Composing and Performing Electronic Music on-the-Fly with Pharo and Coypu

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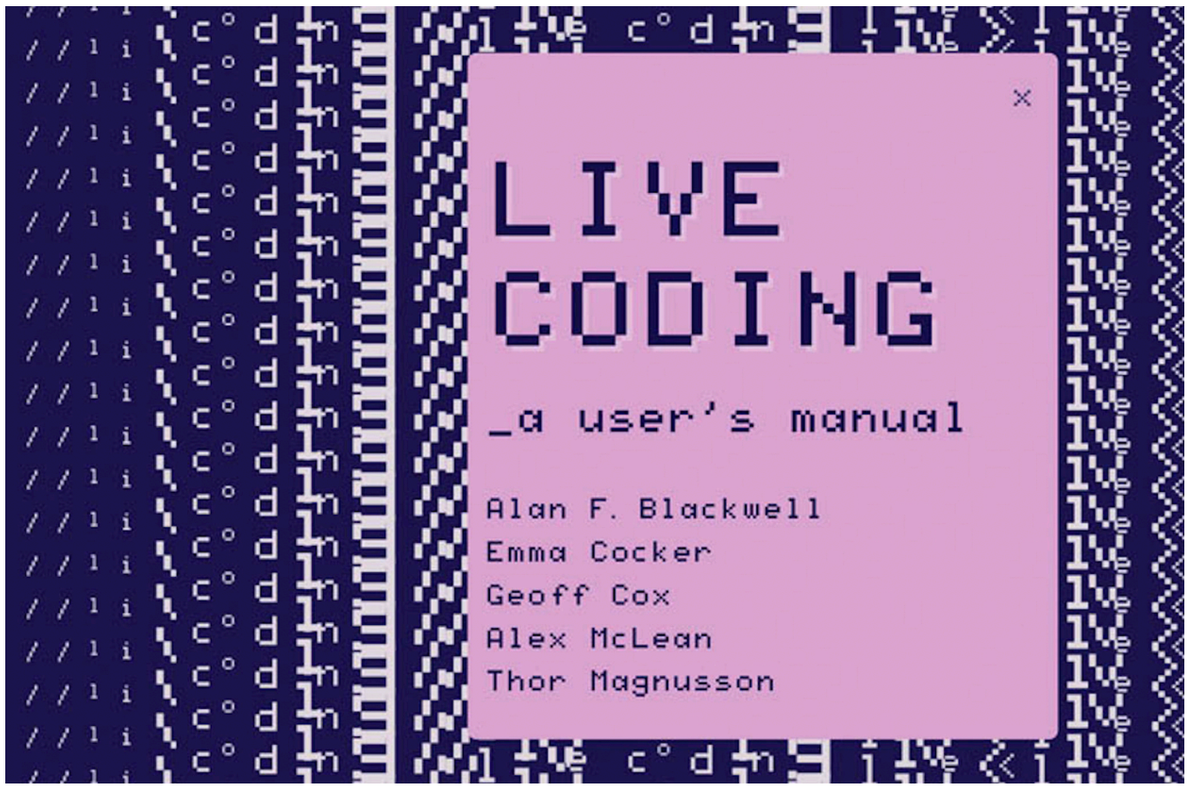
Live coding

In **Live coding**, sometimes referred to as *on-the-fly programming*, *just-in-time programming*, or *conversational programming*, music and video artists expose and rewire the innards of software while it generates improvised music and/or visuals.



Live coding has become increasingly popular in computer music, often as improvisation or combined with algorithmic composition.

All code manipulation is projected for the audience's pleasure

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TOPLAP MANIFESTO

__T__ransnational __O__rganisation for the __P__roliferation of __L__ive __A__rtistic __P__rogramming

- Give us access to the performer's mind, to the whole human instrument.
- Obscurantism is dangerous. Show us your screens.
- Programs are instruments that can change themselves
- The program is to be transcended - Artificial language is the way.
- Code should be seen as well as heard, underlying algorithms viewed as well as their visual outcome.
- Live coding is not about tools. Algorithms are thoughts. Chainsaws are tools. That's why algorithms are sometimes harder to notice than chainsaws

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ICLC

ICLC25, Barcelona ,Catalunya

ICLC24 - Shanghai, China - Algorave @ System

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Why Coypu?

Smalltalk syntax is great for people with little computer literacy.

Pharo is easy to learn → Many resources (2 MOOCs)!

Pharo is easy to learn → It''s reflective!

Pharo is easy to learn → Lively (relatively :)) young community.

Musicians and sound artists might be intimidated by functional or opaque languages

Pharo comes with its own IDE = No extensions to install

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Habitat

Coypu has been developed to program music ***on-the-fly*** with Pharo.

Coypu acts like a *score** for an *orchestra**.

* in traditional *Csound* terms

The *orchestra* is the audio server used to render the sounds

Coypu has been developed to program music ***on-the-fly*** with Pharo.

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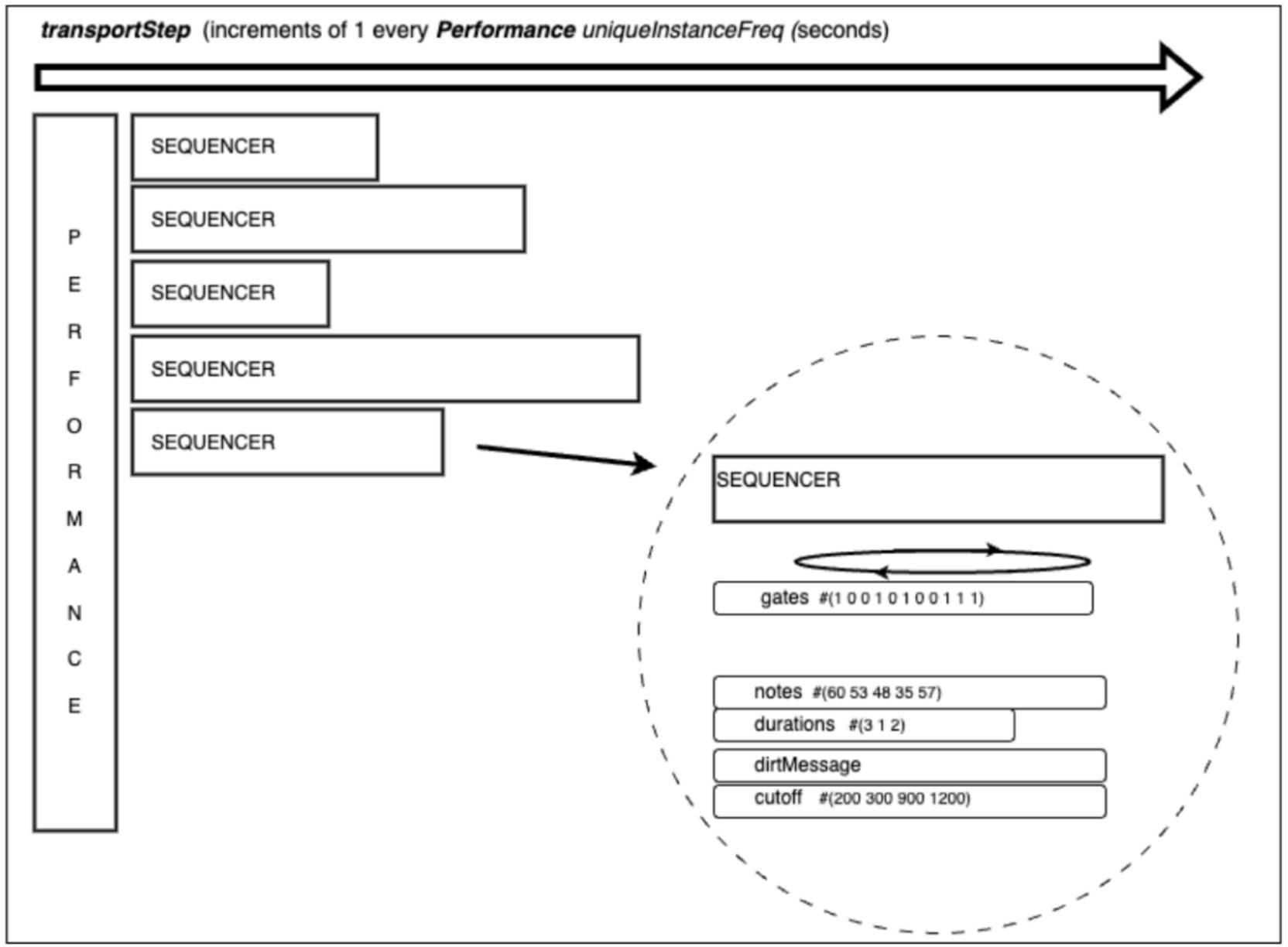
Anatomy



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Hello Coypu

```
p := Performance uniqueInstance .
p performer: PerformerPhausto new.
p freq: 98 bpm.

#rumba to: #conga.

p playFor: 256 bars.
```

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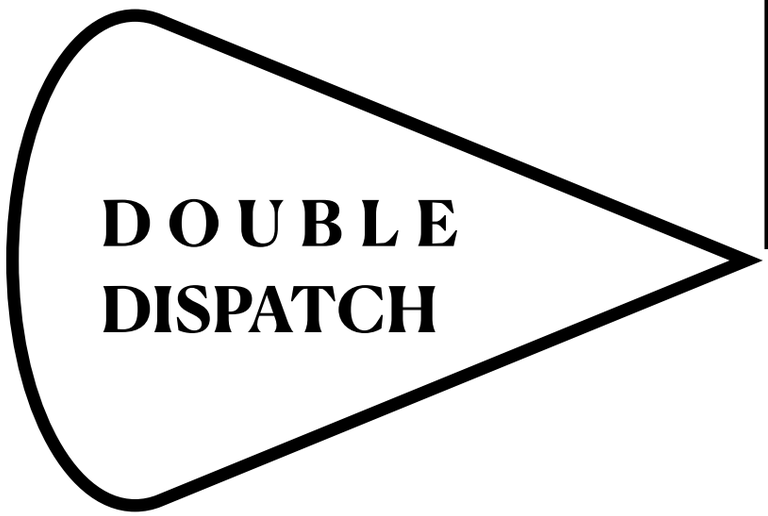
One performance

The Performance is a subclass of Dictionary

Each key of the Performance is assigned to a Sequencer.

The Performance is a Singleton.




```
Performance >> playFor: aNumberOfSteps

self class performer playFor: aNumberOfSteps.
```

The Performer is responsible of
sending events to the audio client!

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5 Performers

`PerformerLocal` → Local OSC audio server (ChucK PureData, SuperCollider, MaxMSP)

`PerformerKyma` → Symbolic Sound Kyma (external OSC connection)

`PerformerSuperDirt` → SuperDirt (local OSC connection)

`PerformerMIDI` → External MIDI hardware or local application

`PerformerPhausto` → Phausto (embedded in Pharo, communication via FFI)

The Performer subclasses implement the `play` method

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Inside a Performer

```
Performer >>playFor: aNumberOfSteps

            performance bpm: 60 / (performance freq * 4).
            performance transportStep: 0.
            performance activeProcess: ([aNumberOfSteps timesRepeat:
                [(Delay forSeconds: performance freq) wait.

            "sequencers scan"

            performance valuesDo: [ :seq |

               (seq gates wrap: performance transportStep) = 1 ifTrue:
                  [ self playEventAt: seq noteIndex in: seq.

               "increment note Index"

                  seq noteIndex: seq noteIndex + 1 ] ] ] forkAt: Processor
timingPriority - 2.

               "step is incremented anyway"
                  performance incrementTransportStep ] ] forkAt:
                  Processor timingPriority - 1)
```

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Play events(phausto)

```
PerformerKyma >> playEventAt: anIndex in: aSequencer

        self subclassResponsibility
```

```
PerformerPhausto >> playEventAt: anIndex dsp: aDsp freq: aFrequency in: aSequencer

        | dur aParameterList |
        dur := aSequencer durations asDirtArray wrap: anIndex.
        aParameterList := self performance activeDSP allParameters.

        aSequencer extraParams keysAndValuesDo: [ :k :v |
                        aParameterList
                                setValue: (v wrap: anIndex)
                                parameter: aSequencer seqKey , k asString
                                forDsp: aDsp ].

        aParameterList
                setValue: (aSequencer notes wrap: anIndex) midiNoteToFreq
                parameter: aSequencer phaustoNoteDestination
                forDsp: aDsp.
        aParameterList
                trig: aSequencer phaustoGateDestination
                for: dur * aFrequency * (aSequencer gateTimes wrap: anIndex)
                forDsp: aDsp
```

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Play events(MIDI)

```
PerformerKyma >> playEventAt: anIndex in: aSequencer

        self subclassResponsibility
```

```
PerformerMIDI >> playEventAt: anIndex in: aSequencer

        | gateTime dur midiNote mch stepDuration midiSender |
        freq := Performance uniqueInstance freq.
        gateTime := 0.9. "must be changeable"
        midiSender := PerformerMIDI midiOut.
        mch := aSequencer midiChannel.
        stepDuration := Performance uniqueInstance freq.
        midiNote := aSequencer notes asDirtArray wrap: anIndex.
        dur := aSequencer durations asDirtArray wrap: anIndex.
        midiSender
                playNote: midiNote
                onChannel: mch
                duration: dur * freq * gateTime.
```

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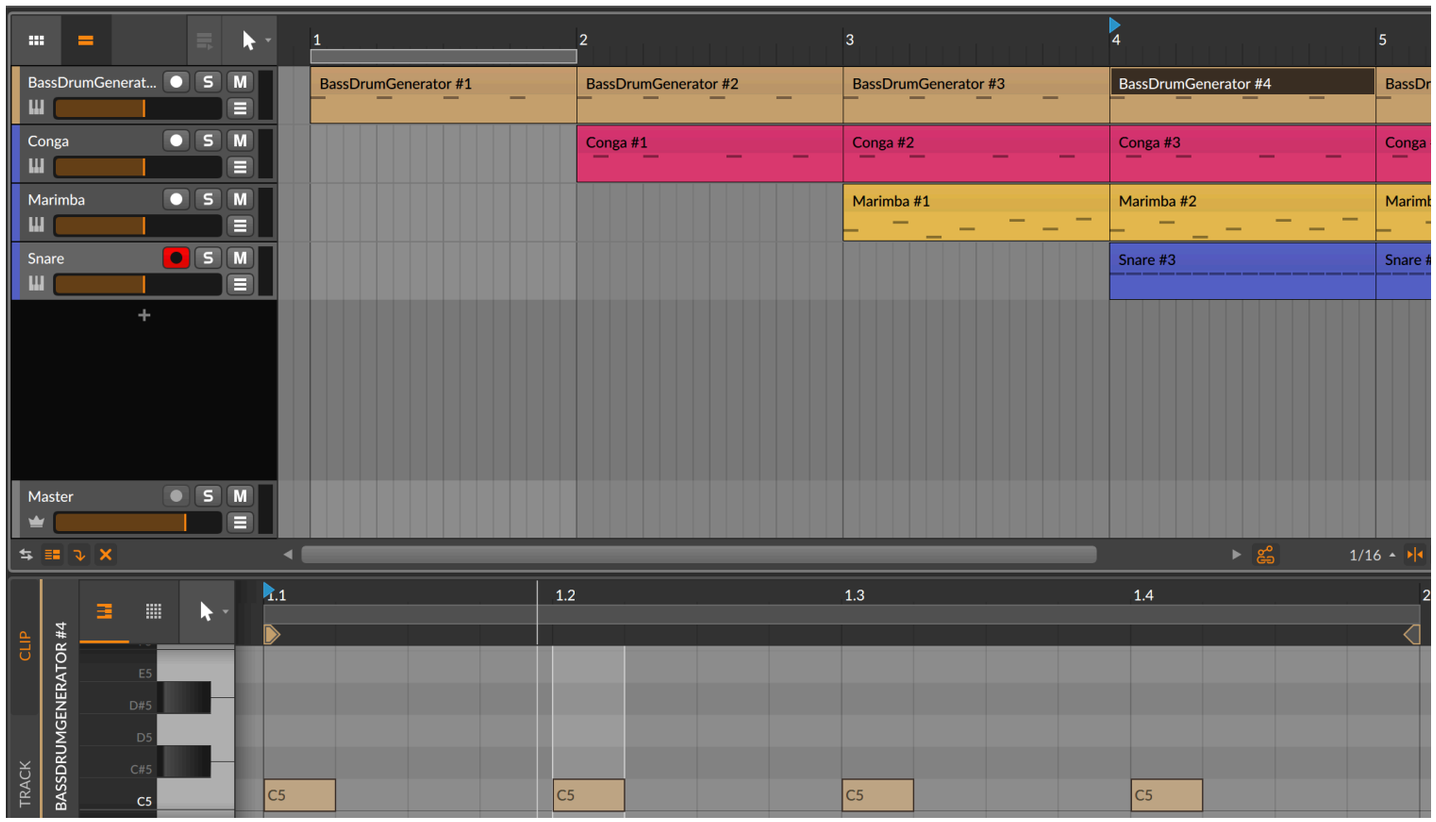
Many sequencers

Virtually has many as you need

A Sequencer resemble a *track* in a Digital Audio WorkStation



But in Coypu its values can have different size !

```
16 semiquavers index: '1 , 7' ; notes: '62 , 65 , 67' to: #speakspell
```

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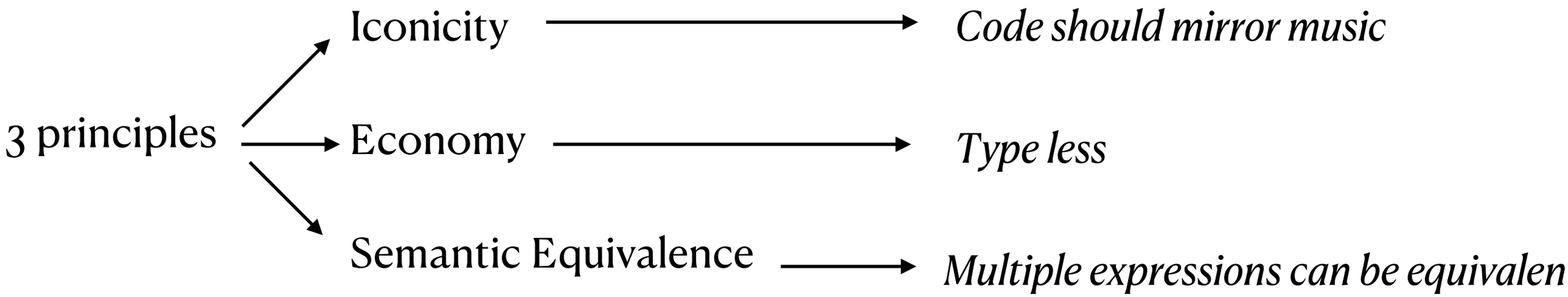
A NEW MUSIC DIALECT



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A NEW MUSIC DIALECT

Create `Sequencers`

- From Arrays → `#(1 0 0 1 0 1 0 0 1 1 ) asSeq.`
- With random generators → `16 randomTrigsWithProbability: 67.`
- From euclidean rhythms → `#(3 16) euclidean.`
- With a *string notation* → `'40*2 , 57 , ~ , 65/3 , ~*5' asDirtNotes.`
- From a *rhythm* name → `16 cumbiaClave.`

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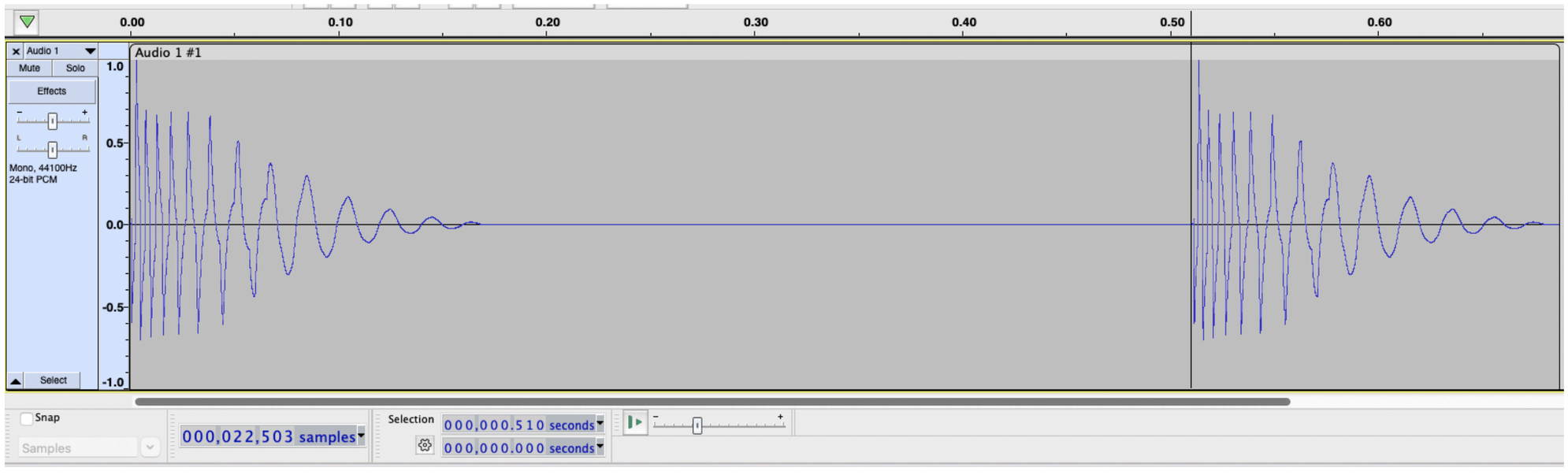
Road to fame

We consider Coypu to still be in its beta phase. In order to proceed toward a stable release, several current limitations need to be addressed:

1. No current support for cyclical structures (e.g., TidalCycles-style patterns).
2. Timing resolution and rhythmic subdivision control currently unavailable.
3. The average jitter in the performance playhead advancement is approximately 1 ms.



We're working toward a solution for testing performance in dynamic, on-the-fly music systems like Coypu.

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Conclusions

ICLC2025 (Algo:noises at Laut, Barcelona)

Festival della Robotica 2025 (Workshop, Pisa)

IFC2024 (Torino)

ESUG2024 (Lille)

ICLC2024 (Algorave at System, Shanghai)

Algorave at OHM (Berlin , 2024)

ESUG2023 (Lyon)

ICLC2023 (Algorave + Workshop, Düsseldorf)

ESUG2023 (Novi Sad)

Cyberspeak (Milano, 2022)

Still in beta,
but already in the wild

Empirical investigation into teaching methods and their real-world application is essential for effective evaluation.

We need more workshops and more users,
to spread everywhere.

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