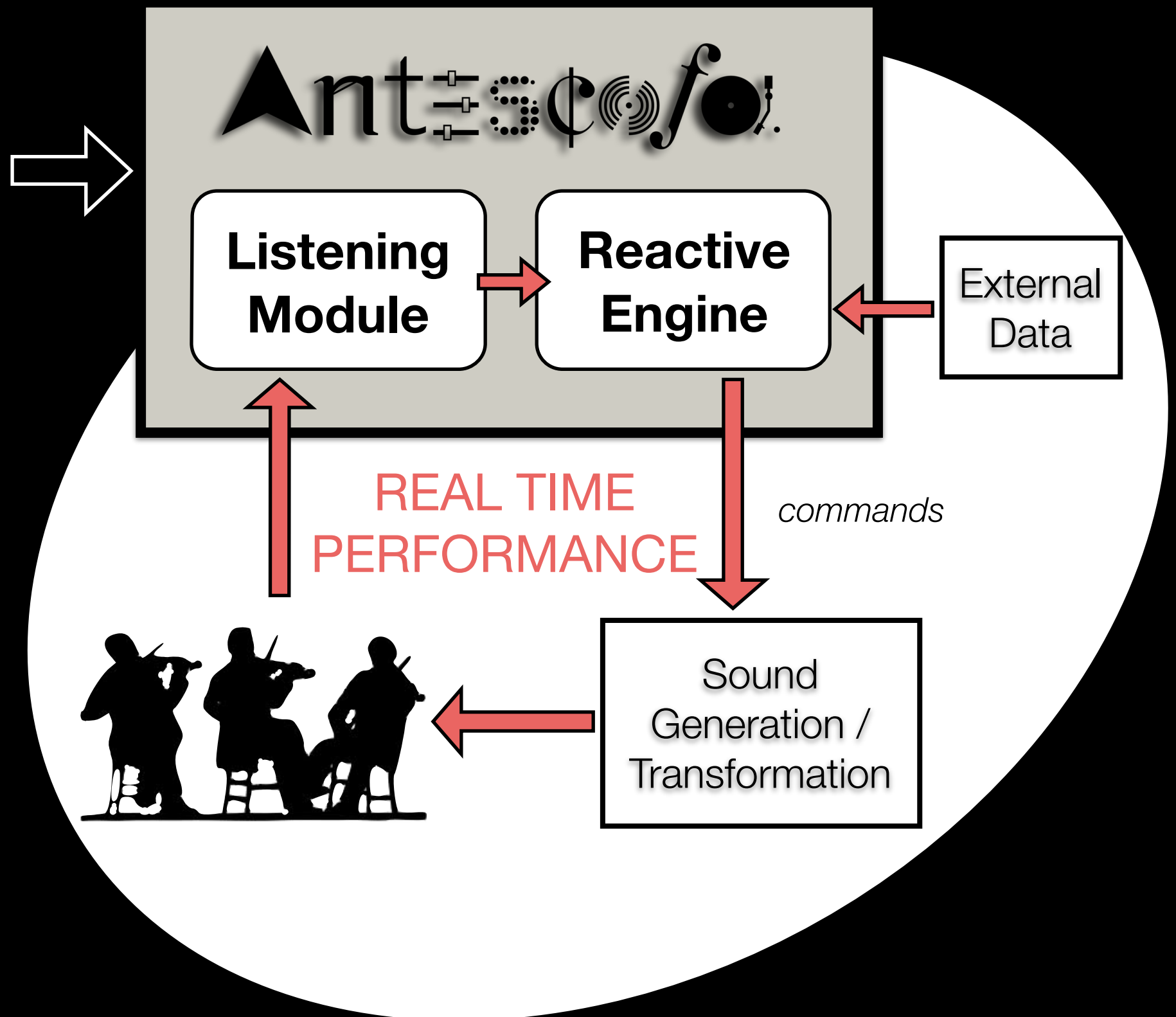
- Heterogeneous Times



Stockhausen: Inori one or two soloists with orchestra



COMPOSITION
TIME



contemporary music

<http://vimeo.com/90623564>



Antescofo

automatic accompaniment



<https://www.youtube.com/watch?v=iN9MmiSIBj0>

improvising electronic music



<http://vimeo.com/83860325>

Writing electronic

Anthèmes 2 (Pierre Boulez)

Libre brusque
(♩ = 92)

Pierre Boulez
(*1925)

(♩ = 92) *rall.* (♩ = 66)
batt. (archet normal)

Violon
f *fff* > *mf* < *ff*

Spatialization
F -11/-18/-18/2.0

Inf. Rev.
reverb. time: 60"

Spatialization
F -11/-18/-18/2.0

Sampl. IR
MIDI: 93.90 85.94 82.80 75.77 75.74
reverb. time: 60"

Spatialization
F -11/-18/-18/2.0

Sampler
MIDI: [74.73 70.69 68.67 66.63]
pizz. = 93 msec.

Spatialization
MR -4/-12/-24/2.0

Freq. Shift.

Spatialization

Anthèmes 2
by Pierre Boulez
Max/MSP program by Andrew Gerzso
Antescofo Integration by Arshia Cont
© 2009 IRCAM & Andrew Gerzso

IRCAM

p Controls
p DSP
p Spat
p Synth

Yielin

Transformation Outputs

CPU 32. %

Spatialization Outputs

Stereo Mix

Score Following with Live Electronics

Antescofo~

Tempogram

START STOP

Anticipatory Score Following, v0.35, Arshia Cont.

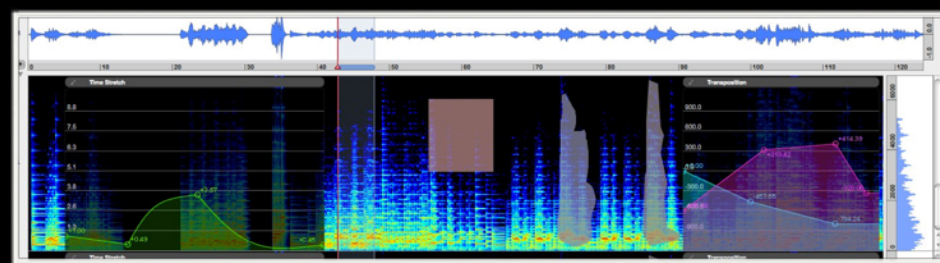
actions on nextlabel
actions off nextfreq
version

Event Position Real-time Tempo Event Label Beat Position Anticipated duration

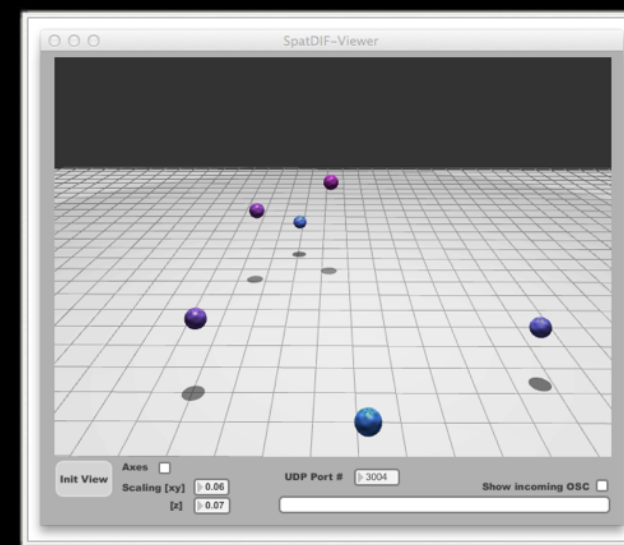
https://www.youtube.com/watch?v=HSab_znc_y8



Gesture

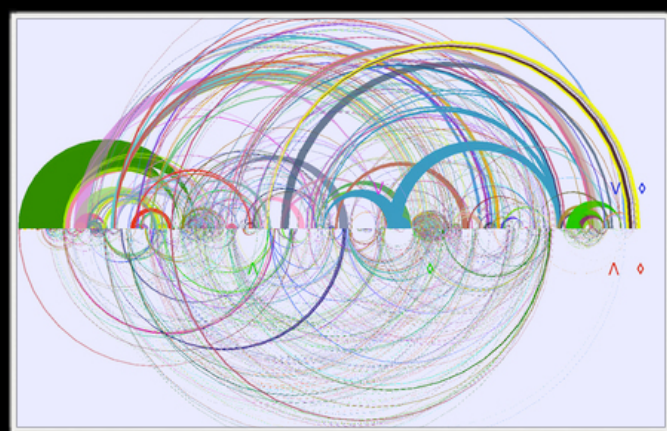


Audio Analysis/Synthesis

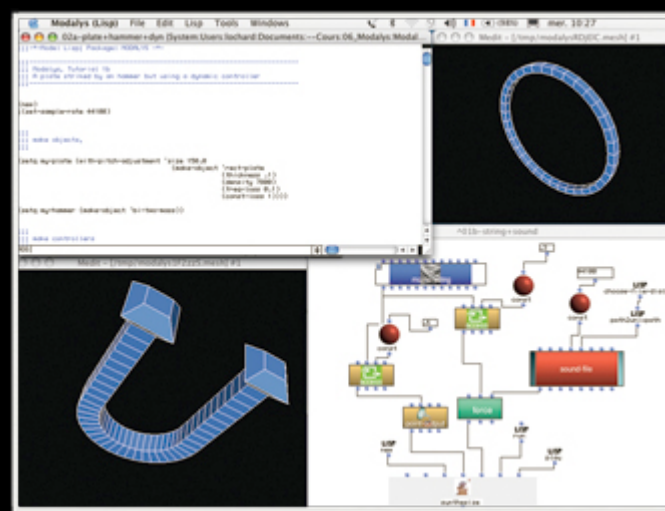


Spatialization

AnteCof



Improvisation



Physical Models



MIDI / Control

More than 50 Creations

New York Philharmonics, Chicago Symphony, Los Angeles Philharmonics, Berlin Philharmonics, BBC Orchestra, ...

Antescofo language

- musical scenarios description
- reaction to discrete event
- management of dynamic duration
- strong coupling with the listening machine
- synchronization strategies
- errors management
- imperative style

simple example

Performer events

Electronic actions



The image shows a musical score with two staves. The top staff is labeled 'Performer events' and the bottom staff is labeled 'Electronic actions'. The electronic actions are divided into two groups: a red group and a blue group. The red group contains two measures of a sixteenth-note triplet and a quarter note. The blue group contains two measures of a quarter note. The entire electronic actions section is enclosed in a green box.

Writing parallel and
hierarchical phrases

NOTE Ab4 1/2
NOTE Db5 1/2

```
loop 2.0 {  
  group {  
    1/6 play Ab3  
    1/6 play F4  
    1/6 play Db4  
    1/6 play Ab4  
    1/6 play F4  
    1/6 play Db5  
    1/2 play Ab4  
  }  
  loop 1.0 {  
    0.0 play Db3  
    1/2 play F3  
    0.0 play Ab3  
  }  
}
```

NOTE Db5 1/2
NOTE F5 1/2
NOTE F5 1/2
NOTE Db5 1.0
NOTE Ab4 1/2
NOTE 0 1/4
NOTE Ab4 1/4

Syntax

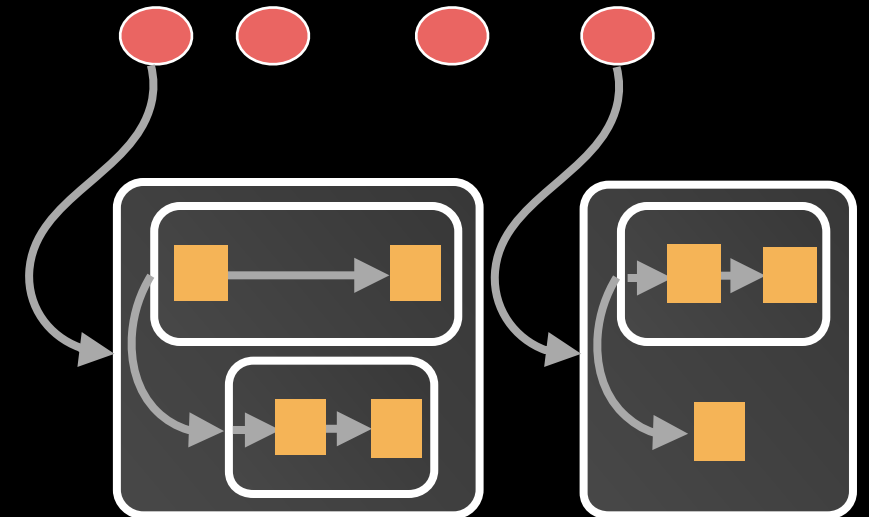
● events:

■ atomics actions:

... structured actions:

NOTE 60 2.0
CHORDS (66 43) 2.0

`$v := @sin($x)`
`superVP ($v+3)`



```
group {
  a_name arg1 arg2
  2.0 a_name2 arg21
}
```

```
loop 3.0 {
  a_name arg
} during [6#]
```

```
curve @grain 0.1s
  @action synth $x
{
  $x { 0.3
      4s 0.9 }
}
```

```
whenever ( $y > 3.0 ) {
  print «$y = » $y
}
```

```
@proc_def ::my_proc($p)
{
  loop 2.0 {
    actions...
  } during [2#]
}
```

↕
::my_proc(\$p)

durations & delays are expressed

- in seconds or
- in **beats** depending on **global** or **local tempo**

NOTE C4 2.0

```
(1/4 + 1/8) action1  
1/4 s          action2
```

NOTE D4 1.0

```
group @tempo = ( $RT_TEMPO * 2 )  
{  
    action_group1  
    1/2 action_group2  
    $v  action_group3  
}
```


expressions

► values:

`int - float - bool - string - tab - map - function - process`

► variables:

history:

```
[ 2# ] : $v
```

```
[ 2.5 ] : $v
```

```
[ 3s ] : $v
```

```
@date( [ 2# ] : $v )
```

```
@rdate( [ 2# ] : $v )
```

\$v	.	43	52	53	49
timestamps in beats	0.0	1.0	2.5	4.0	5.5
timestamps in sec	0.0	2.3	4.2	5.9	7.5

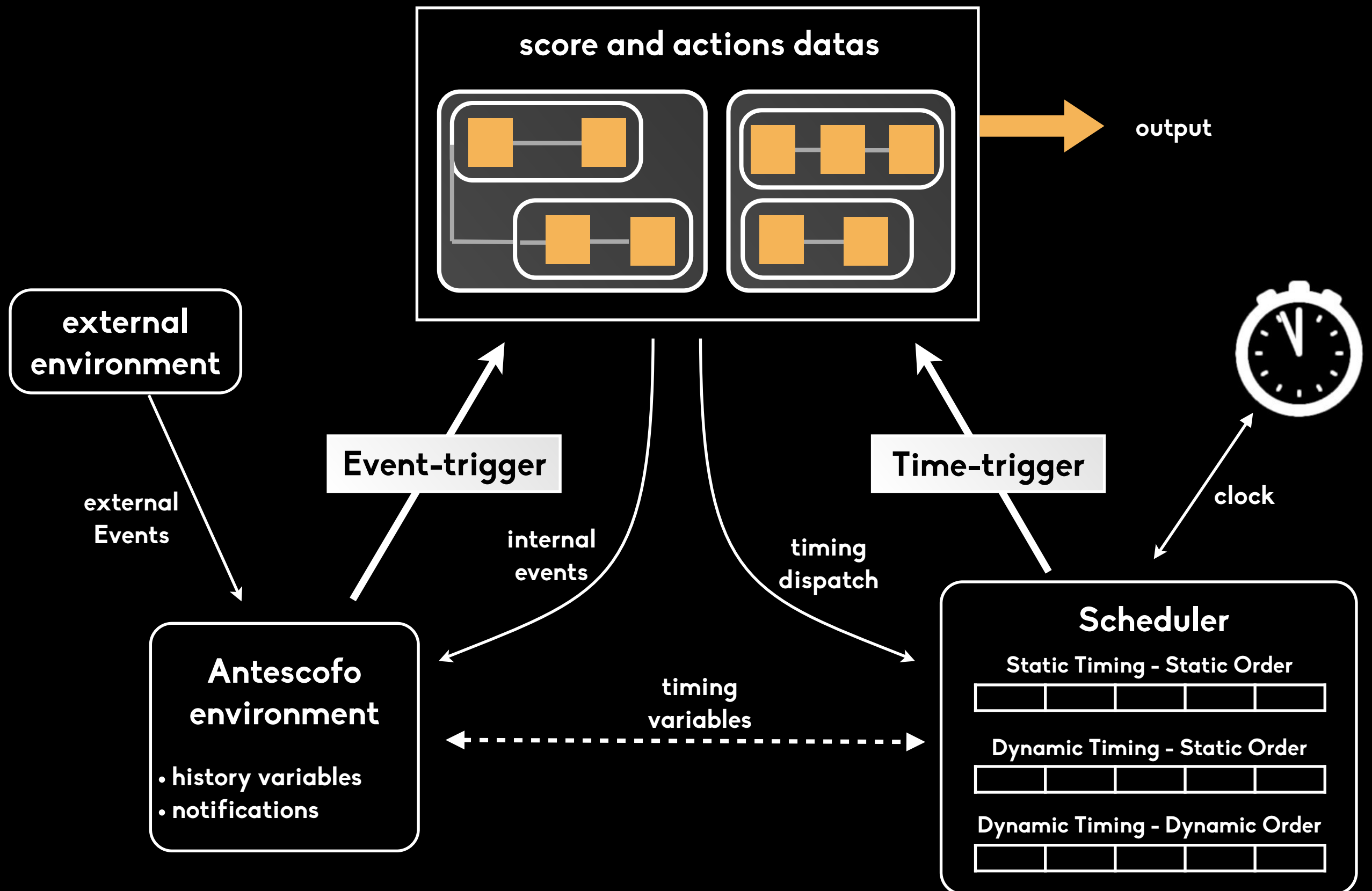
system variables:

`$RT_TEMPO - $NOW - $RNOW - $PITCH - etc.`

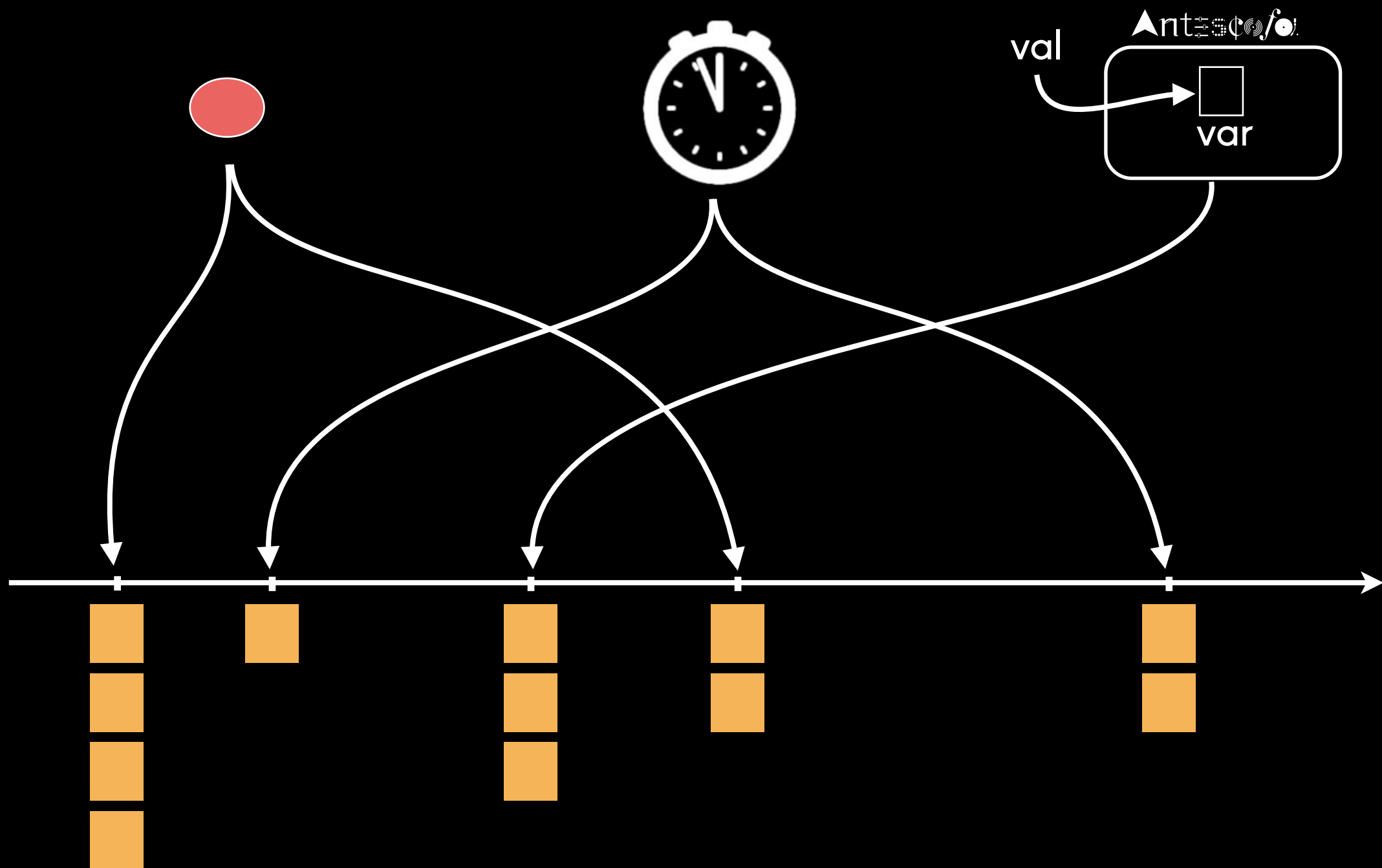
► operators and functions:

`@sin - @exp - if( ... , ... , ... ) - etc.`

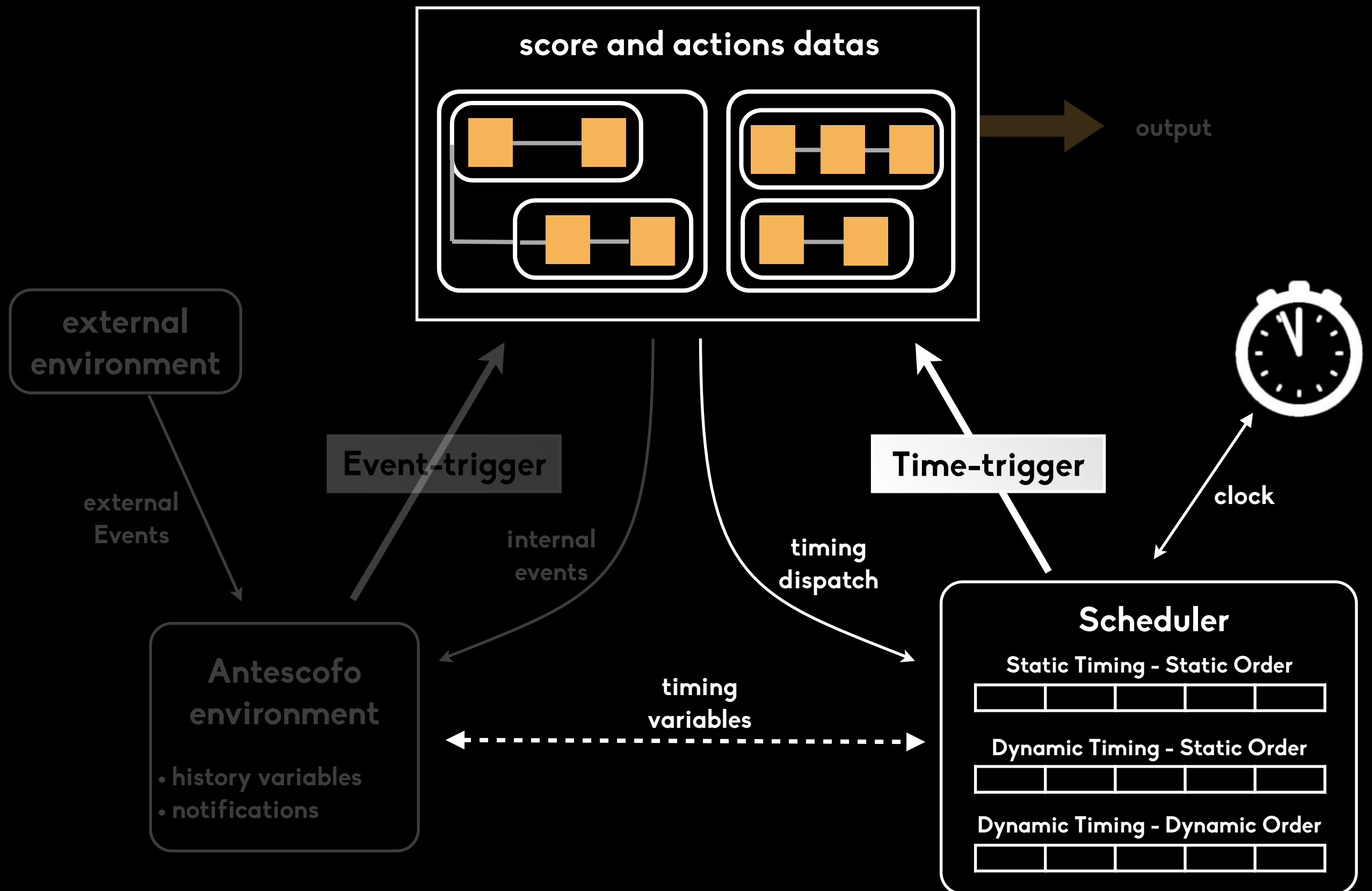
Runtime



Logical Instants



Runtime



Scheduler

```
group{  
    4 a11  
    2 a12  
}  
group{  
    3 a21  
    2 a22  
}
```

Dynamic Timing - Static Order

4	1			
---	---	--	--	--

```
group  
{  
    2s a31  
    1s a32  
}  
group  
@tempo=65{  
    4 a41  
    2 a42  
}
```

Static Timing - Static Order

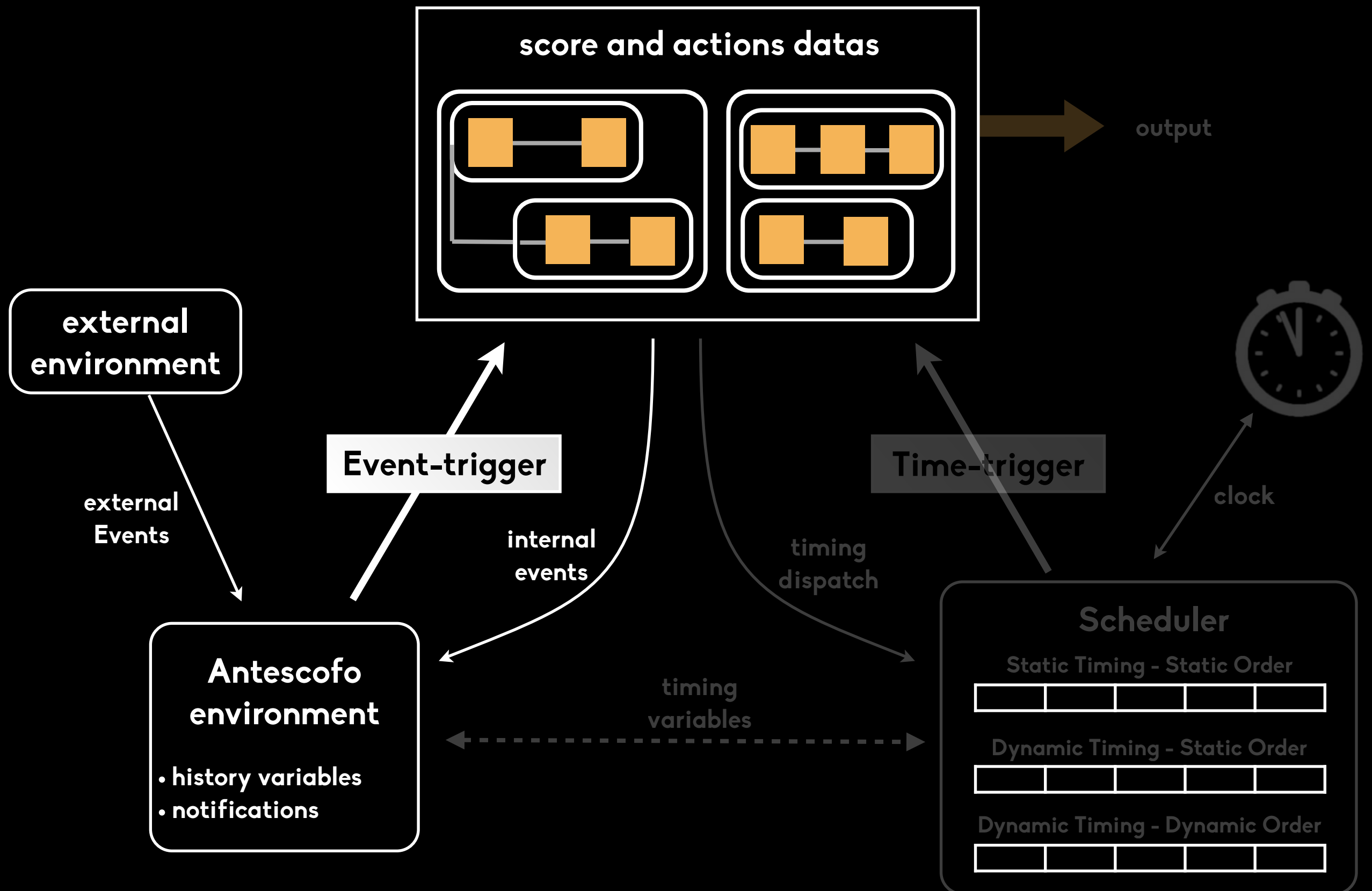
--	--	--	--	--

```
group  
@tempo=$RT_TEMPO*2{  
    1/2 a51  
    1 a52  
}  
group  
@tempo=$v{  
    2 a61  
    3 a62  
}
```

Dynamic Timing - Dynamic Order

--	--	--	--	--

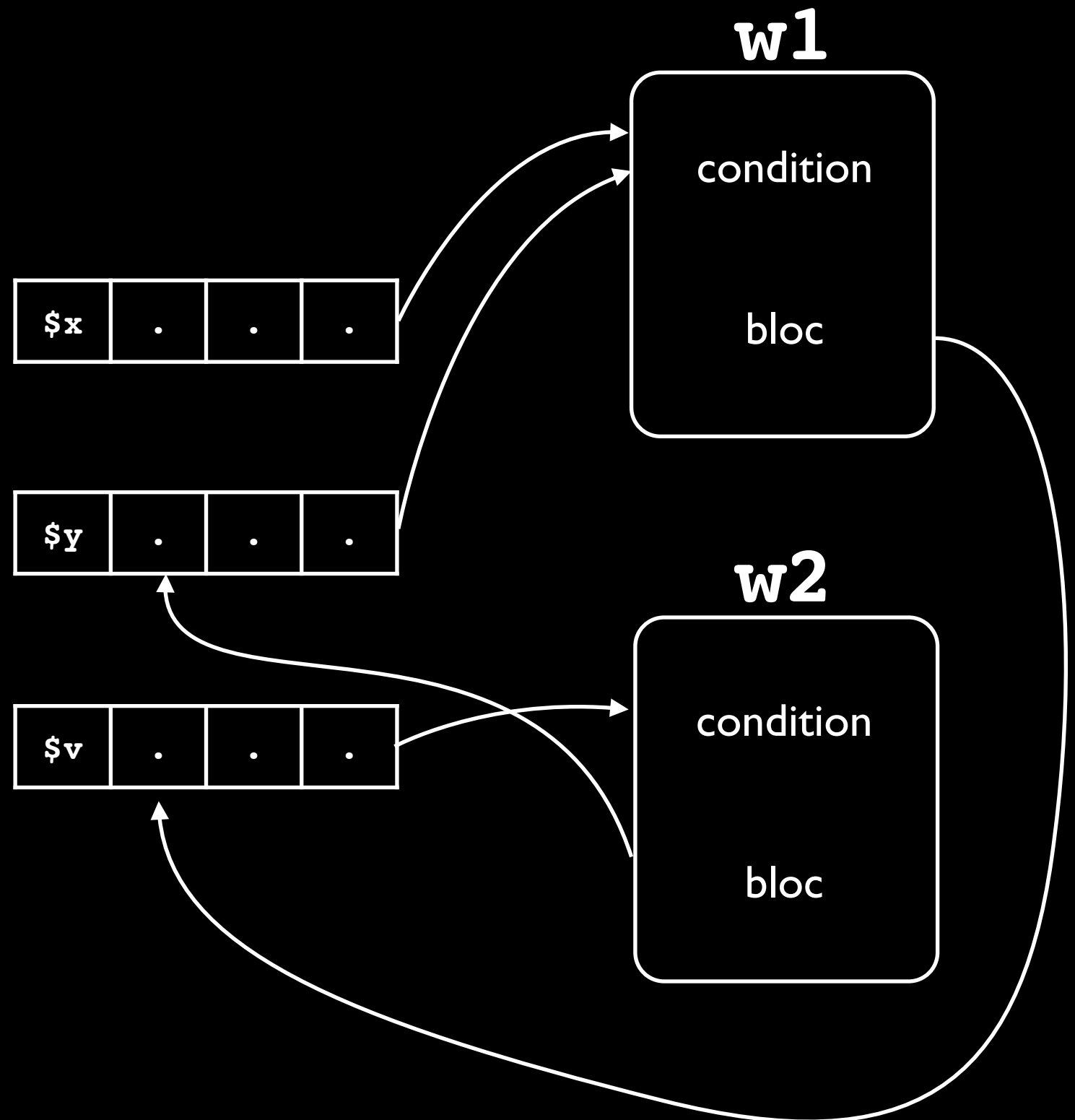
Runtime



Causality problems

```
whenever($x>$y)
@label w1
{
    $v := $v+1
}

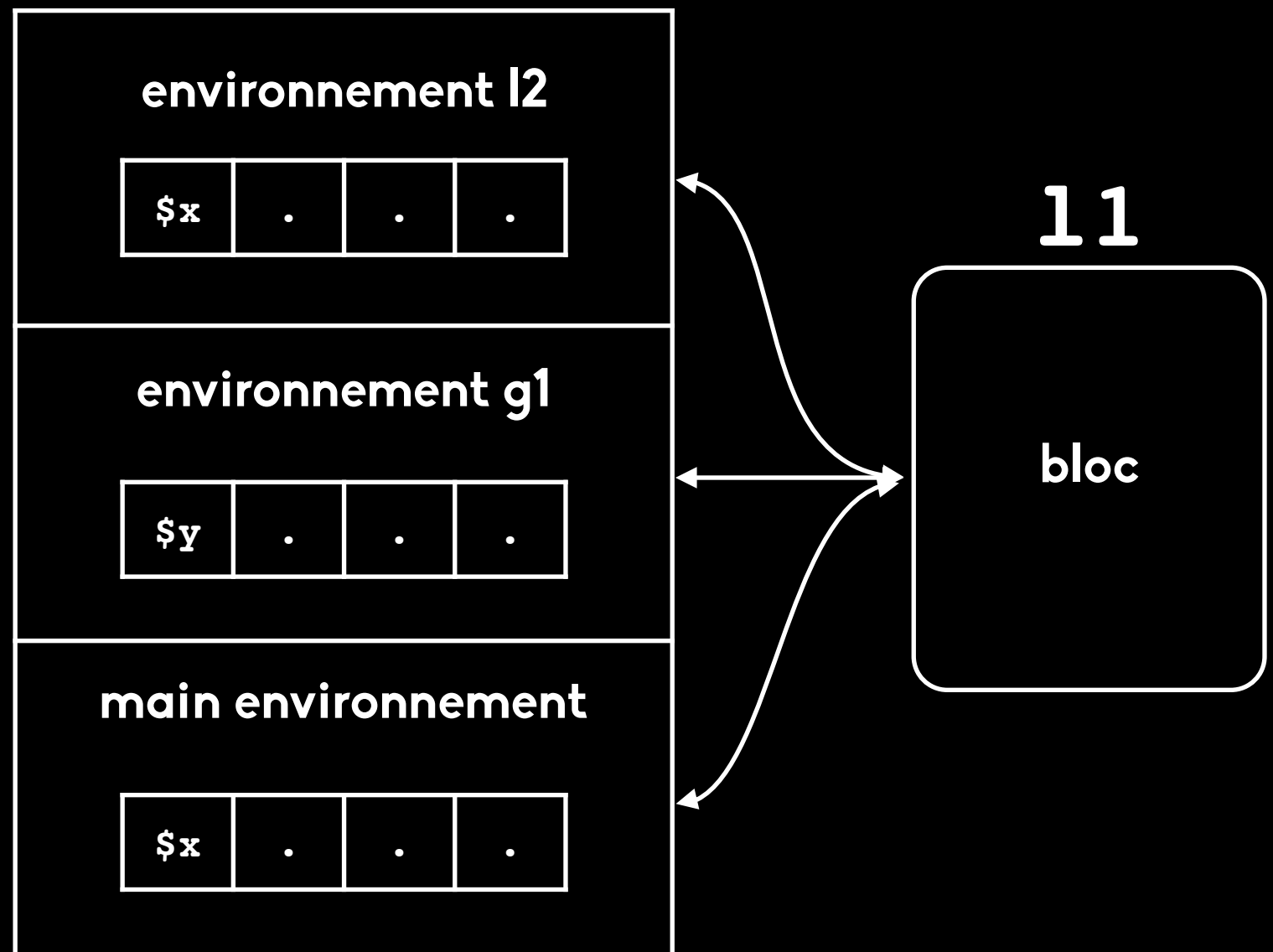
whenever($v=10)
@label w2
{
    $y := 34
}
```



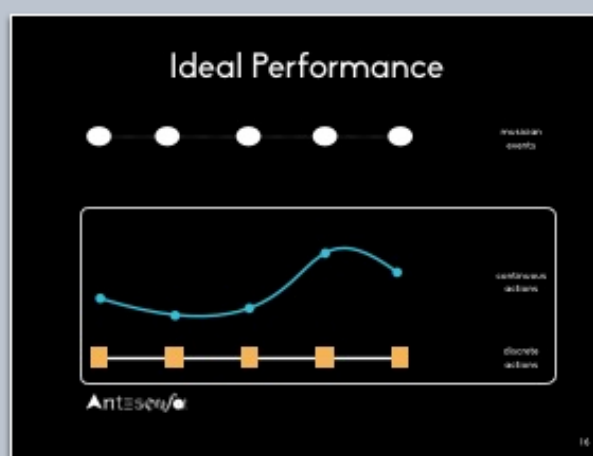
environnements management

```
$x := 2
group g1{
  @local $y
  $y := $x + 3

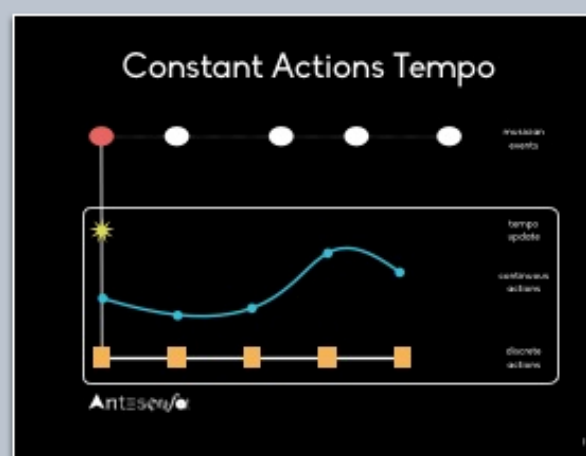
  loop 11 2{
    @local $x
    $x := 1
    $y := 2
    send $x $y
  }
}
```



Stratégies de Synchronisation



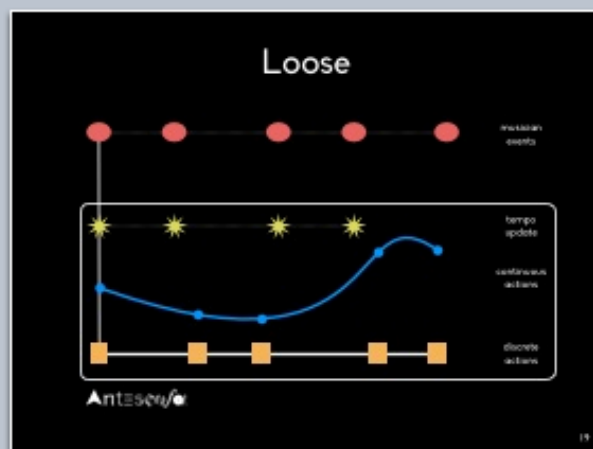
16



17



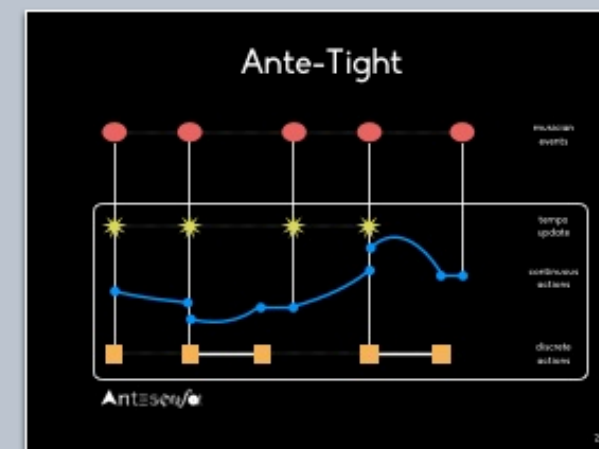
18



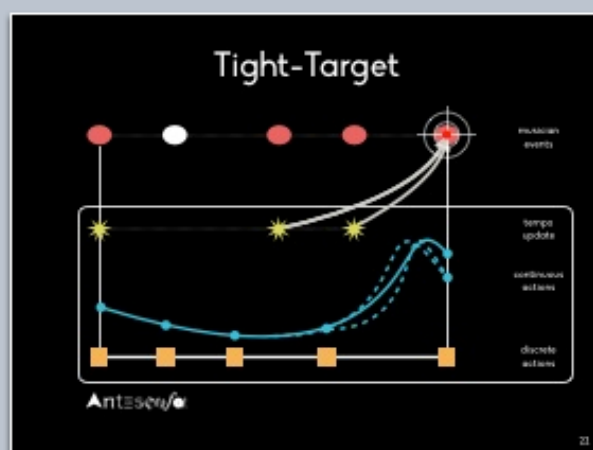
19



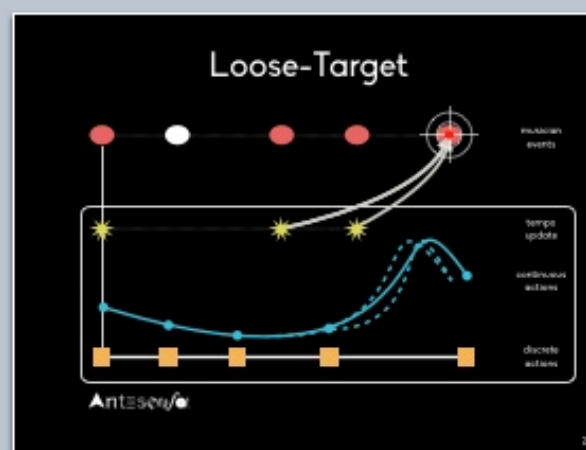
20



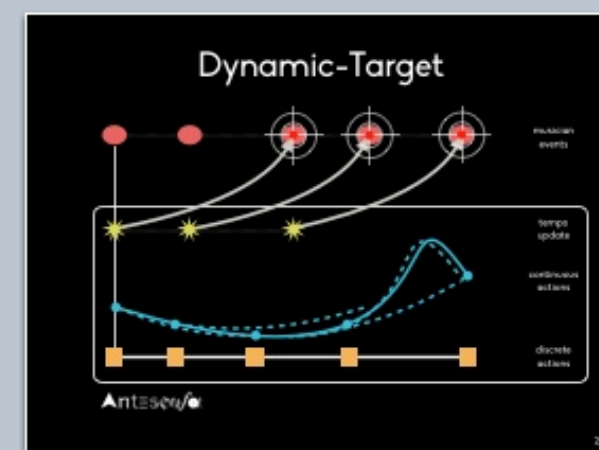
21



22

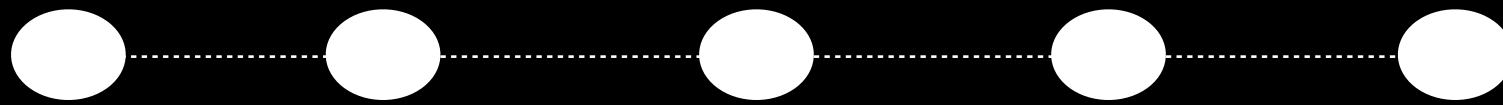


23

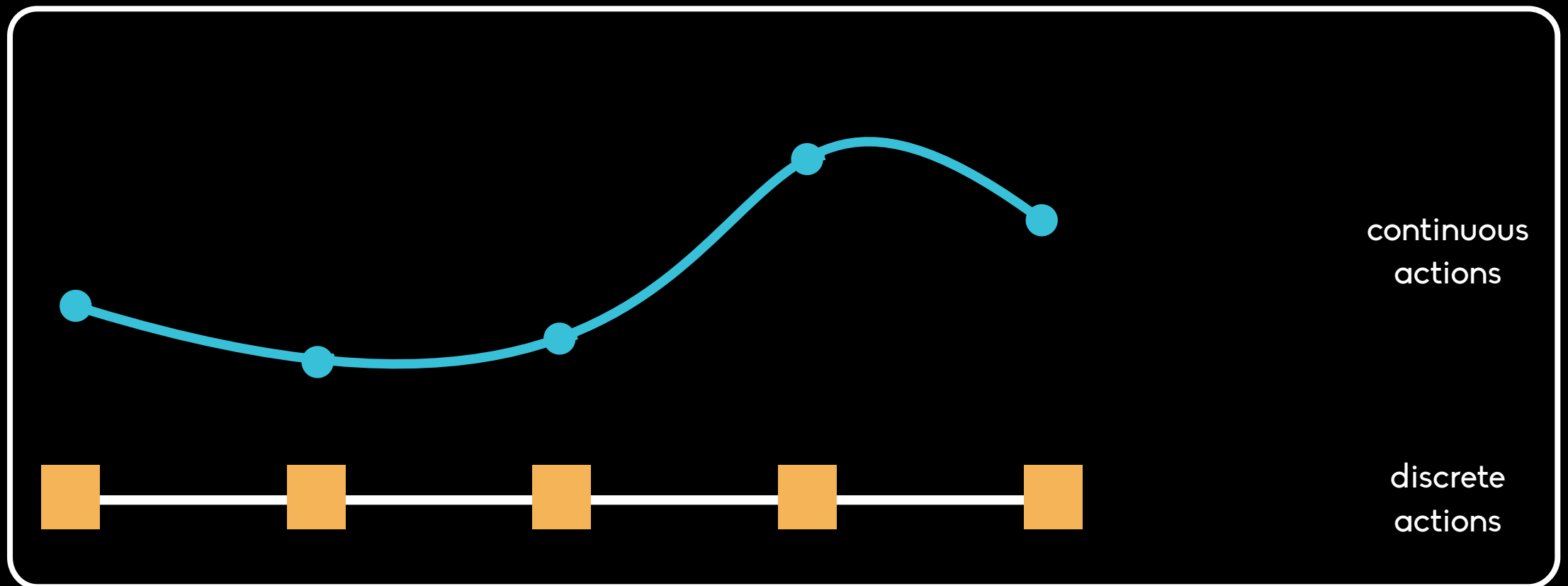


24

Ideal Performance

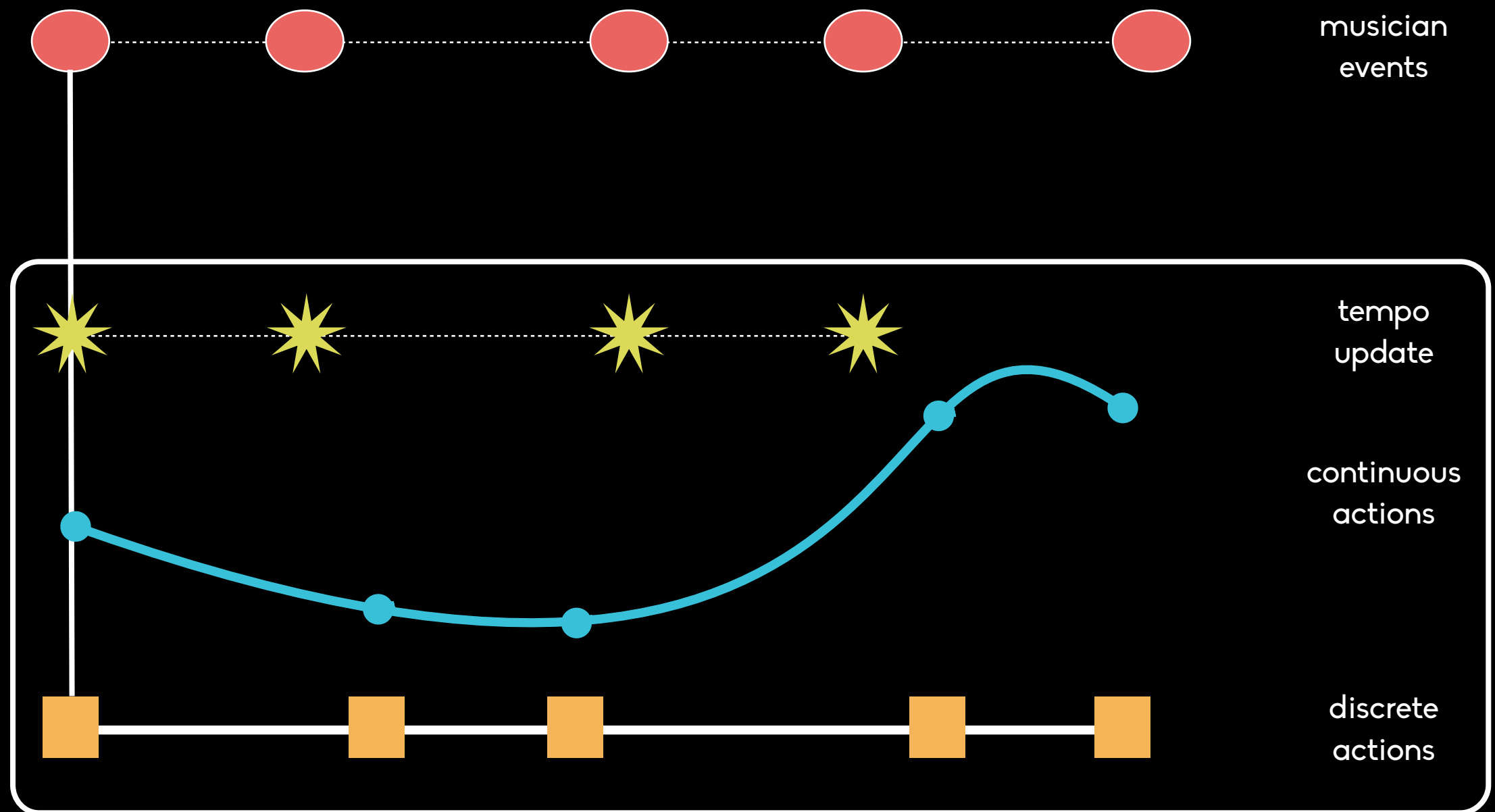


musician
events

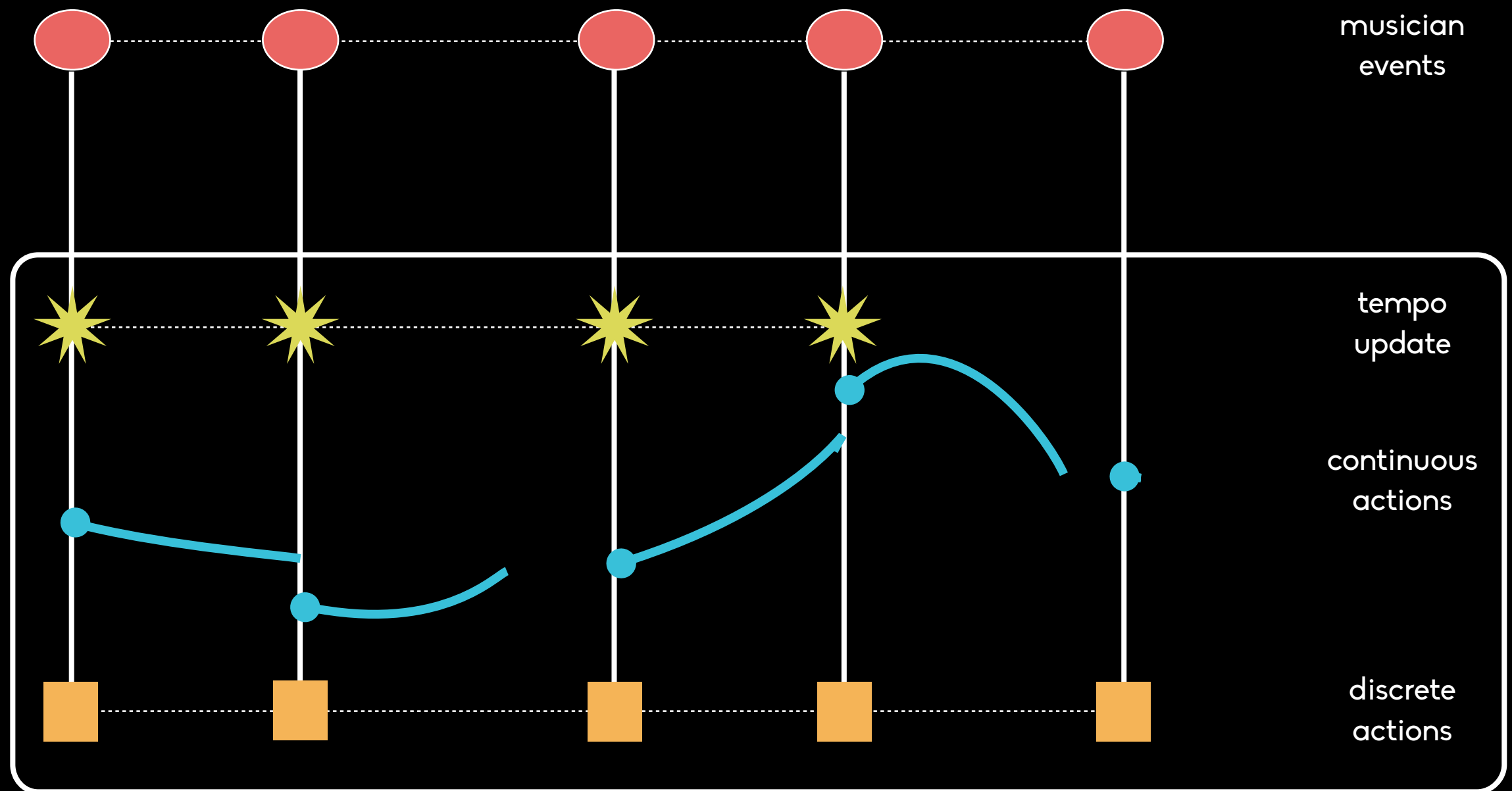


Antescofo

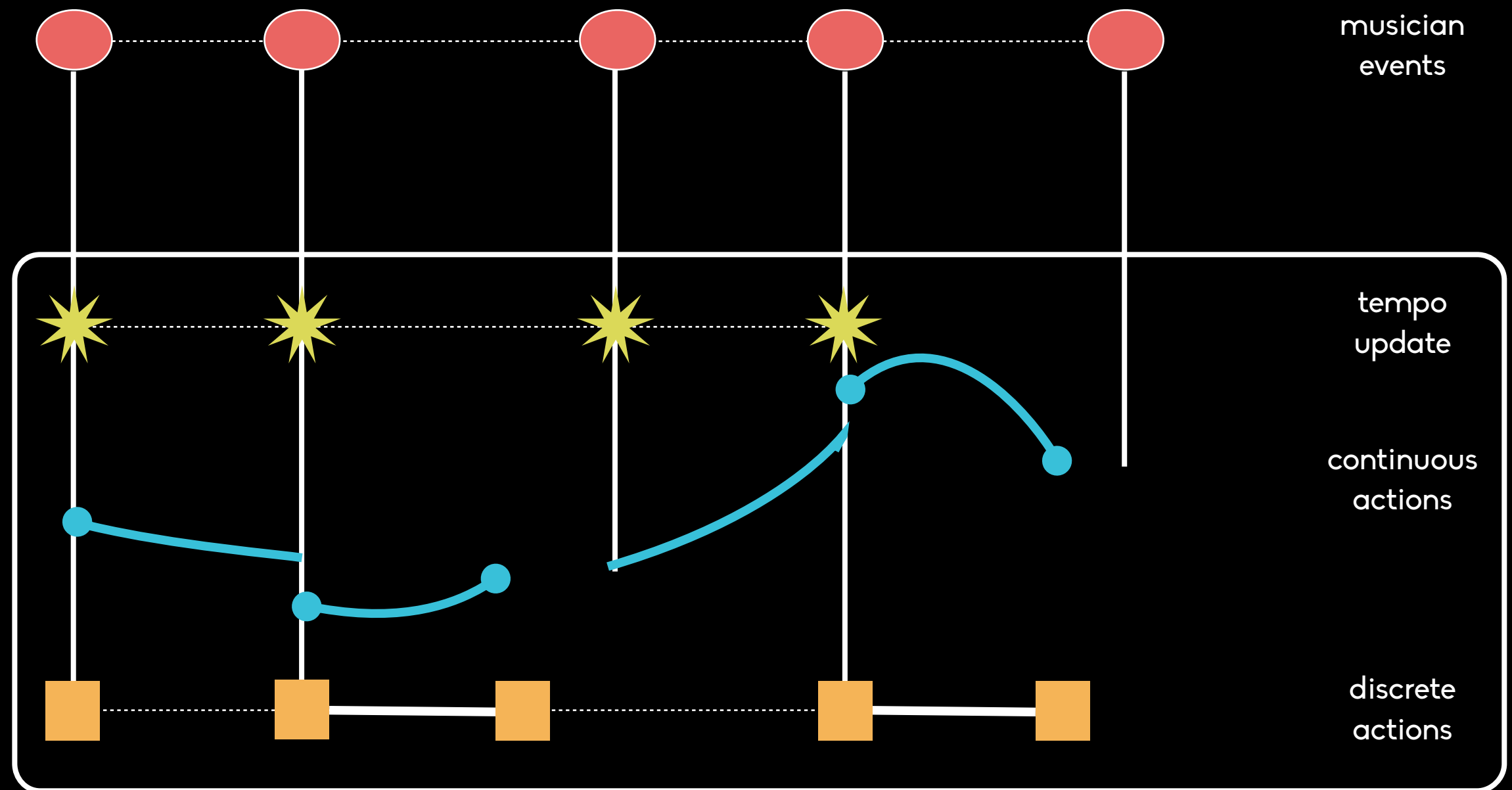
Loose Strategie



Tight

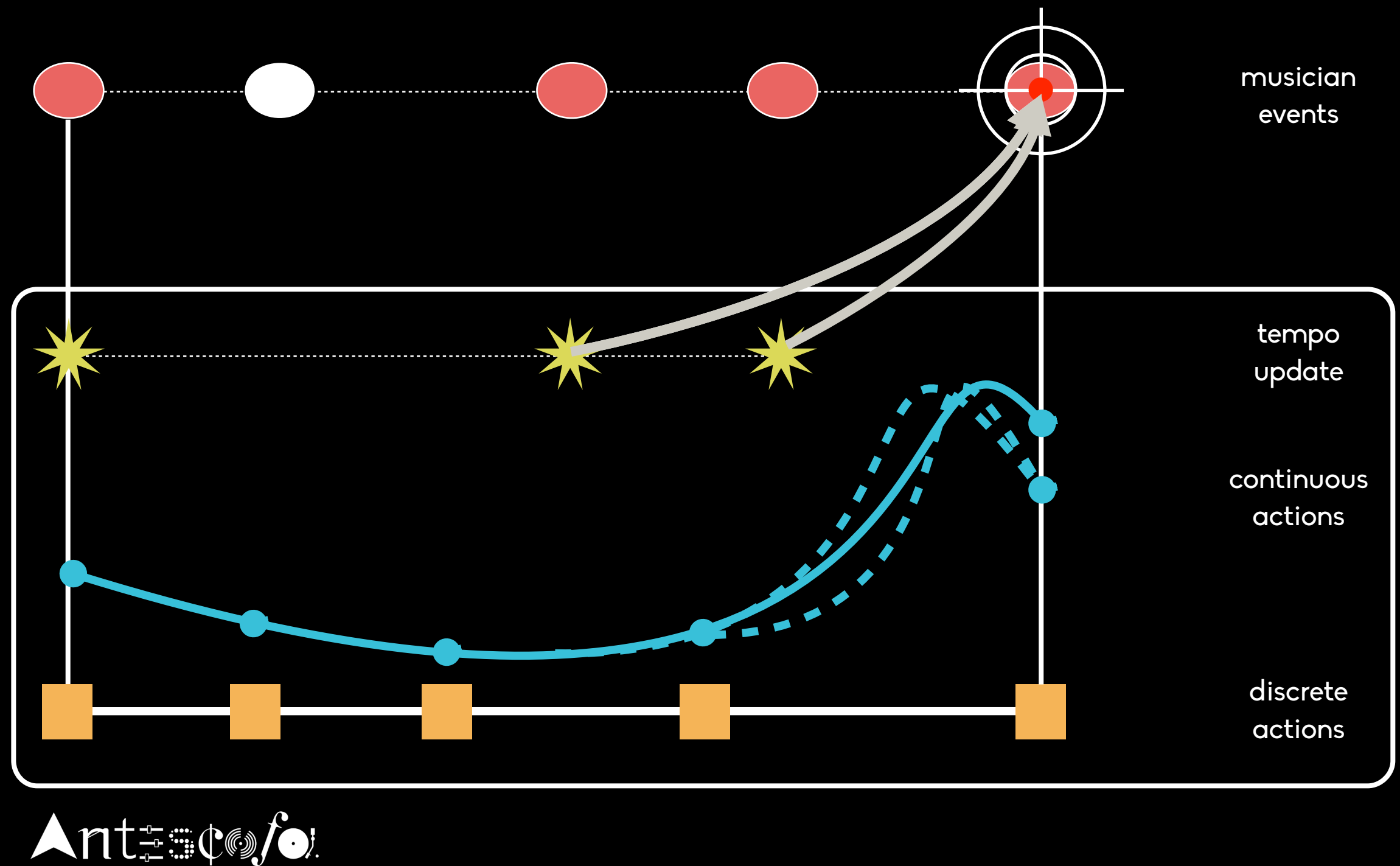


Ante-Tight

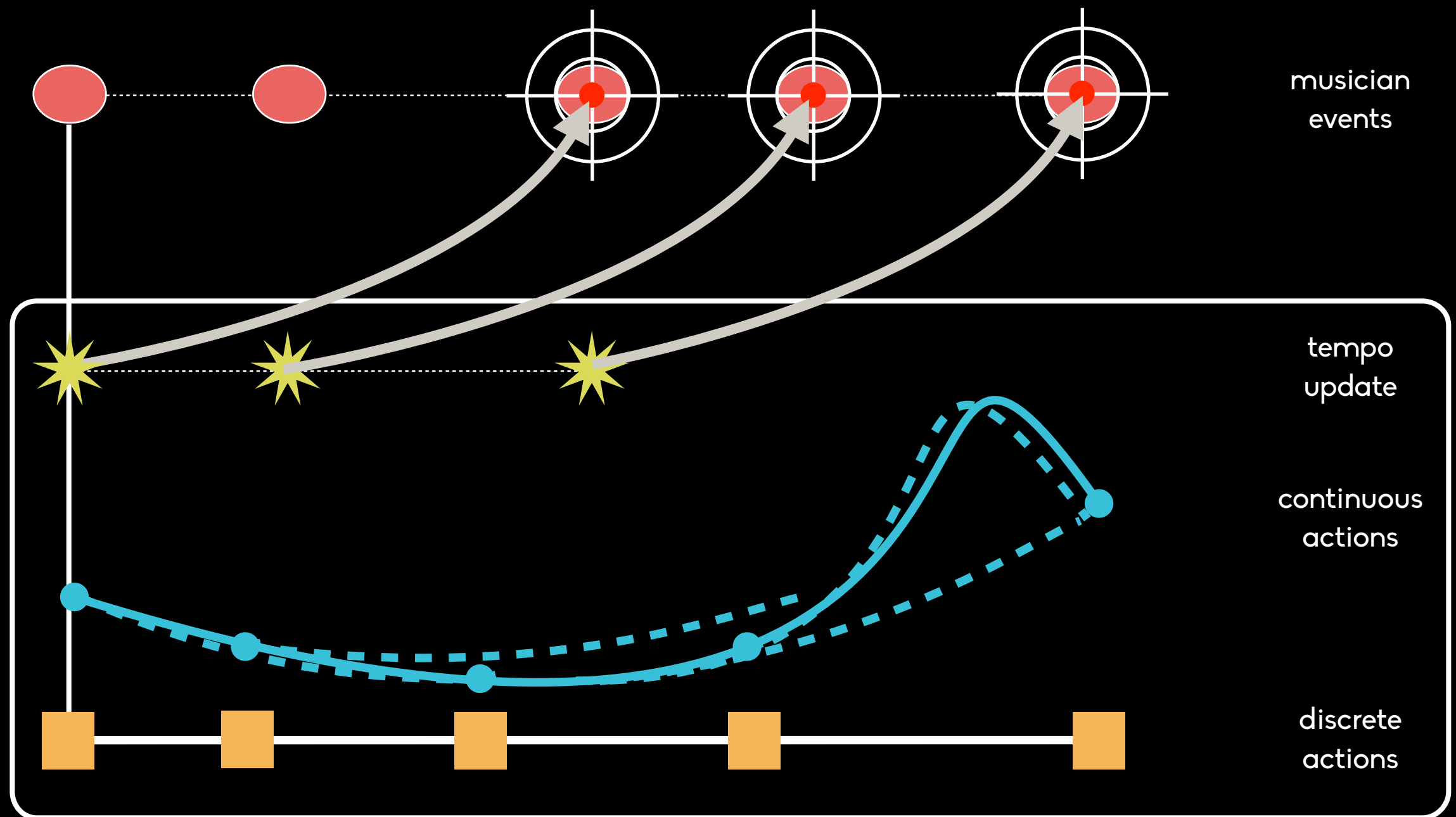


Antescofo

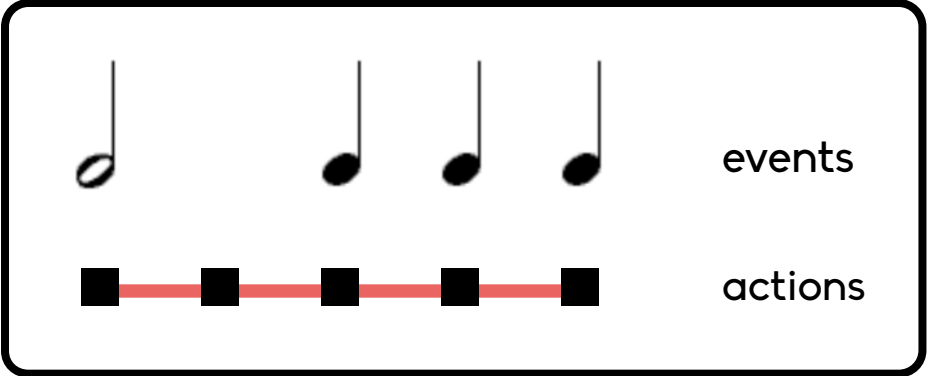
Static Target



Dynamic-Target



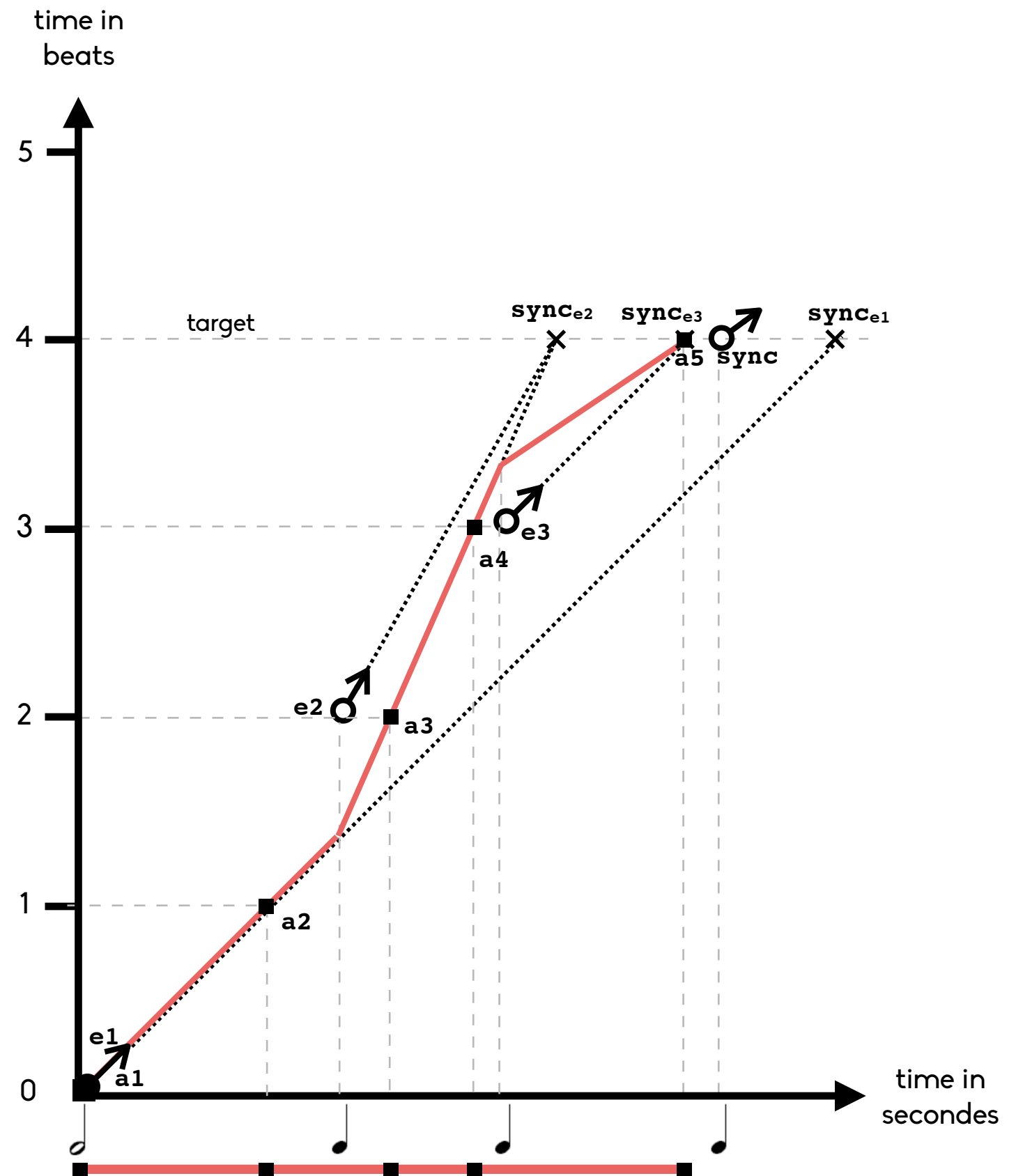
Antescofo



```

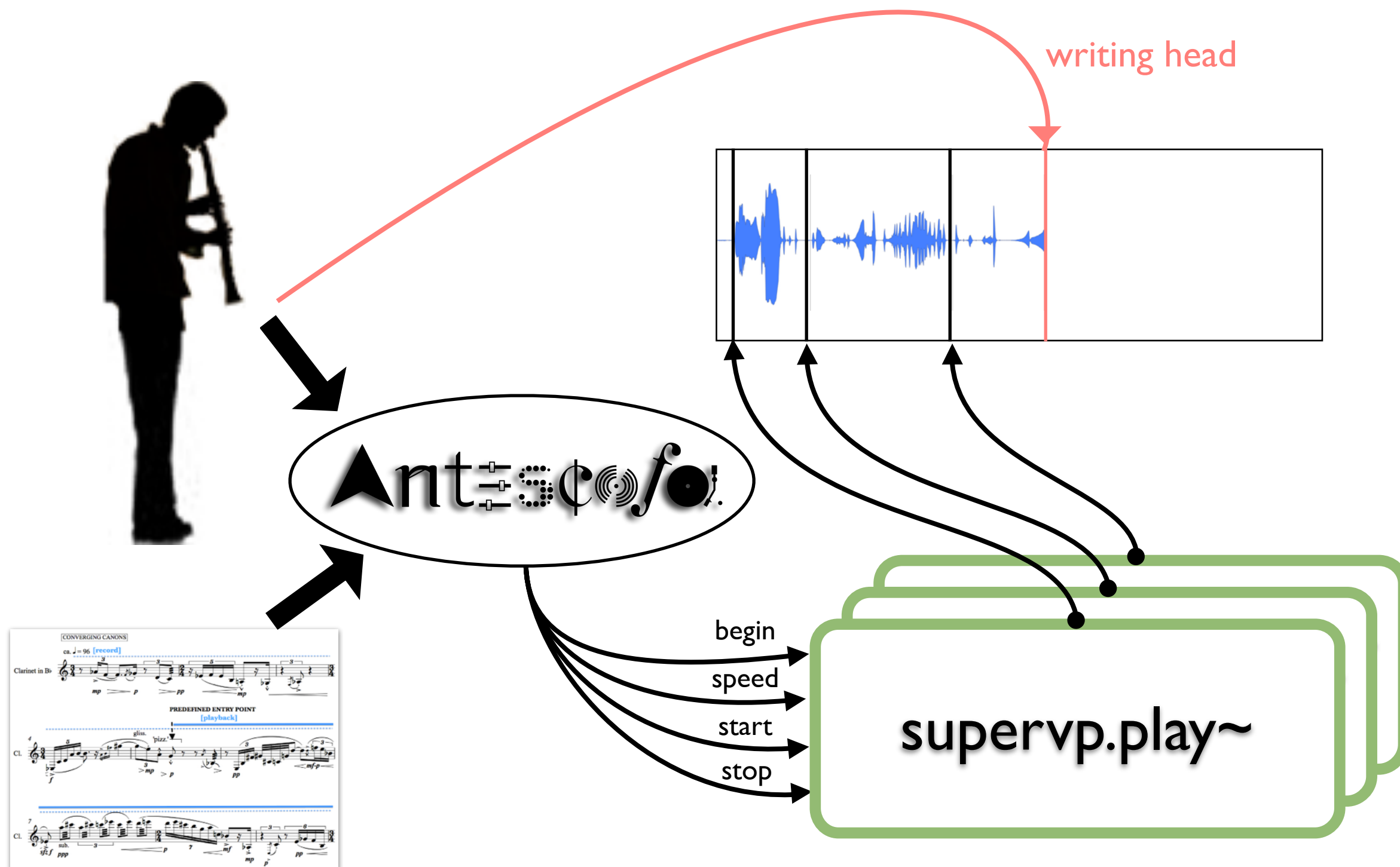
NOTE 60 2.0
  group @target:={sync}
  {
    action
    1.0 action
    1.0 action
    1.0 action
    1.0 action
  }
NOTE 60 1.0
NOTE 60 1.0
NOTE 60 1.0 sync

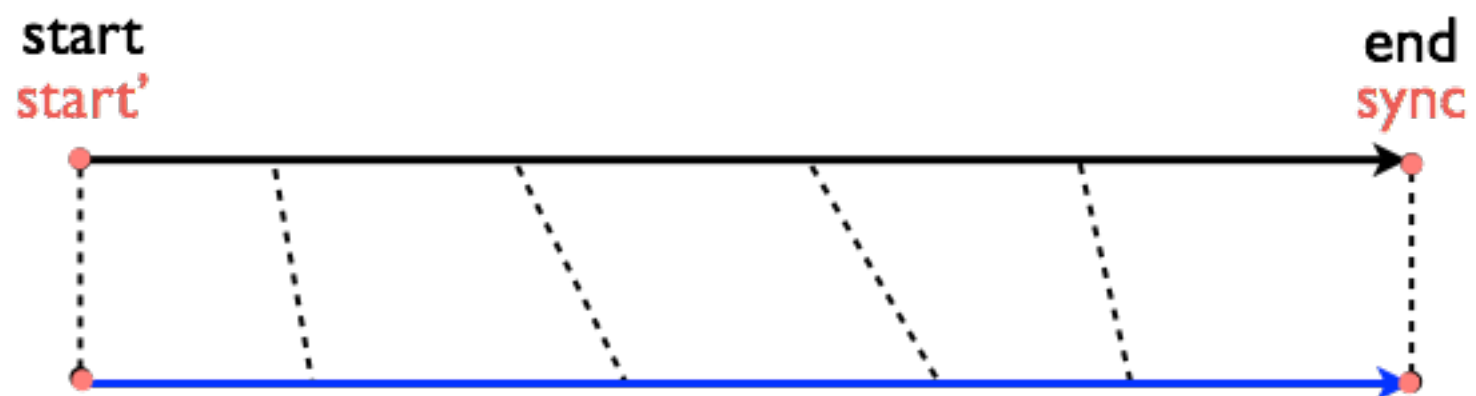
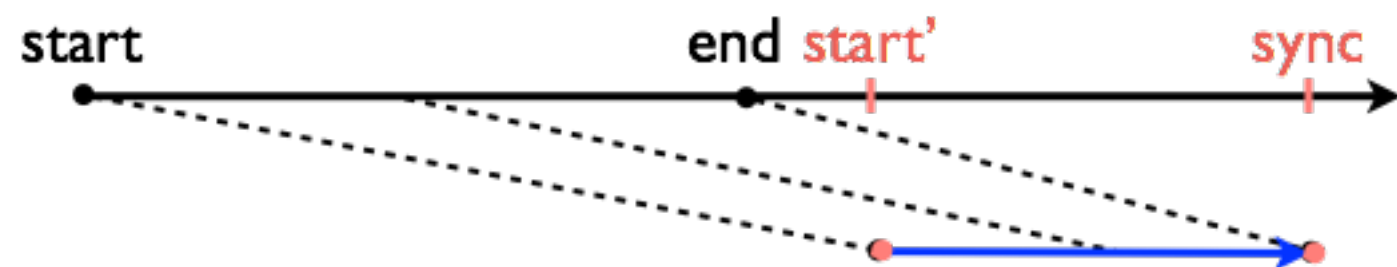
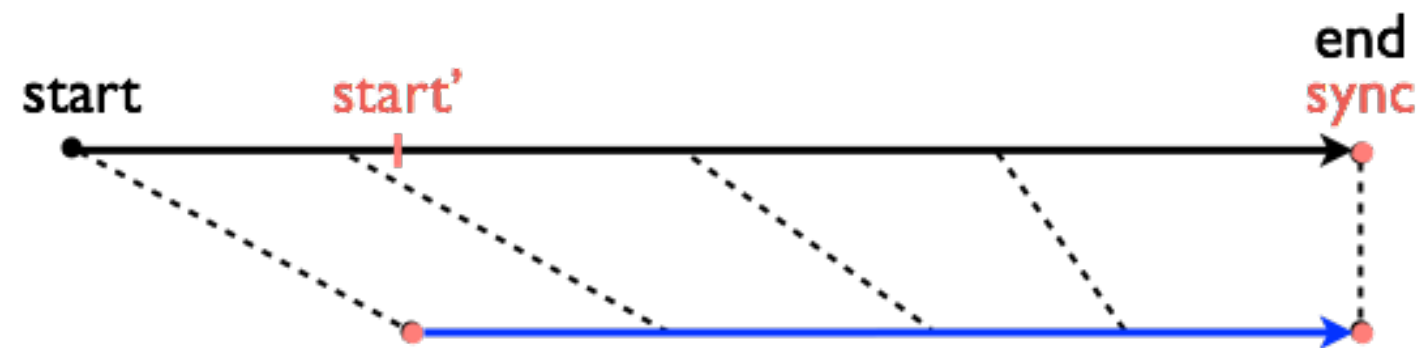
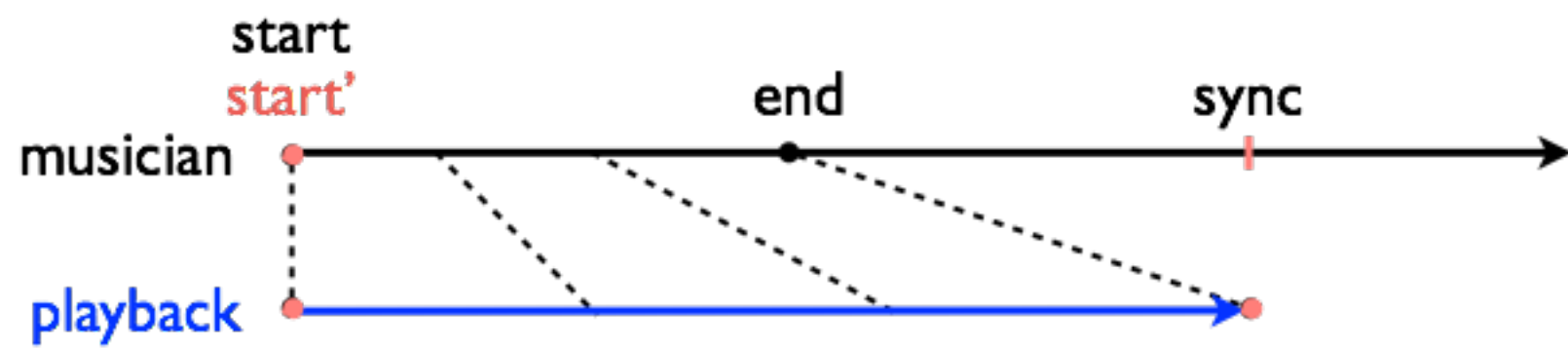
```

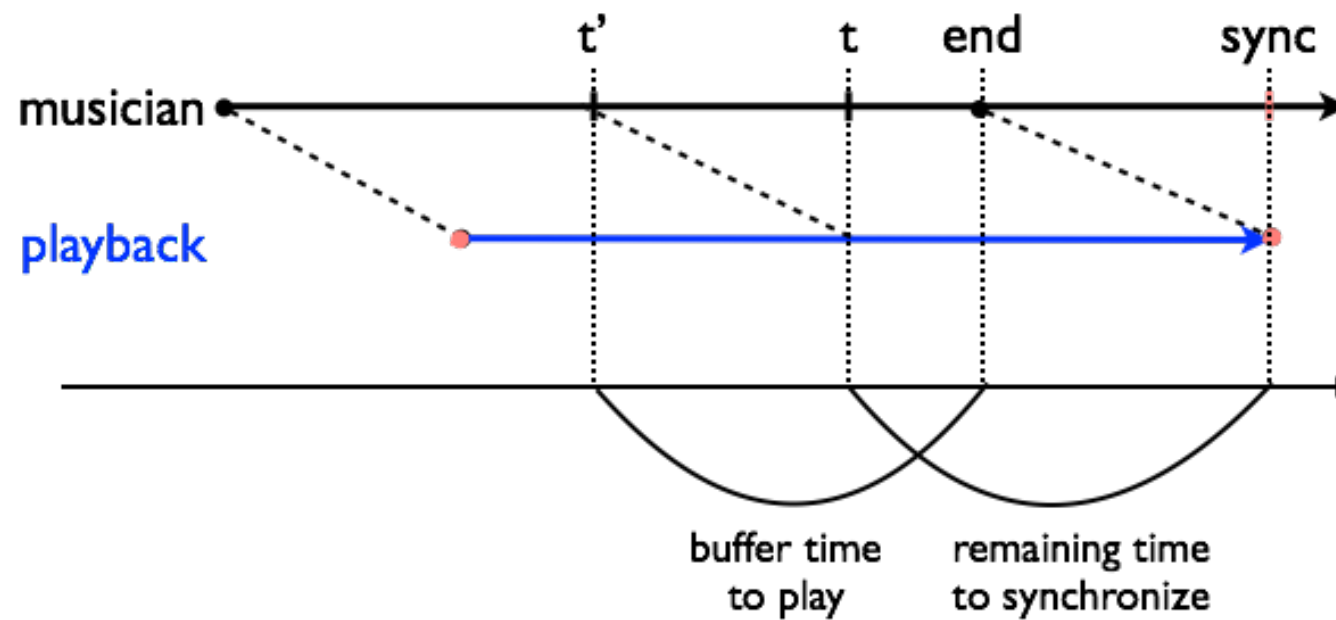


Examples

Sketches of C. Trapani







```

whenever ($RT_TEMPO)
{
  $t' := $t' + ( (@date ($t') - $NOW) * $speed)

  $end := $NOW + ($end_pos - $RNOW) * 60 / $RT_TEMPO
  $sync := $NOW + ($sync_pos - $RNOW) * 60 / $RT_TEMPO

  $speed := ($end - $t') / ($sync - $NOW)
  ph_voc speed $speed

}until ($RNOW ≥ $end_pos)

```

Recorded 21 March 2013 at IRCAM

Jérôme Comte, clarinet

sketch by Christopher Trapani

collaboration in the framework of a Musical
Research Residency with the MuTant team

contributions from José Echeveste,
Jean-Louis Giavitto, and Arshia Cont

Antescofo for Composing

- "Tensio" by P. Manoury for string quartet & live electronics
- G. Nouno (Computer Music Designer), Premiered in 12/2010.

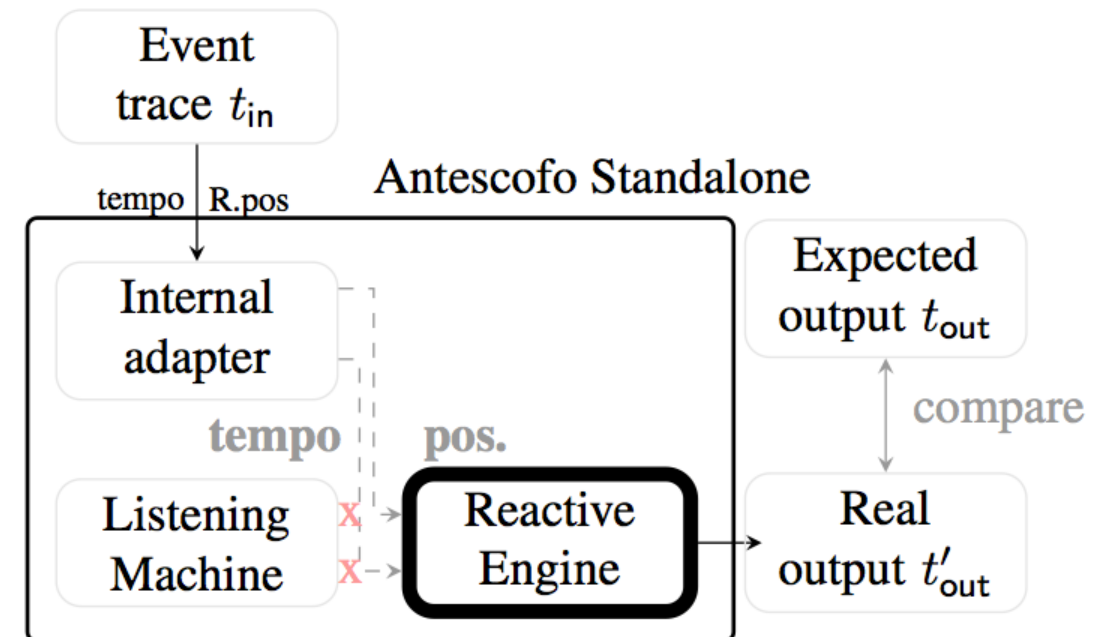
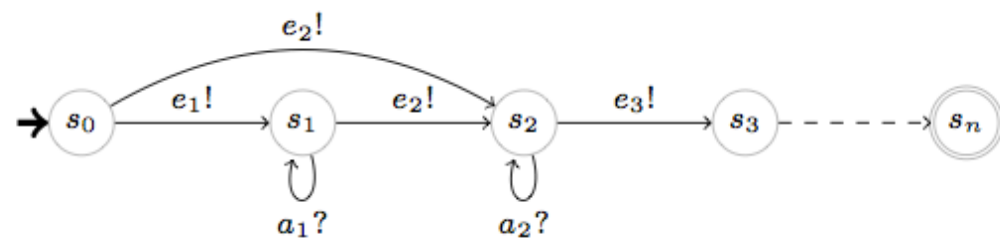
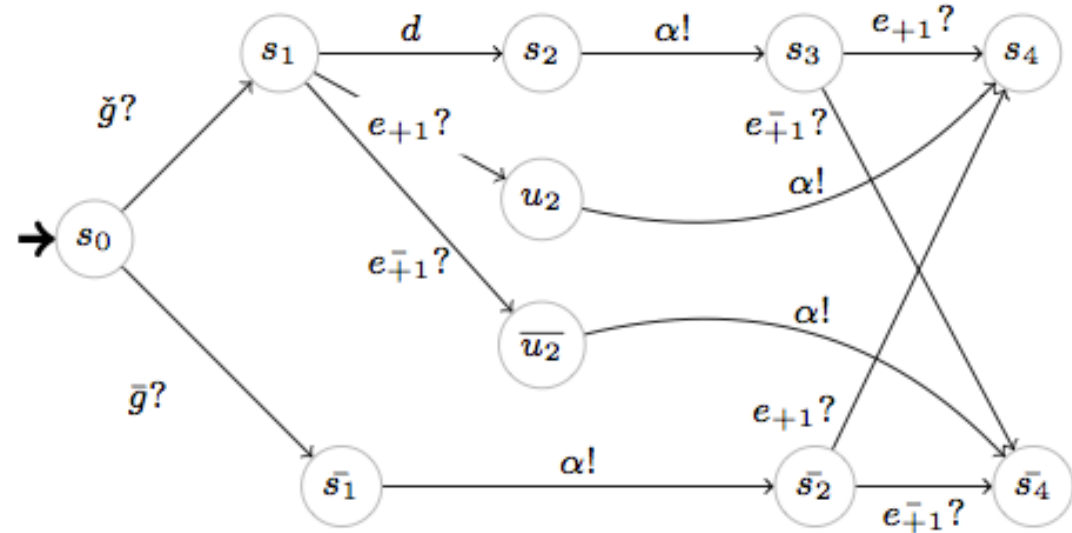
```

BPM 72
TRILL (8500) 0.5
GFWD arco
{
  syn_voices 1 pgm 40 bnk 7 vol 122
  syn_voices 1 56 120 @b(2)
  syn_voices 1 50 120 @b(2)
  syn_voices 1 46 120 @b(2)
  2.0 syn_voices 1 53 120 @b(0.36)
  syn_voices 1 52 120 @b(0.36)
  syn_voices 1 58 120 @b(0.36)
  0.36 syn_voices 1 69 120 @b(1.5)
  syn_voices 1 63 120 @b(1.5)
  syn_voices 1 59 120 @b(1.5)
  1.5 syn_voices 1 66 120 @b(0.8)
  syn_voices 1 65 120 @b(0.8)
  syn_voices 1 62 120 @b(0.8)
}
CFWD h1_trans @grain 30ms
{
  0 0
  2.0 300
  0 0
  0.46 800
  0 0
  1.5 -500
}
GFWD 0.5 Pizzicati
{
  Bsyn_voices 4 vol 127
  1/5.5 Bsyn_voices 4 85 127 100
  1/5.5 Bsyn_voices 4 85 127 100
  1/5.5 Bsyn_voices 4 85 127 100
  1/5.5 Bsyn_voices 4 85 127 100
  1/5.5 Bsyn_voices 4 85 127 100
  1/5.5 Bsyn_voices 4 85 127 100
  1/5.5 Bsyn_voices 4 85 127 100
}
NOTE 0 0.5
TRILL (8100) 0.5
NOTE 0 0.5
TRILL (7500) 0.5
IA...EVT-2
  
```

Others...

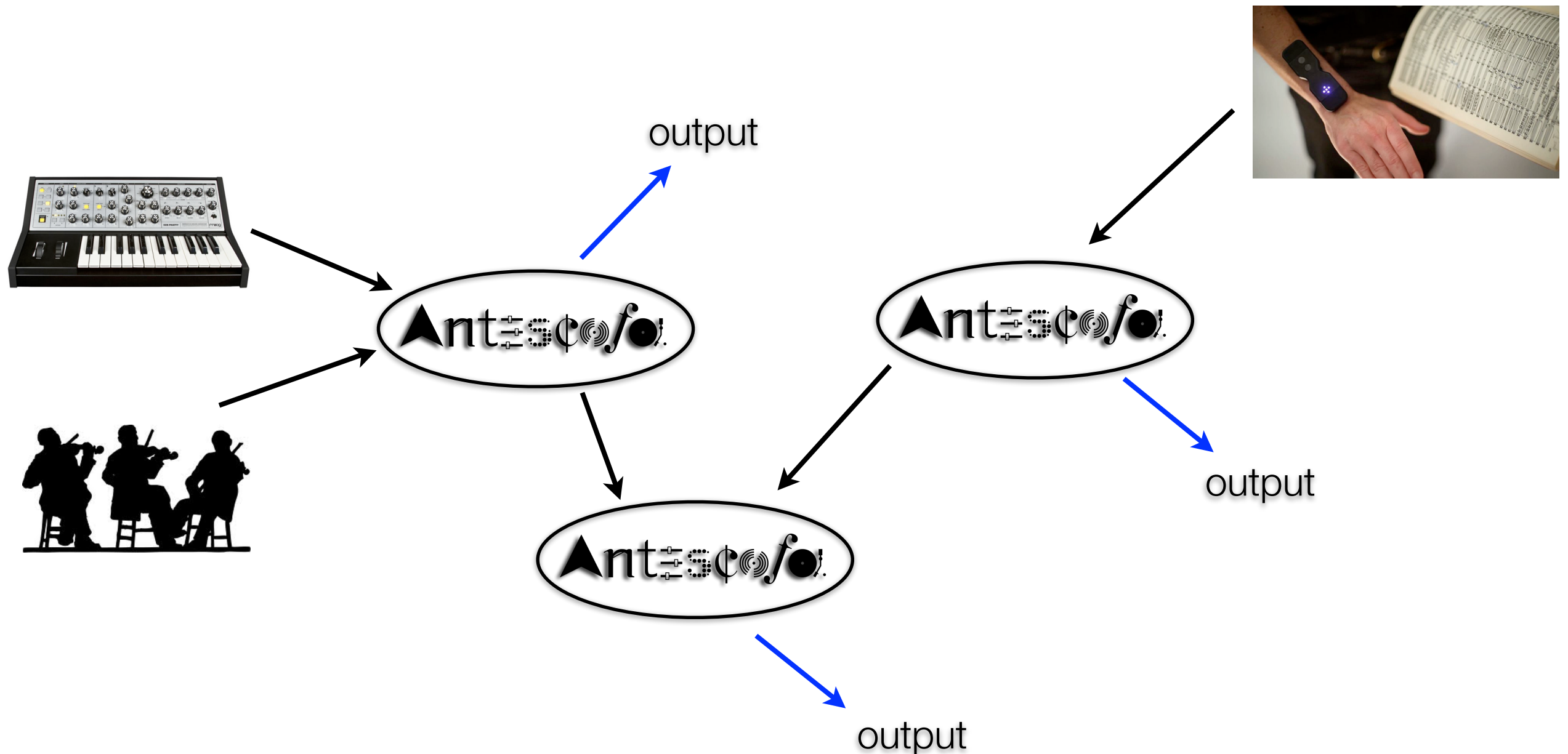
- Andrea Agostini
 - “Legno sabbia vetro cenere”, for string quartet & electronics (2010)
 - concurrent synchronous sound synthesis phrasing
 - Emmanuel Nunes
 - “Einspielung I”, for Violin & live electronics (2011)
- José Miguel Fernandez, Computer Music Design

Static Verification and Test Methods



Perspectives

- distributed coordination (multimodal, multi-objective listening)



Perspectives

- audio computation
- dynamic scheduling
- more synchronization strategies

Further Reading

Papers and seminars:

<http://repmus.ircam.fr/mutant>

Get Antescofo:

<http://forumnet.ircam.fr/product/antescofo/>