

Virtual Agents in Live Coding

Preliminary Investigations

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A Venn diagram consisting of three overlapping circles on a light blue background. The top circle is light blue and labeled 'Research'. The bottom-left circle is light green and labeled 'Teaching'. The bottom-right circle is light red and labeled 'Practice'. The intersections are shaded: the intersection of Research and Teaching is teal; the intersection of Research and Practice is purple; the intersection of Teaching and Practice is olive green; and the central intersection of all three is a darker shade of olive green.

Research

Teaching

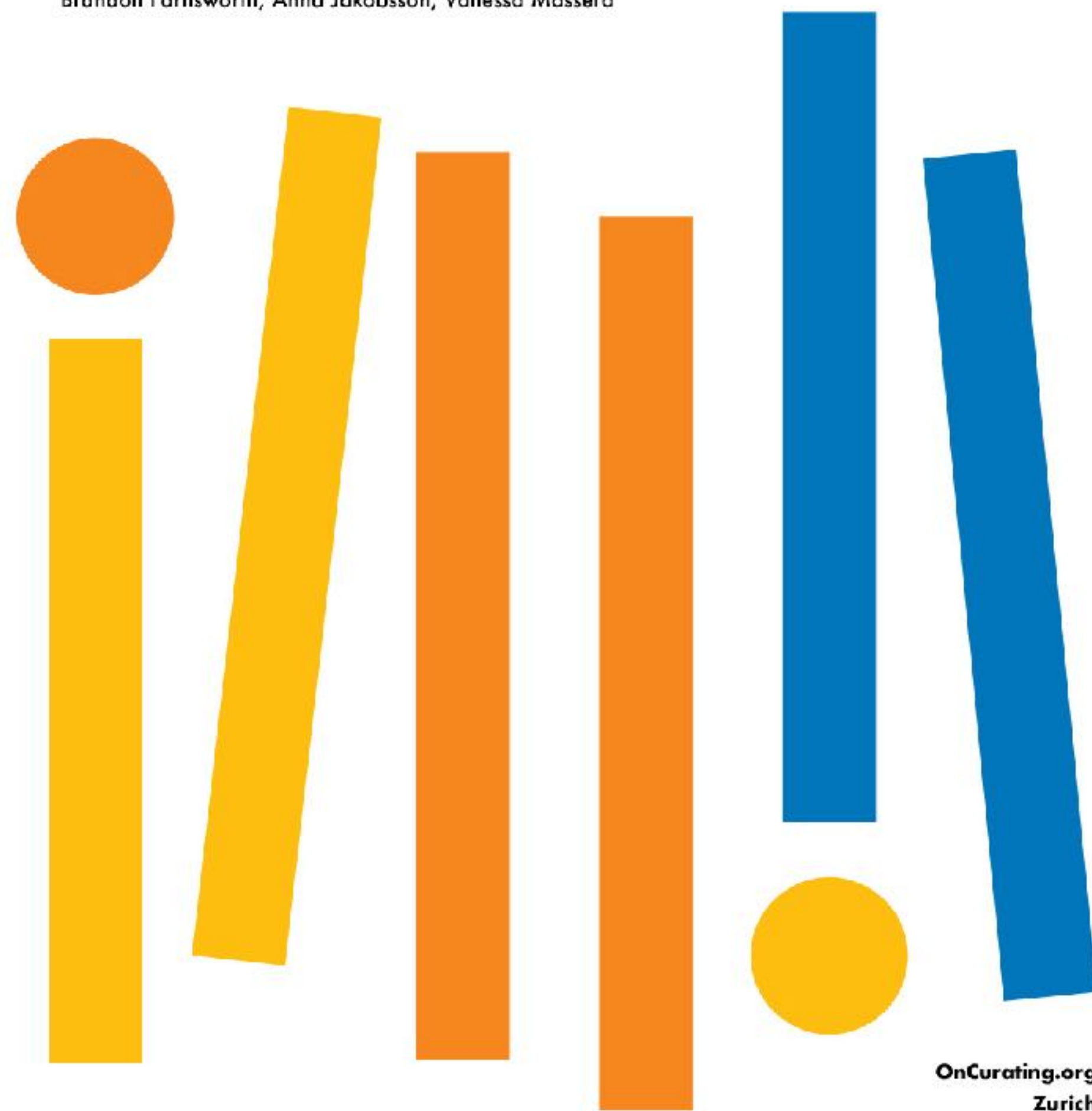
Practice

Taking the Temperature

Crisis, Curating, and Musical Diversity

Edited by

Brandon Farnsworth, Anna Jakobsson, Vanessa Massera



OnCurating.org
Zurich

Crisis, Curating, and Musical Diversity

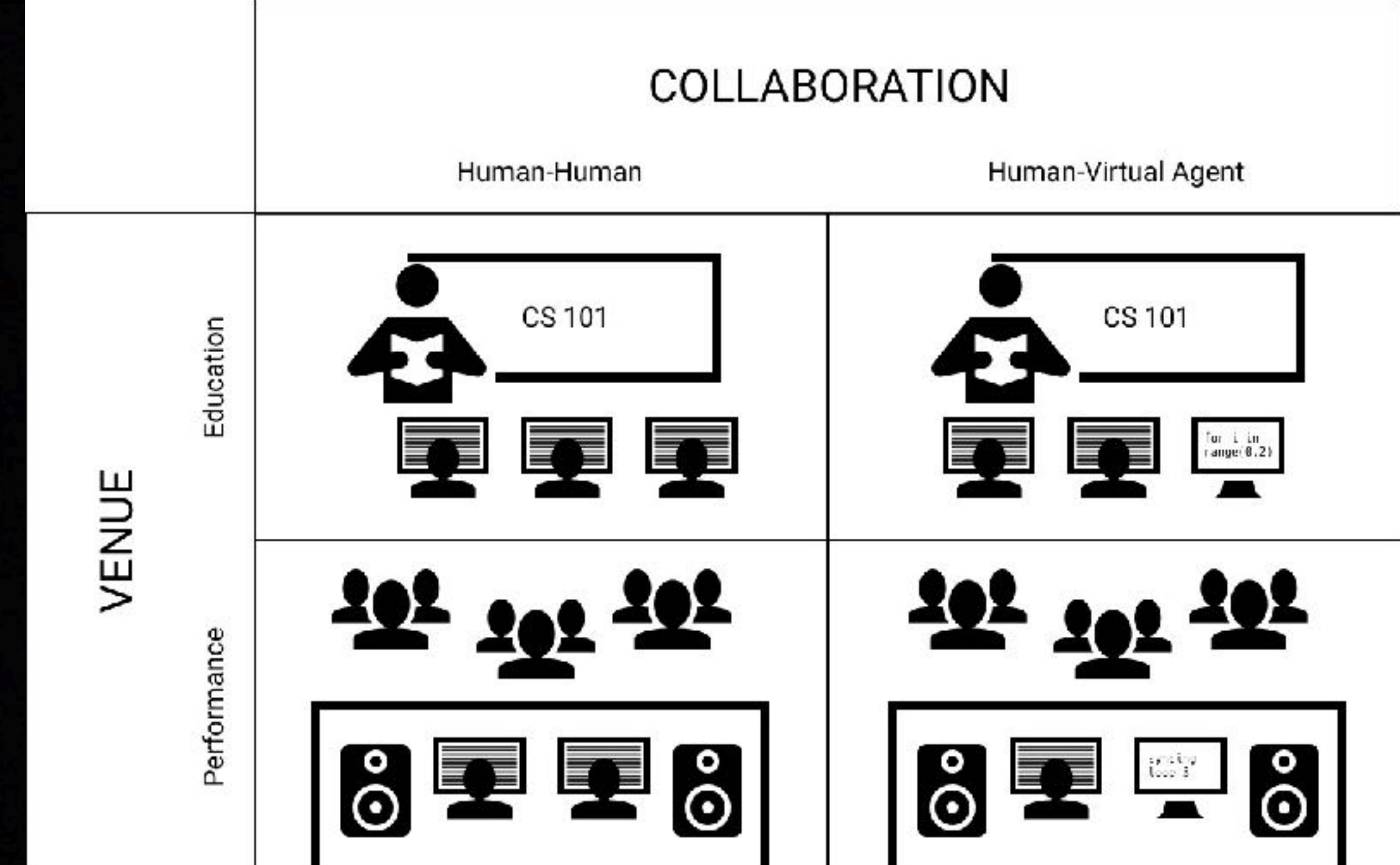
Farnsworth, B., Jakobsson, A., Massera, V.
(2020) *"Taking the Temperature: Crisis, Curating, and Musical Diversity"*, OnCurating.org, Zurich


```
MTI@00.m4d
36 // instr: grain, lfo, sin
37 // source, overlay, onsets, amps, beats
38 // free, plotserver
39
40 // fx: reverb, delay, lowpf, highpf, bandpf, bitcrush
41
42
43 // Space
44 // East Midlands
45 // Neil Armstrong
46
47
48 a = MIRLCAuto2.new
49 a.tag("east+midlands+train")
50 a.reverb
51
52
53 b = MIRLCAuto2.new
54 b.tag("Neil+Armstrong")
55 b.play(-1)
56
57
58 c = MIRLCAuto2.new
59 c.source
60 c.onsets
61 c.onsets(flo)
62 c.delay
63
64
65
66
67
68
Interpreter: Active Server: 3.29% 5.90% 298u 10s 11g 145d 0.0dB
```

MIRLCAuto: A Virtual Agent for Music Information Retrieval in Live Coding

In collaboration with: IKLECTIK, Leicester Hackspace, L'ull cec, Phonos, MTI²

Awarded with an EPSRC HDI Network Plus Grant



The screenshot displays the EarSketch web application interface, which is divided into several functional areas:

- Top Navigation:** Includes links for "ABOUT", "CONTACT", and "DISCUSS". On the right, there are fields for "Username" and "Password", and a "Create / Reset Account" button.
- Sound Browser (Left Panel):** Features a search bar with the term "groove" and filters for "Artists", "Genres", and "Instruments". A list of sound files is shown under the category "HIP_HOP_98_BPM_HHDUSTYGROOVE", including files like "HIPHOP_DUSTYGROOVEPART_001" through "HIPHOP_DUSTYGROOVE_007". A "Results per page: 10" indicator is at the bottom.
- Digital Audio Workstation (Center):** Shows a timeline with two tracks labeled "Effects" and "Bypass". The "Effects" track contains several delay and mix effects, such as "DELAY-DELAY...", "DELAY-MIX", and "Bypass". A red vertical line indicates the current playback position.
- Code Editor (Bottom Center):** Displays a Python script in a "Code Editor" window titled "untitled.py". The script uses the Firepad library to control the audio effects. The code includes:


```

30 setEffect(2, DELAY, DELAY_TIME, 50)
31 setEffect(2, DELAY, MIX, 0.9)
32 setEffect(4, DELAY, DELAY_TIME, 150)
33 setEffect(4, DELAY, MIX, 0.9)
34 setEffect(3, DELAY, DELAY_TIME, 250)
35 setEffect(3, DELAY, MIX, 0.9)
36
37
38 beatPattern = "0---0---0---0---"
39
40 001. 3. 2.0. beatPattern
      
```

 The "FIREPAD" logo is visible in the background of the code editor. Below the code, a status message reads "Running script..." and "Script ran successfully."
- Chat Room (Right Panel):** Shows a list of users in the room, including "sketch_foo" and "gerard". A chat history shows messages such as "are any of the groove sounds good here? e.g. HIPHOP_DUSTYGROOVEPART_001" and "want to add another delay to MASTER_TRACK too??" A "Your message:" input field is at the bottom.

The bottom of the browser window shows a taskbar with open files: "WAC2016-15.pdf", "133_Do_the_Buzzer_S....pdf", and "Snagit.dmg".

Xambó, A., Roma, G., Shah, P., Freeman, J., Magerko, B. (2017) "Computational Challenges of Co-creation in Collaborative Music Live Coding: An Outline". 2017 Co-Creation Workshop at the International Conference on Computational Creativity. Atlanta, GA, USA.

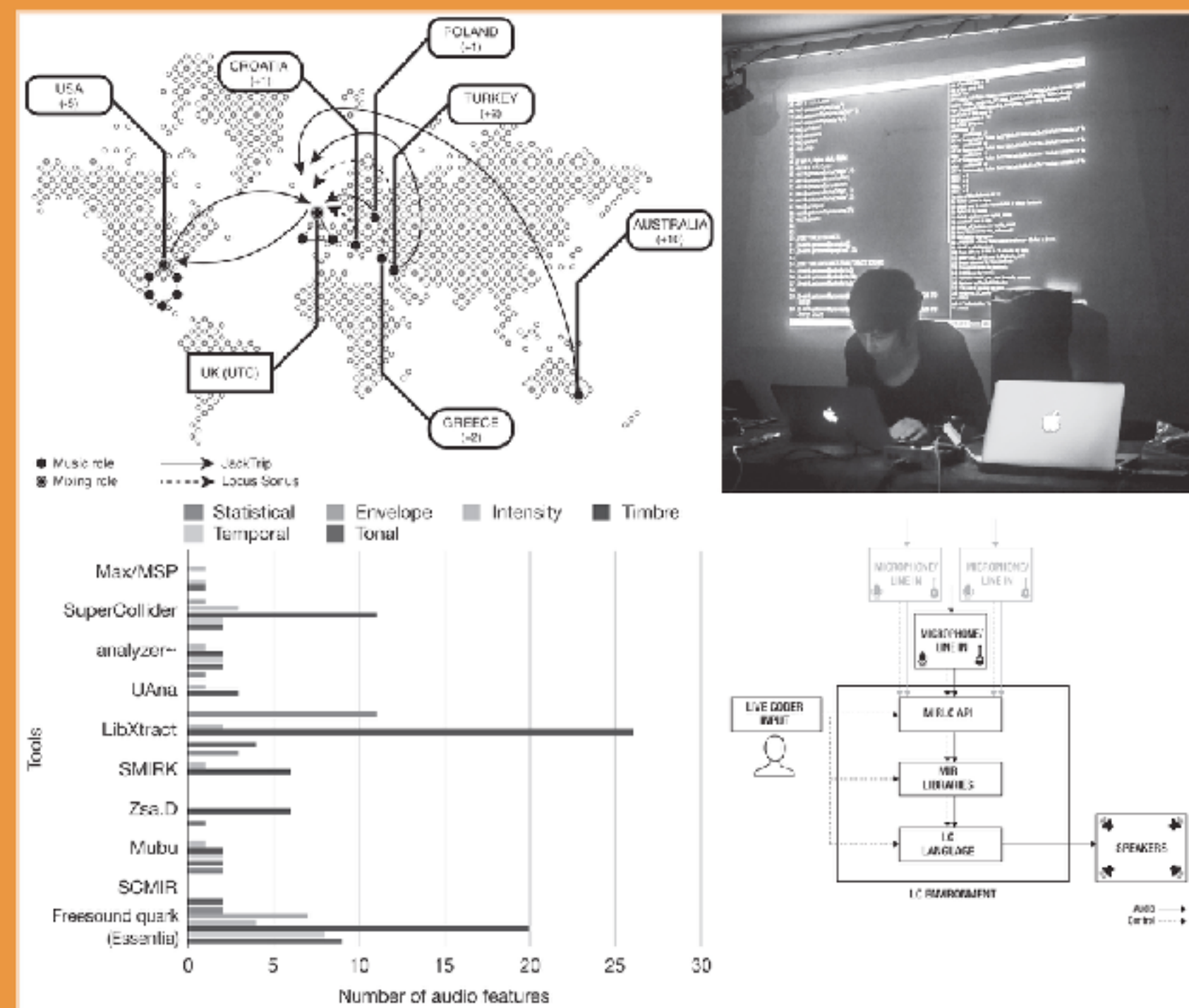
Computer Music Journal

Volume 42, Number 4

ISSN 0148-9267 \$19.00

Winter 2018

Music Information Retrieval in Live Coding



MIR in Live Coding

- **MIRLCRep**: audio repurposing
- **MIRLCRew**: audio rewiring
- **MIRLCRex**: audio remixing

Xambó, A., Lerch, A. and Freeman, J. "Music Information Retrieval in Live Coding: A Theoretical Framework". Computer Music Journal, 42(4), Winter 2018, pp. 9-25.


```
// instantiation
~a = MIRLCRep.new
~b = MIRLCRep.new

// GET SOUNDS BY TEXT

// getsound(id=31362, size=1)
~a.id(323399)
~a.id(19246)
~a.id(19247)
~b.id(19248)
~b.id(192468)

// random(size=1)
~a.random
~a.random(2)
~a.random(3)
~b.random

// tag(tag="noise", size=1)
~a.tag("nail", 3)
~a.tag("chimes", 2)
~a.tag("noise", 2)
~a.tag("hammer", 2)
~b.tag("grain", 2)
~b.tag("humming", 3)
```

MIRLCRep 1.0

```
// GET SOUNDS BY CONTENT & GET SOUNDS BY CONTENT WITH FILTER

// content(size=1, feature = 'dur', fvalue = 1, fx = 'conf', fxvalue = 'hi')
~a.content // sounds of 1 sec of duration
~a.content(1, 'dur', 10) // sounds of 10 sec of duration
~a.content(1, 'dur', 1, 'key', 'A')
~a.content(1, 'dur', 4, 'scale', 'minor')
~a.content(1, 'dur', 1, 'conf', 'lo')
~a.content(2, 'pitch', 100, 'conf', 'lo')
~a.content(1, 'key', 'Asharp')
~a.content(5, '.lowlevel.spectral_complexity.mean:', 1, 'conf', '[0 TO 0.3]') // Using directly Essentia's format
~b.content(1, 'bpm', 120)


// GET SIMILAR SOUNDS BY EXAMPLE

// similar(targetnumsnd=0, size=1)

~a.similar
~a.similar(0)
~a.similar(0, 2)
~b.similar(1)


// GET SIMILAR SOUNDS BY FILTER

// filter (targetnumsnd=0, size=1, fx = 'conf', fxvalue = 'hi')

~a.content(1, 'dur', 4, 'scale', 'minor')
~a.filter(1, 1, 'conf', 'lo')
~a.filter(1, 1, 'conf', 'hi')
~a.filter(2, 1, 'conf', 'hi')

~b.content(1, 'dur', 2)
```

MIRLCRep 1.0


```
Equinox-22-03-2020-19-30.scd
31
32 // Hello !
33
34
35
36
37
38
39 // Tag
40
41 a.tag("morse"+"two")
42
43
44 b|
45
46
47
48 c
49
50
51 d
52
53
54 e
55
56
:: Anna Xambó ::
```

```
Post window
server 'localhost' already booting
server 'localhost' already booting
server 'localhost' already booting
server 'localhost' already booting
server 'localhost' already booting
server 'localhost' already booting
server 'localhost' already booting
server 'localhost' already booting
-> a MIRCRep2
Booting server 'localhost' on address 127.0.0.1:57110.
Found 0 LADSPA plugins
Number of Devices: 8
0 : "Built-In Microph"
1 : "Built-In Output"
2 : "Scarlett 6i6 USB"
3 : "BlackHole 16ch"
4 : "Soundflower (2ch)"
5 : "Soundflower (64ch)"
6 : "ZoomAudioDevice"
7 : "Multi-Output Device"

"Scarlett 6i6 USB" Input Device
Streams: 1
0 channels 6

"BlackHole 16ch" Output Device
Streams: 1
0 channels 16

SC_AudioDriver: sample rate = 44100.000000, driver's block size = 512
SuperCollider 3 server ready.
Requested notification messages from server 'localhost'
localhost: server process's maxLogins (1) matches with my options.
localhost: keeping clientID (0) as confirmed by server process.
Shared memory server interface initialized
Sounds selected by tag: 1
curl -H 'Authorization: Token 5a837b803eb5a6da25dd3b42346fd6550080b919' 'https://www.free
-> a MIRCRep2
{"count":7,"next":null,"results":[{"id":47487,"name":"sw-13.wav","tags":["electronic","morse","noise"],
found sound by tag, id: 47487name: sw-13.wav
curl -H 'Authorization: Token 5a837b803eb5a6da25dd3b42346fd6550080b919' 'https://www.free
{"id":47487,"url":"https://freesound.org/people/galeku/sounds/47487/","name":"sw-13.wav","tags"
curl -H 'Authorization: Token 5a837b803eb5a6da25dd3b42346fd6550080b919' 'https://freesound
[0]: id: 47487 name: sw-13.wav by: galeku dur: 83.5293

Interpreter: Active Server: 0.22% 0.29% 8u 1s 52g 134d 0.0dB M R
```

“Crowdsourced Eulerisms”. Eulerroom Equinox 2020.
Streaming from Sheffield, UK. March 23, 2020.

MIRCRep 2.0

Unwanted Situations: The Guitar Case

n02-peterMann

from [noiselets](#) by [carpal tunnel](#)



04:13 / 11:10



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from [noiselets](#), released January 8, 2018

List of sounds used from [Freesound.org](#) coming soon.

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<https://carpal-tunnel.bandcamp.com/track/n02-petermann> (around 04:26)

Research Question

Can we build a **virtual agent live coder companion** that **learns** from human live coders using **machine learning** algorithms and a **large dataset of sounds** which goes beyond the approach of following live coder actions (also known as the call-response strategy) and creates **legible and negotiable actions**?

Outline

- Project's context and research question.
- Short review of different perspectives of using VAs in LC.
- Towards identifying the first ML task.

Different Perspectives of VAs in LC

Xambó, A. (2020) “Virtual Agents in Live Coding: A Short Review”. Submitted to e-Contact! (online journal).

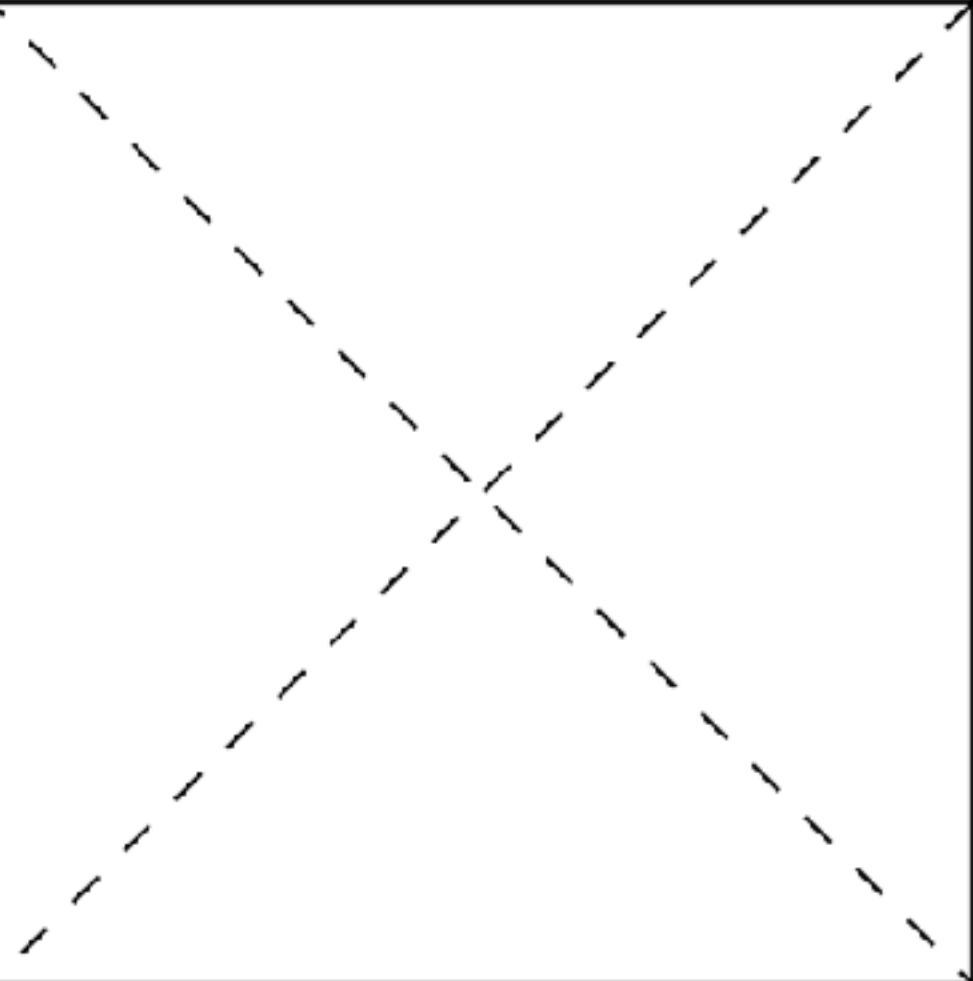
“An **autonomous agent** is a system situated within and a part of an environment that **senses that environment and acts on it**, over time, in pursuit of its own agenda and so as to **effect what it senses in the future.**” (Franklin and Graesser 1996, 25)

Franklin, Stan and Graesser, Art. “Is it an Agent, or just a Program?: A Taxonomy for Autonomous Agents.” In Intelligent Agents III Agent Theories, Architectures, and Languages. Edited by Müller, Jörg P., Wooldridge, Michael J. and Jennings, Nicholas R. Berlin: Springer, 1996, pp. 21–35.

“For each possible percept sequence [the complete history of everything the agent has ever perceived], a **rational agent** should **select an action** that is expected to **maximize its performance measure**, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.” (Russell and Norvig 2016, 37)

Hence “a **rational agent** should be **autonomous**” (Russell and Norvig 2016, 39).

Matrix of Learnability & Social Interactivity

		LEARNABILITY	
		Yes	No
SOCIAL INTERACTIVITY	Yes	<p>Mégra (2020)</p> <p>Autopia (2019)</p> <p>Cacharpo (2017)</p> <p>Flock (2016)</p> <p>Betablocker (2007, 2014)</p>	<p>LOLbot (2012)</p> <p>Autocode (2011)</p>
	No	<p>Cibo v2 (2020)</p> <p>Cibo (2019)</p>	

- **Assumption:** VAs are **autonomous** (ranging from simple to complex agents).
- **Social interactivity:** does it cooperate with other agents, either virtual or human?
- **Learnability:** does it learn, either online or offline?

Cacharpo

- VA capable of live coding that works as a co-performer of a human live code. Music genre is inspired by the cumbia sonidera from Mexico.
- The agent ‘listens’ to the audio produced in SuperCollider by the live coder and responds. ML engine built using Artificial Neural Networks (ANNs).
- Example of an autonomous agent that has the ability to interact with other agents (in this case humans) with summative actions and has the ability to learn during offline training.

Navarro, Luis and Ogborn, David. “Cacharpo: Co-performing Cumbia Sonidera with Deep Abstractions.” Proceedings of the 2017 International Conference on Live Coding (Morelia, Mexico, 4–8 December 2017).

Cibo and Cibo v2

- VA built with interconnected NNs that generate TidalCycles code in solo performance style using samples from a training corpus.
- An encoder-decoder sequence-to-sequence architecture is implemented using the PyTorch library.
- Example of autonomous agents that have the ability to learn during offline training. At the moment the agent performs solo.

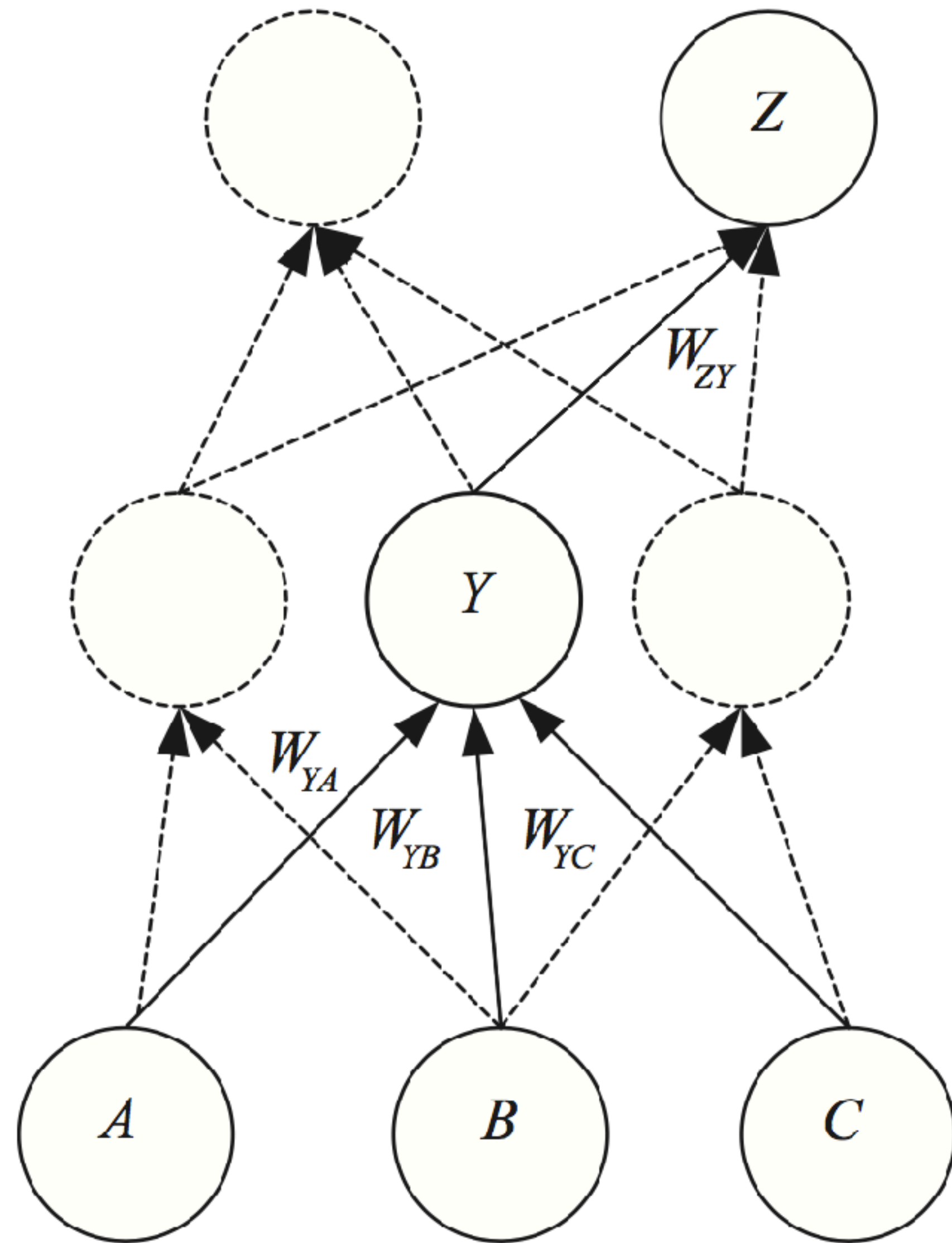
Stewart, Jeremy and Lawson, Shawn. “Cibo: An Autonomous TidalCycles Performer.” Proceedings of the Fourth International Conference on Live Coding (Madrid, Spain: Medialab Prado / Madrid Destino, 16–18 January 2019).

Stewart, Jeremy, Lawson, Shawn, Hodnick, Mike and Gold, Ben. “Cibo v2: Realtime Livecoding A.I. Agent.” Proceedings of the 2020 International Conference on Live Coding (Limerick, Ireland: University of Limerick, 5–7 February 2020), pp. 20–31.

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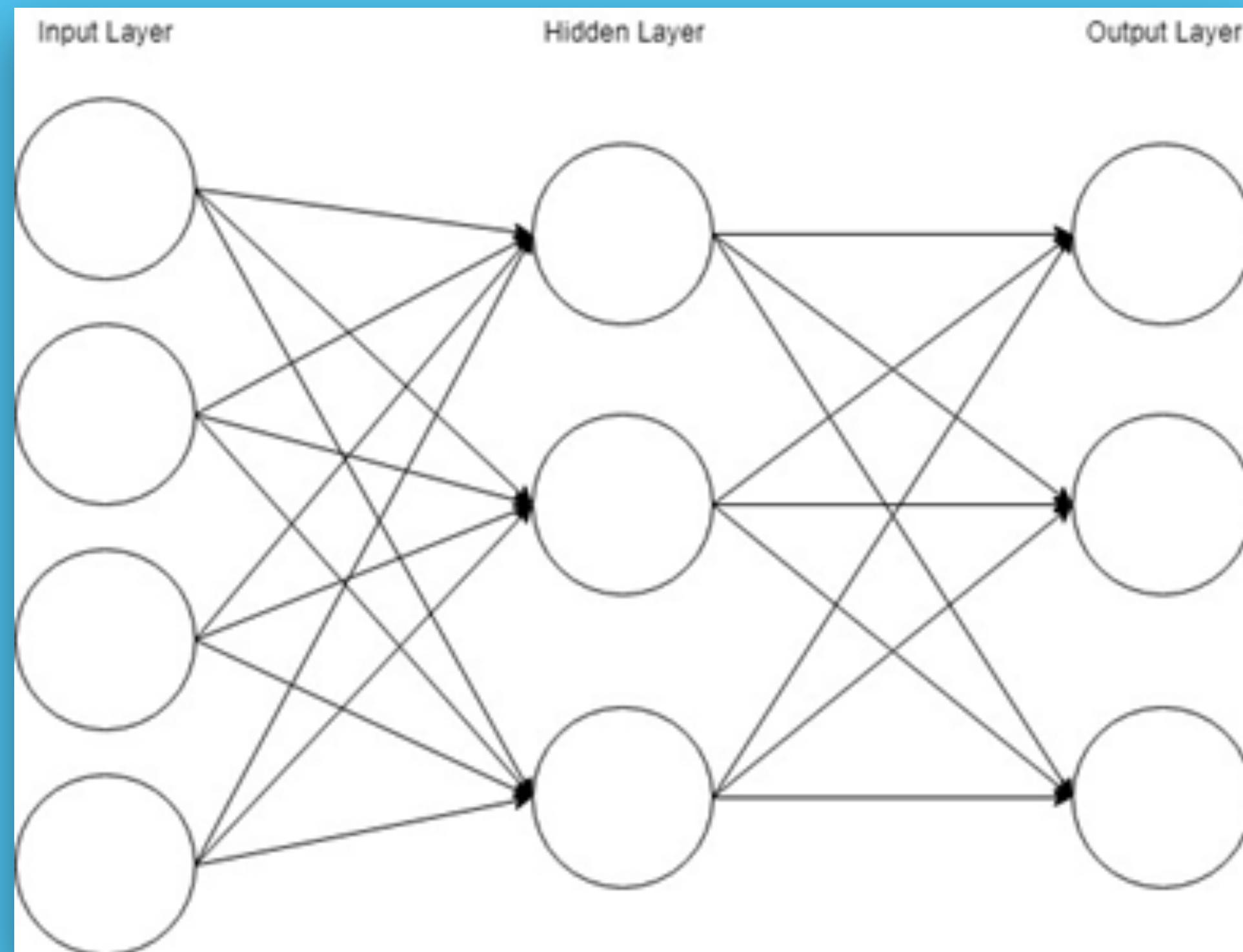
NNs



- Left: example of a neural network (NN) with neurons and synaptic connections.

Alpaydin, Ethem. Machine Learning: The New AI. Cambridge, MA: MIT Press, 2016.

MLP



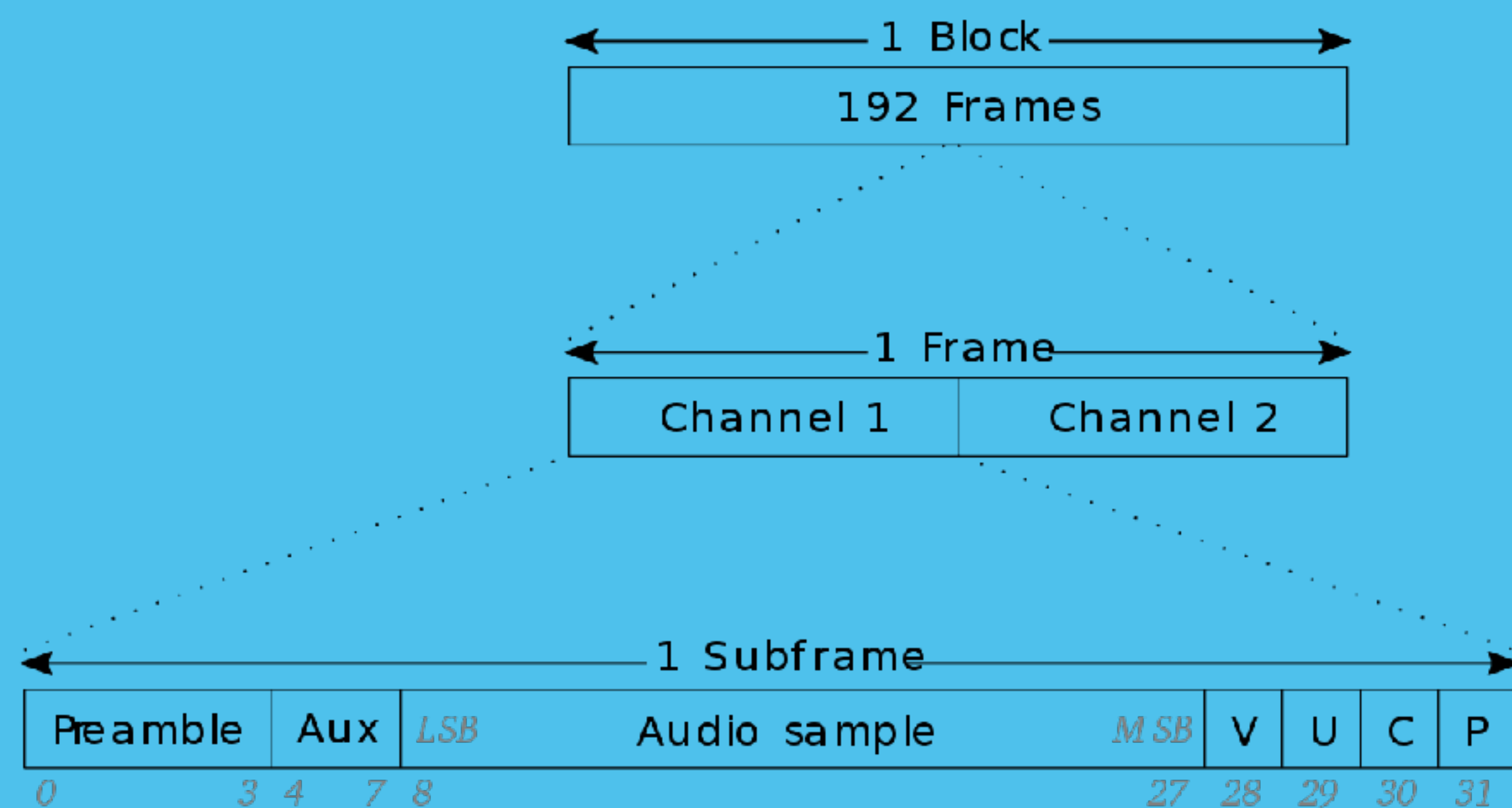
- Left: example of a multilayer perceptron (ML), which is a NN with an input layer, output layer, and may have hidden layers in between.
- A complex architecture suitable to learn regression and classification models for difficult datasets.

<https://deepai.org/machine-learning-glossary-and-terms/multilayer-perceptron>

ML Task

- **Two tasks** identified:
 1. **NN-1** learns my musical taste when retrieving sounds from Freesound: do I like it or not?
 2. **NN-2** learns to reply (call-response) with another query based on the existing sound and my musical taste. The response can be based on pitch, bmp or similarity.
- **For each NN:**
 - Phase 1. **Training.**
 - Phase 2. **Testing.**

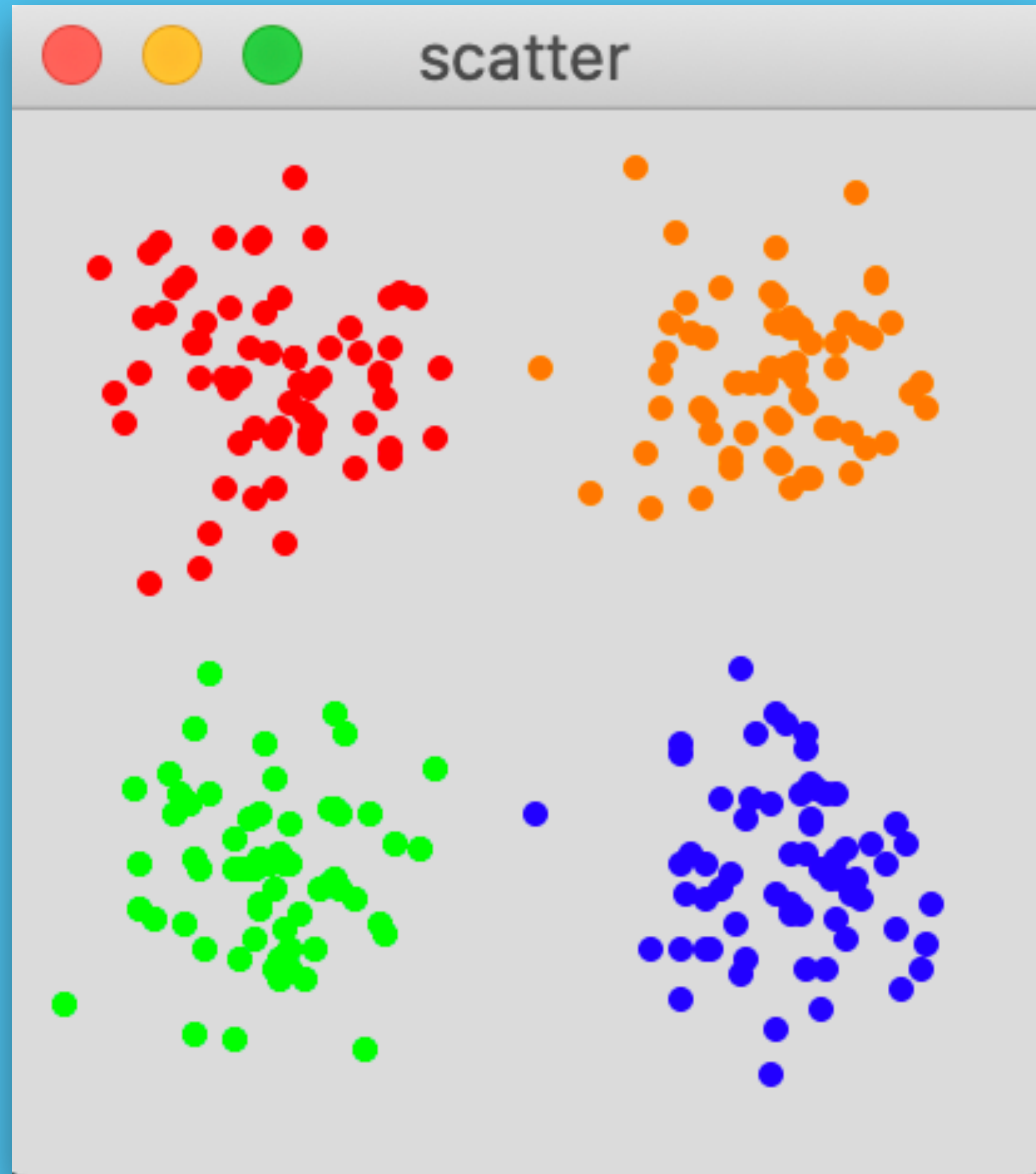
NN-1: Data Structure



- Choose a set of relevant sound descriptors that characterise the sound samples from Freesound, e.g.:
 1. pitch
 2. rhythm (bpm)
 3. brightness (spectral centroid)
 4. noisiness (spectral flatness)
- Map these sound descriptors to input layers of the NN (encode the information into meaningful numbers).

Left: AES3 Block Frame SubFrame from commons.wikimedia.org

Flucoma MLP NN



- FluidMLPClassifier: Perform classification using a MLP NN.
- FluidMLPRegressor: Perform regression using a MLP NN.

www.flucoma.org

How It Will Look Like?

Avoiding the Guitar Case

n02-peterMann

from [noiselets](#) by [carpal tunnel](#)



04:13 / 11:10



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List of sounds used from [Freesound.org](#) coming soon.

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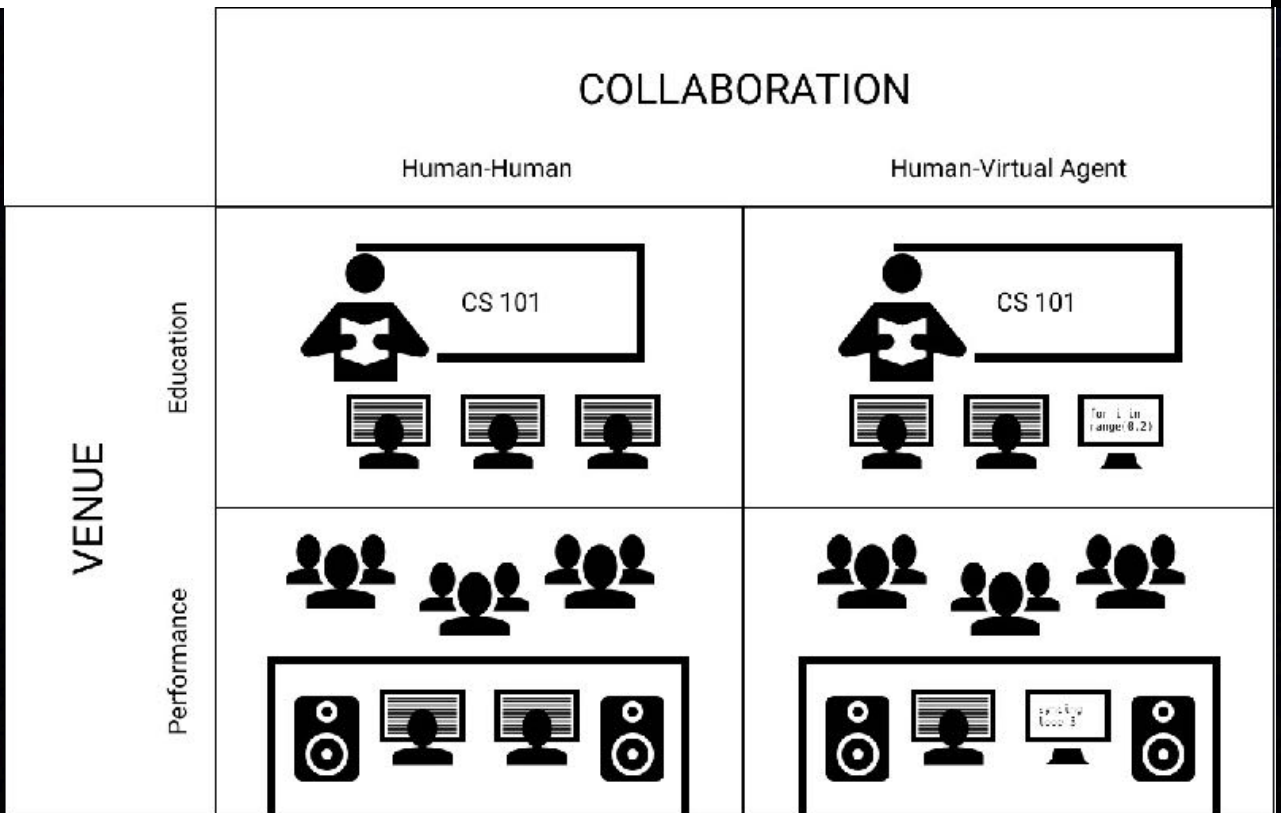
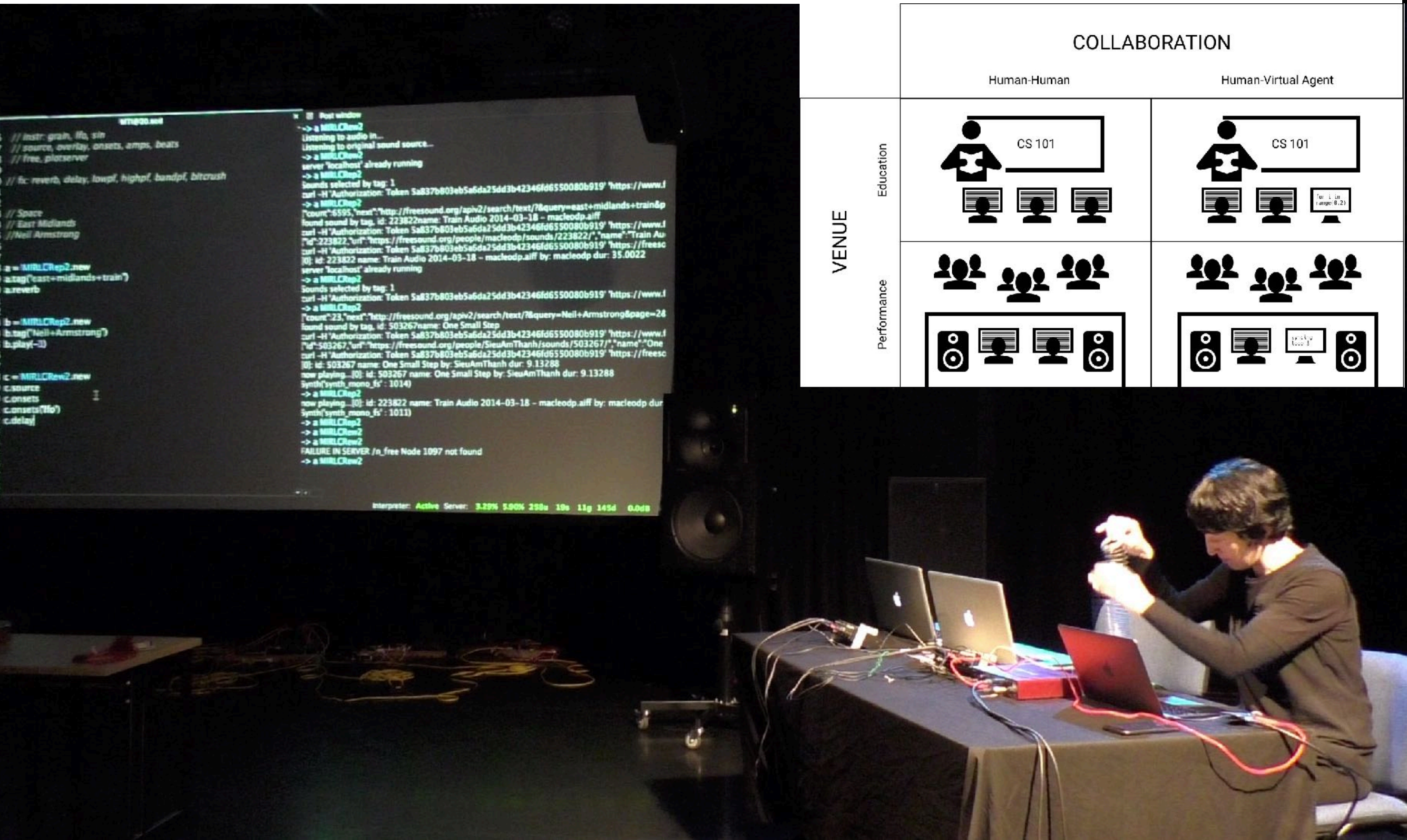
<https://carpal-tunnel.bandcamp.com/track/n02-petermann> (around 04:26)

What's next?

- Complete a working prototype.
- Online concerts in collaboration with IKLECTIK, Phonos, and MTI².
- Online workshops with Leicester Hackspace, IKLECTIC, and L'Ull Cec.

Acknowledgments

- Eduard Solaz & Isa Ferri (IKLECTIK)
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- Ángel Faraldo (Phonos / UPF)
- Leigh Landy (MTI²)
- Steve Gale (Leicester Hackspace)
- Gerard Roma (Flucoma)



Thanks for listening!

- Have you used ML in your practice?
- How have you formulated your ML problem?