Virtual Agents in Live Coding

Preliminary Investigations

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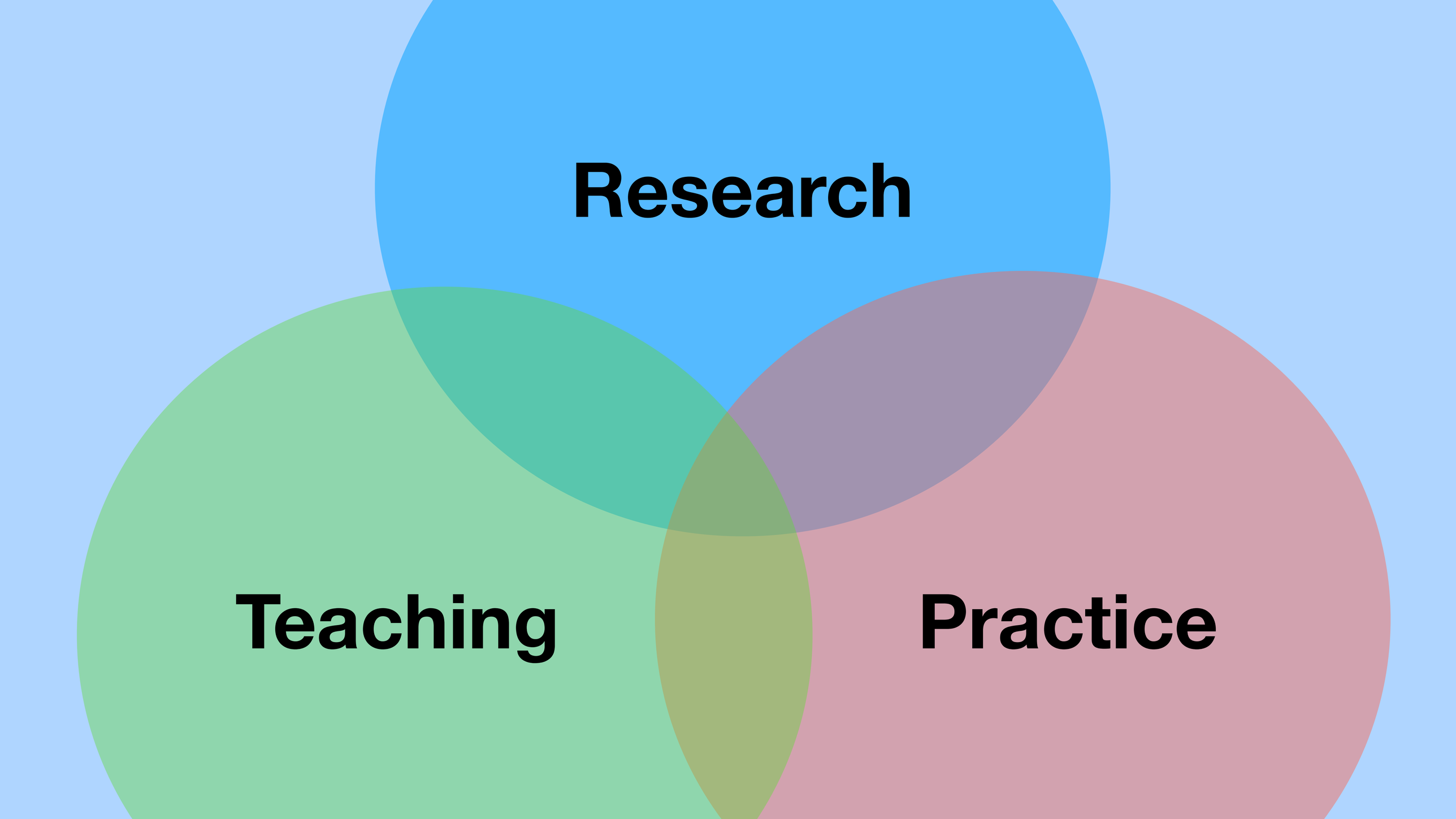
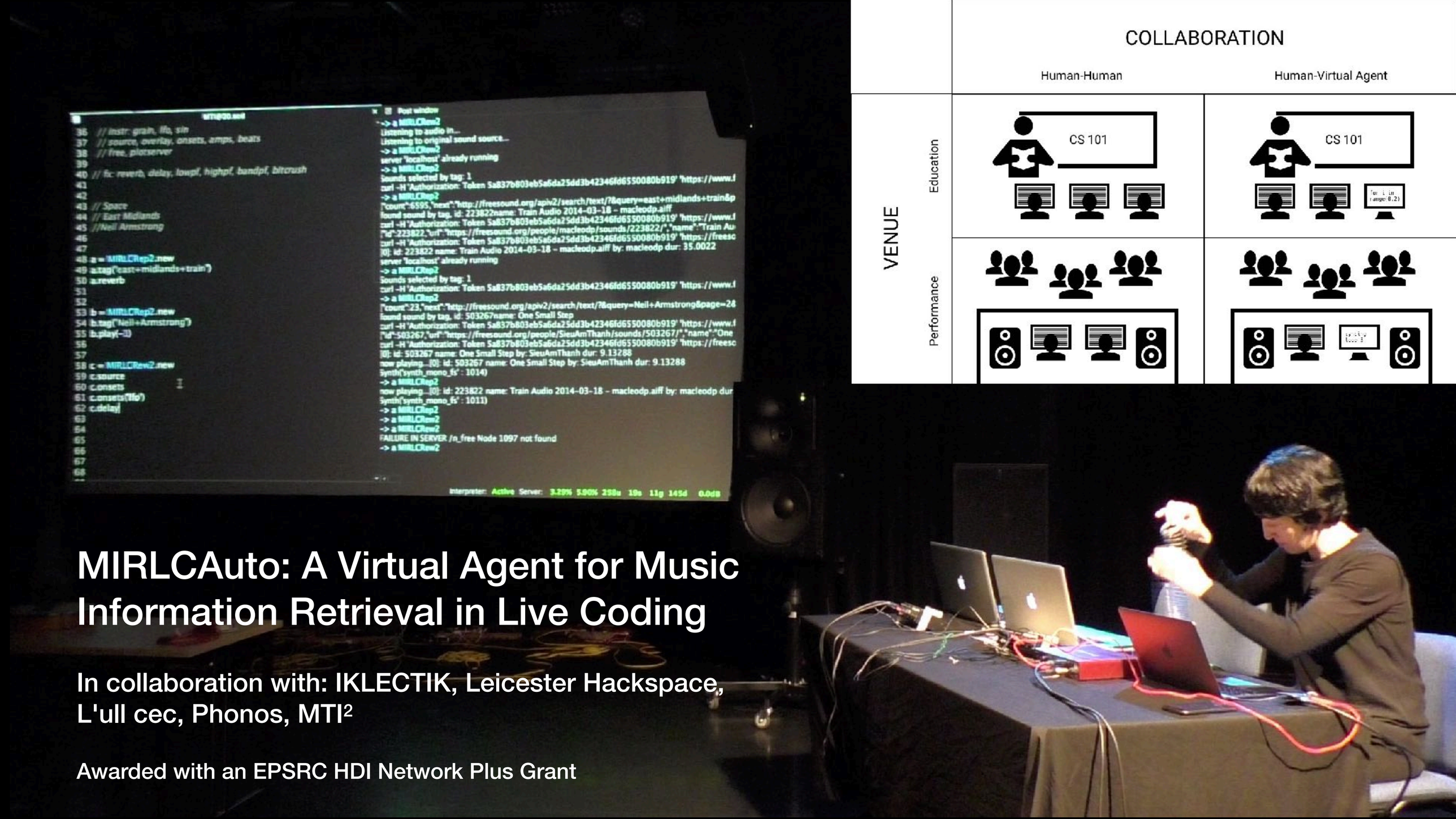
NOTAM 21.09.2020


Research
Teaching
Practice

Crisis, Curating, and Musical Diversity

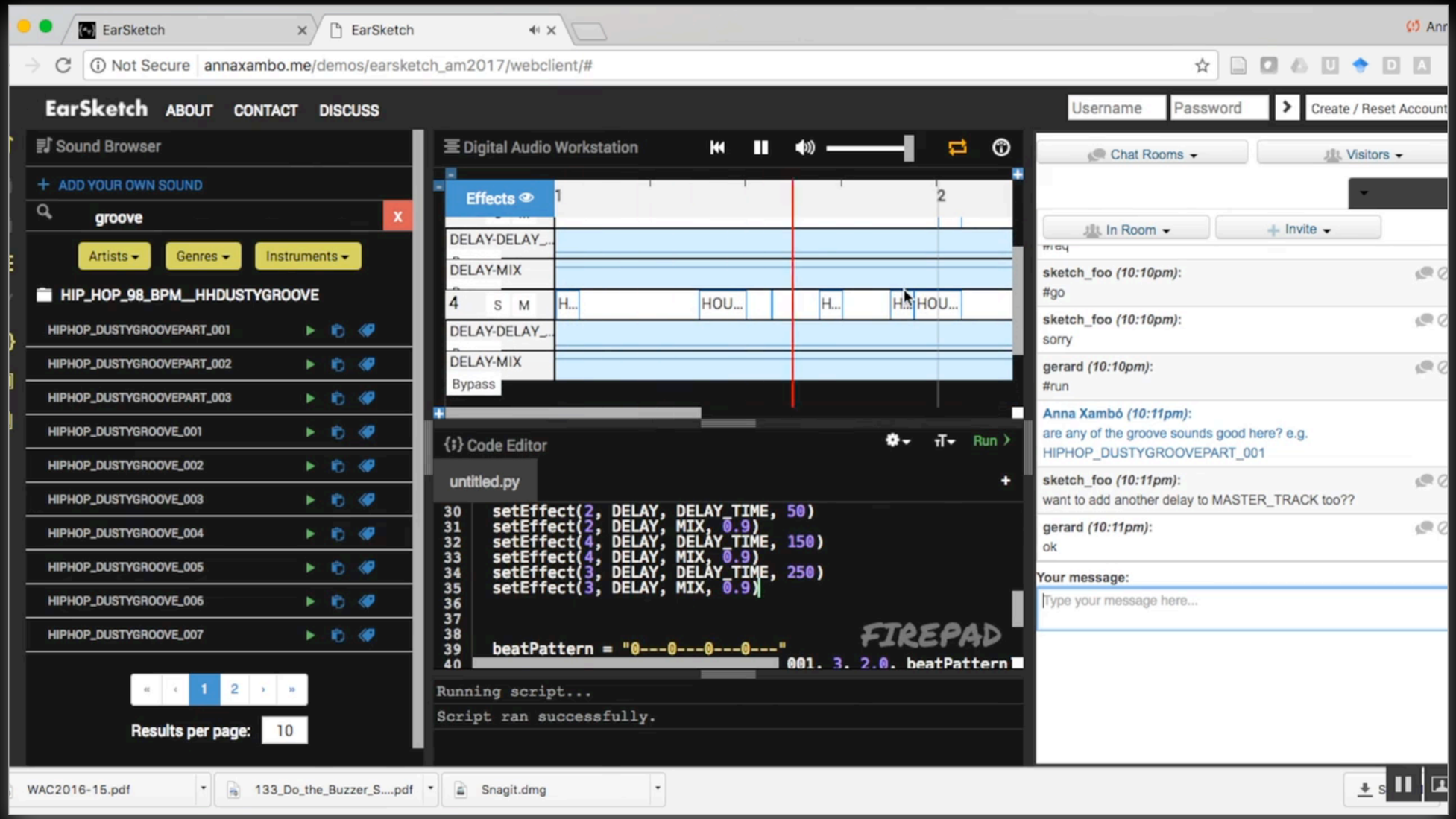
Farnsworth, B., Jakobsson, A., Massera, V. (2020) "*Taking the Temperature: Crisis, Curating, and Musical Diversity*", OnCurating.org, Zurich



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

In collaboration with: IKLECTIK, Leicester Hackspace, L'ull cec, Phonos, MTI^2

Awarded with an EPSRC HDI Network Plus Grant

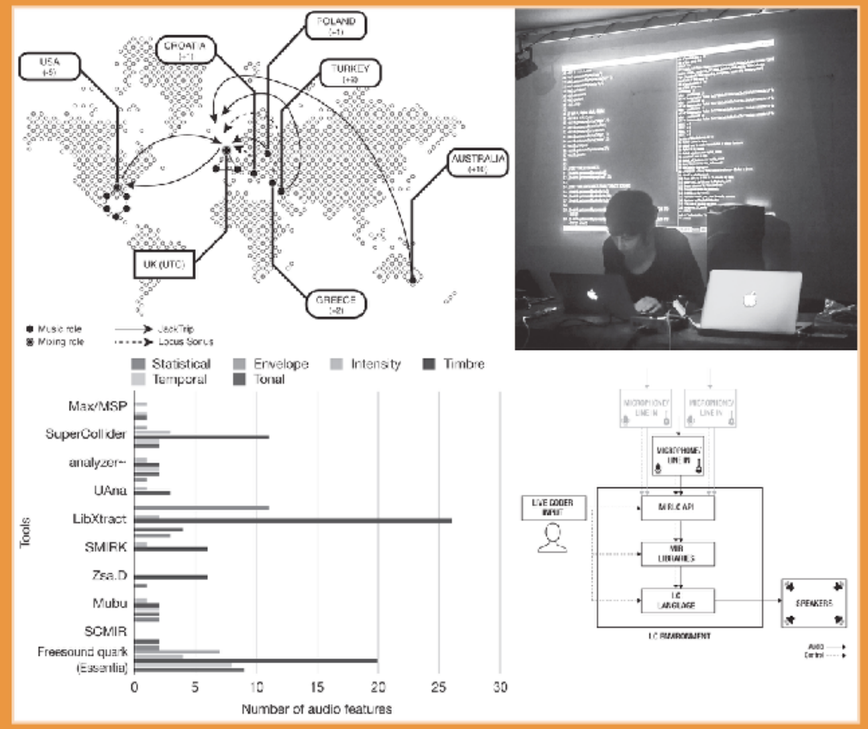


Xambó, A., Roma, G., Shah, P., Freeman, J., Magerko, B. (2017) “Computational Challenges of Co-creation in Collaborative Music Live Coding: An Outline”. 2017 Co-Creation Workshop at the International Conference on Computational Creativity. Atlanta, GA, USA.

Computer Music Journal

Volume 42, Number 4 ISSN 0148-9267 $19.00 Winter 2018

Music Information Retrieval in Live Coding



Published by The MIT Press http://mitpressjournals.org/cmj

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

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

MIRLCRep 2.0

Unwanted Situations: The Guitar Case

n02-peterMann

from noiselets by carpal tunnel

04:13 / 11:10

Digital Track

Streaming + Download

Includes high-quality download in MP3, FLAC and more. Paying supporters also get unlimited streaming via the free Bandcamp app.

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Send as Gift

Buy the Full Digital Album

from noiselets, released January 8, 2018
List of sounds used from Freesound.org coming soon.

Share / Embed Wishlist

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).

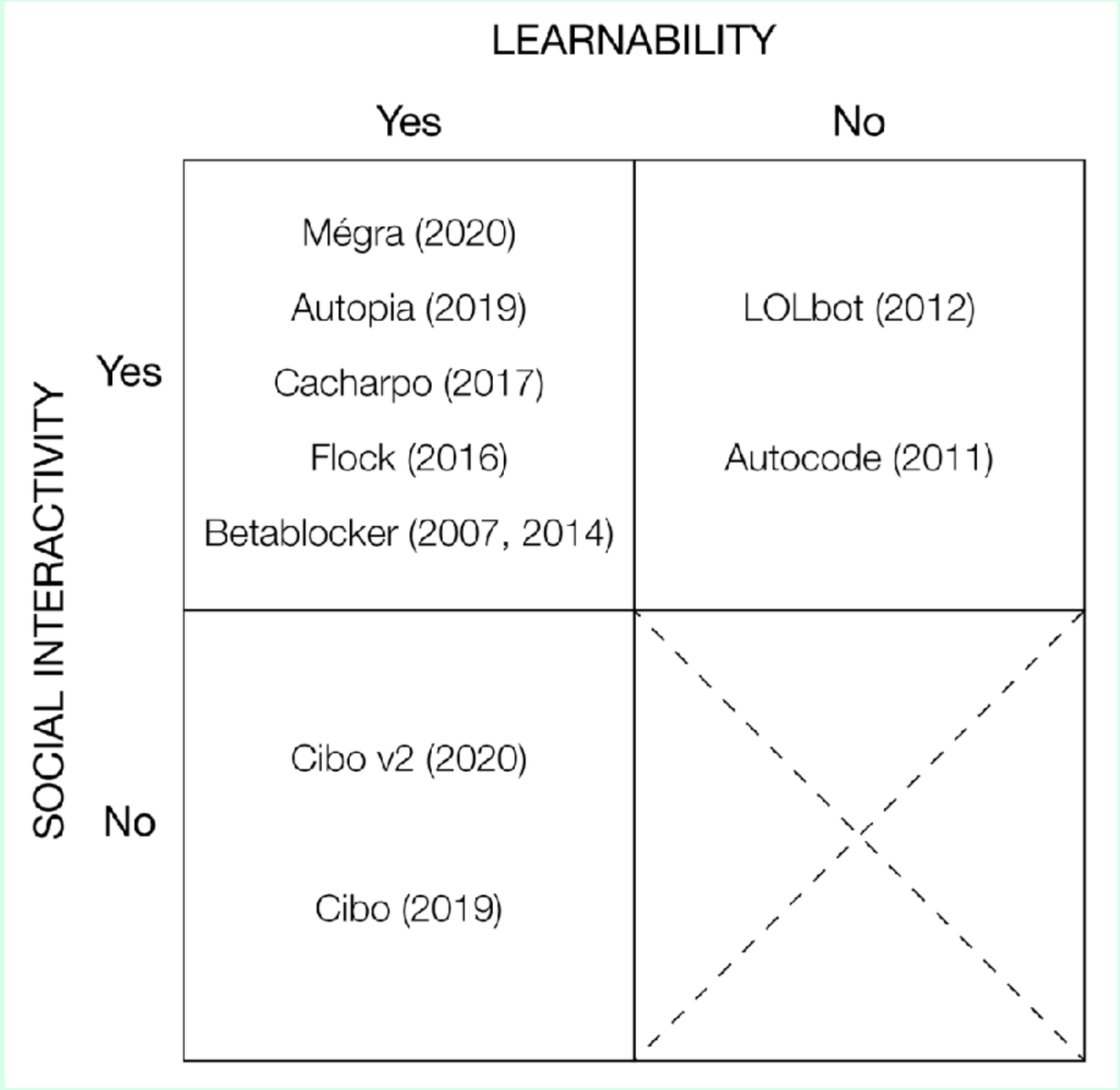
“An **autonomous agent** is a system situated within and a part of an environment that **senses that environment and acts on it**, over time, in pursuit of its own agenda and so as to **effect what it senses in the future**.” (Franklin and Graesser 1996, 25)

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 r**ational 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).

Russell, Stuart J. and Norvig, Peter. Artificial Intelligence A Modern Approach. 3rd edition. Essex: Pearson, 2016.



Matrix of Learnability & Social Interactivity

- **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 TidalCyles 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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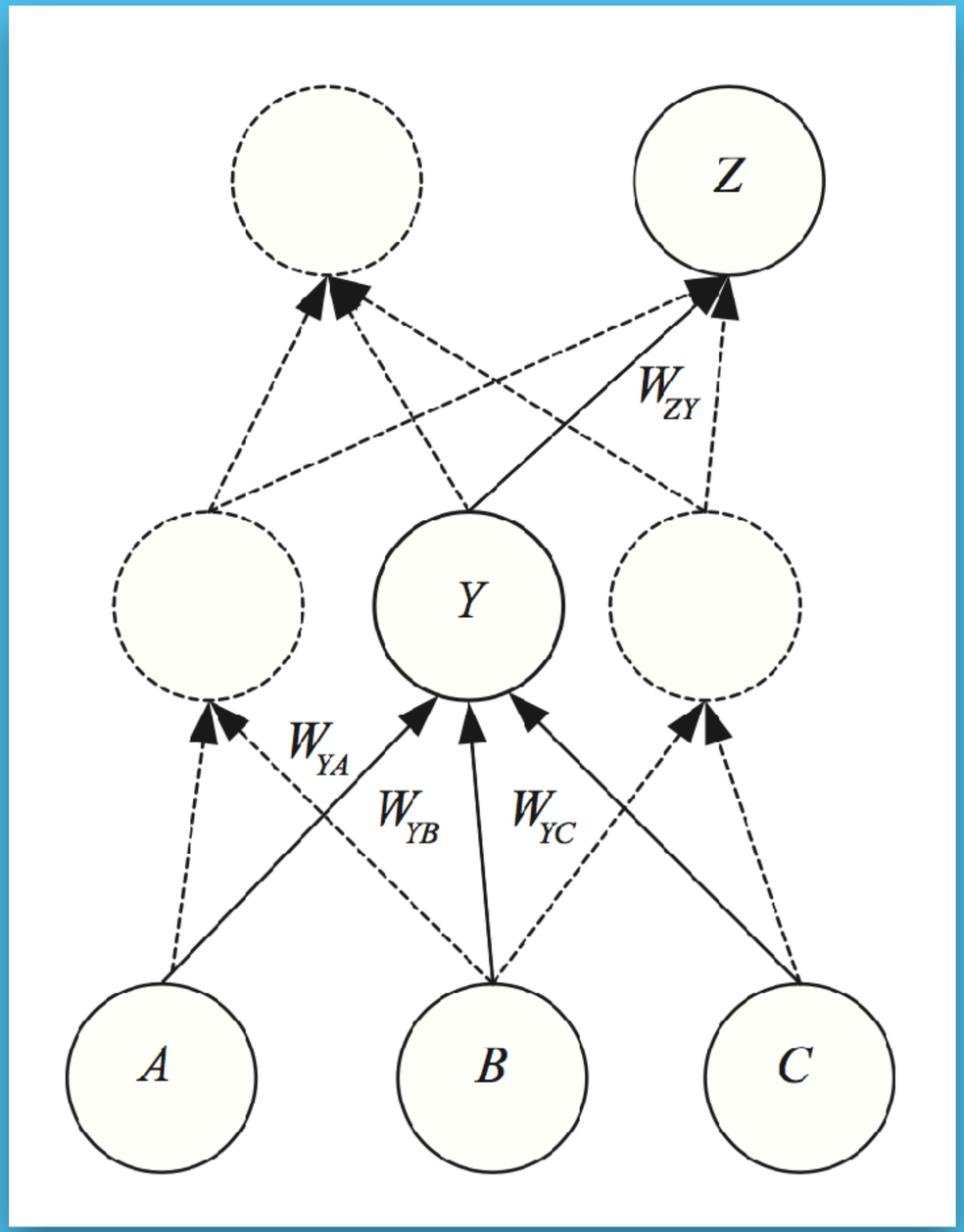
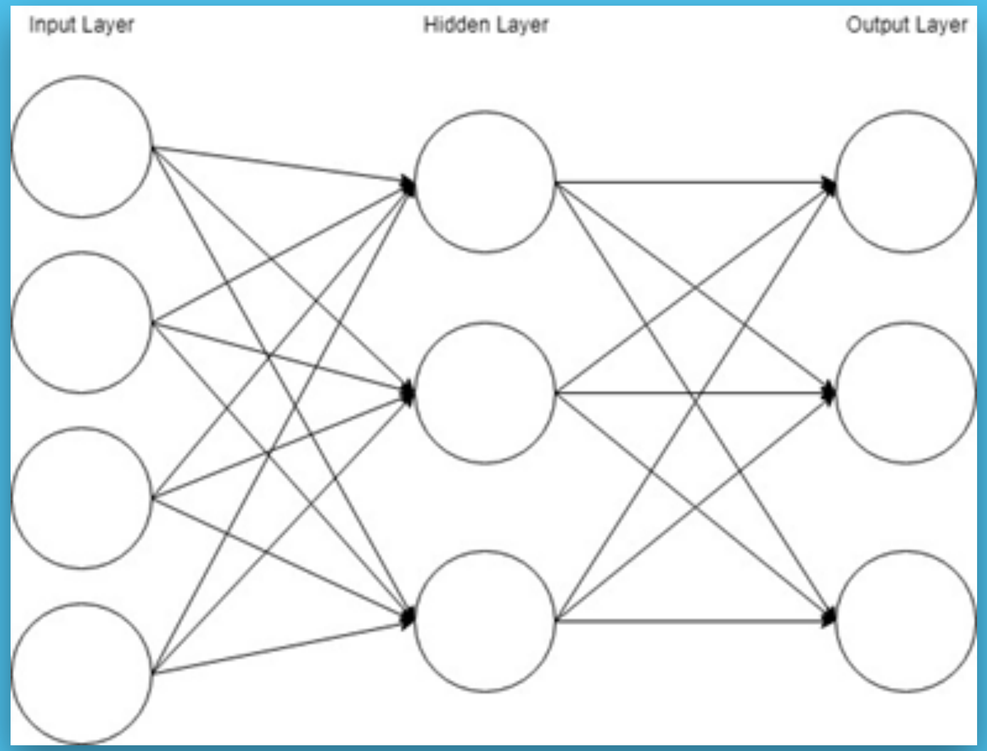
NNs



- 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



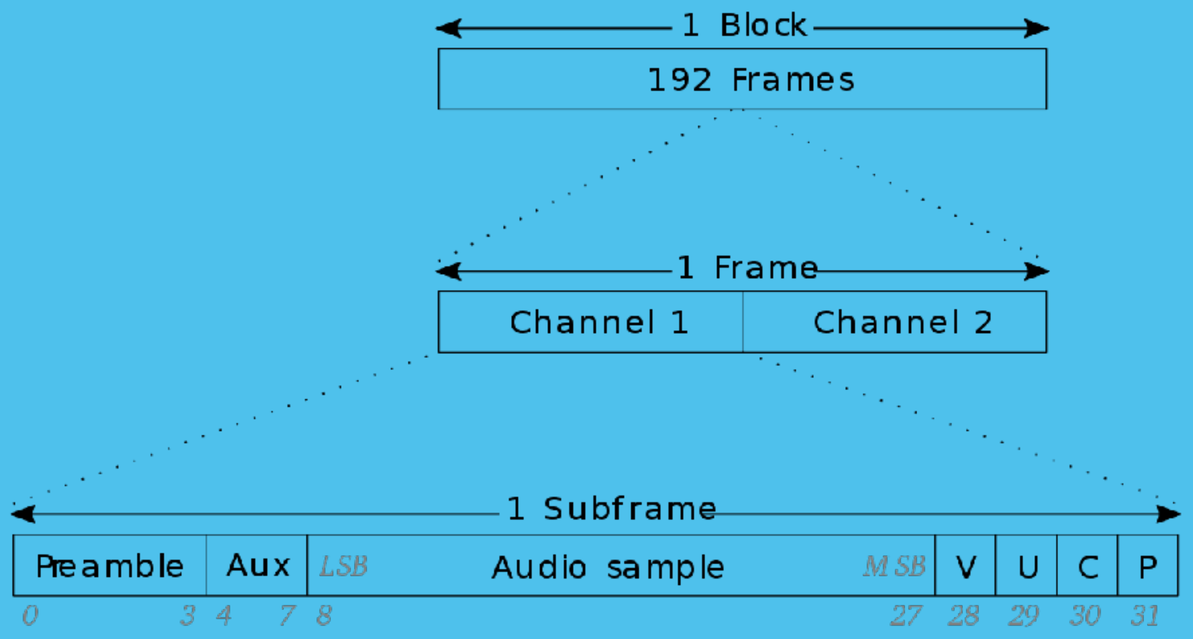
- Left: example of a multilayer perceptron (ML), which is a NN with an input layer, output layer, and may have hidden layers in between.
- A complex architecture suitable to learn regression and classification models for difficult datasets.

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

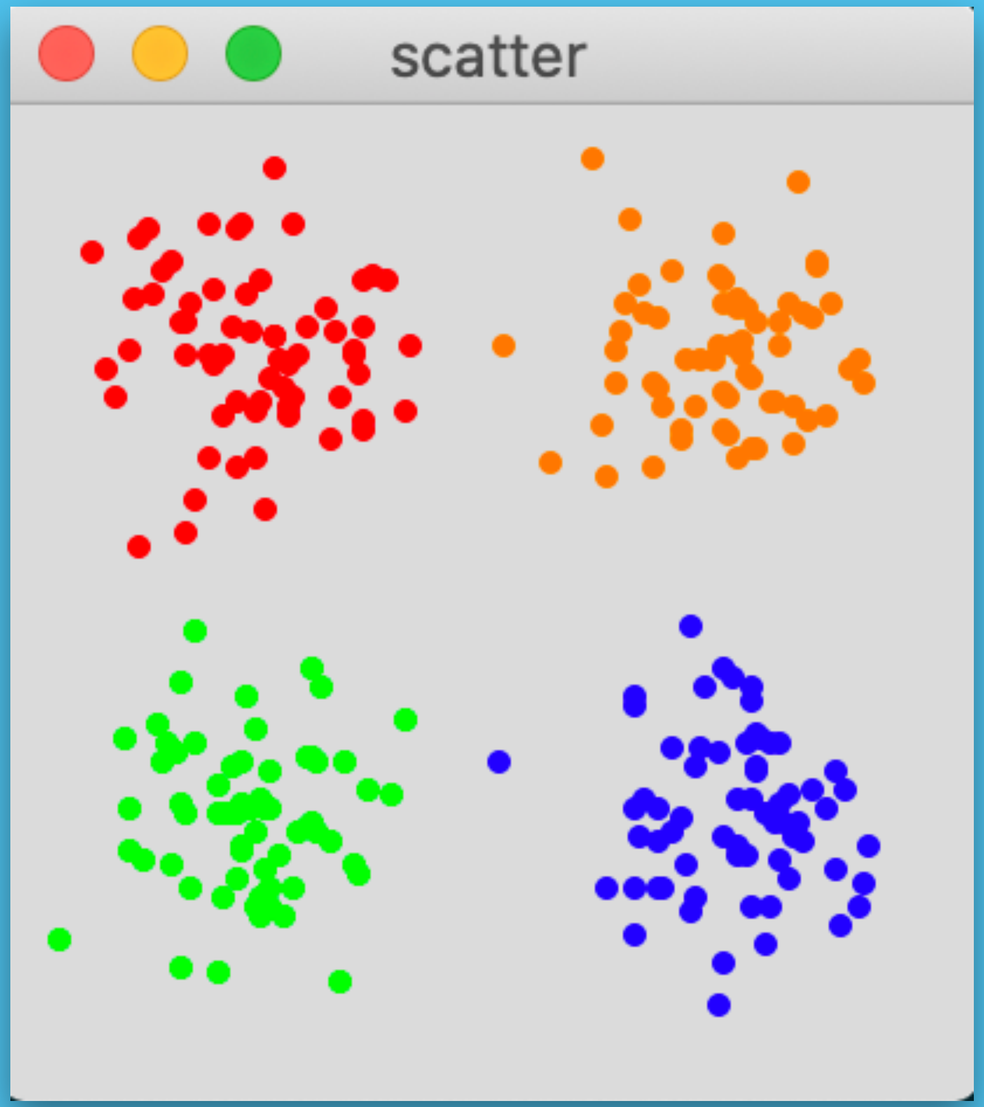


- Choose a set of relevant sound descriptors that characterise the sound samples from Freesound, e.g.:

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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from noiselets, released January 8, 2018
List of sounds used from Freesound.org coming soon.

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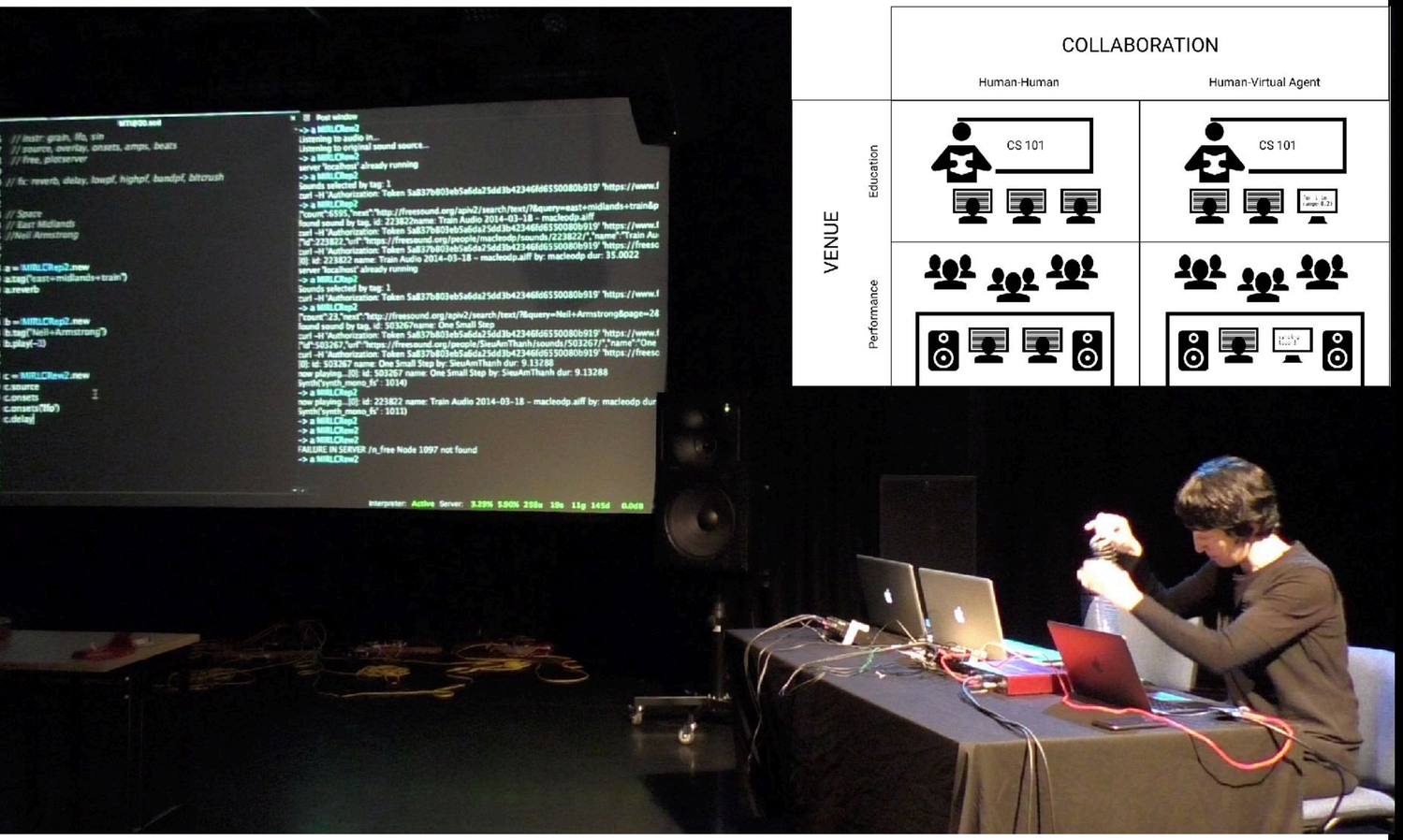
https://carpal-tunnel.bandcamp.com/track/n02-petermann (around 04:26)

What’s next?

- Complete a working prototype.
- Online concerts in collaboration with IKLECTIK, Phonos, and MTI^2.
- Online workshops with Leicester Hackspace, IKLECTIC, and L’Ull Cec.

Acknowledgments

- Eduard Solaz & Isa Ferri (IKLECTIK)
- Sam Roig (L’Ull Cec)
- Ángel Faraldo (Phonos / UPF)
- Leigh Landy (MTI^2)
- Steve Gale (Leicester Hackspace)
- Gerard Roma (Flucoma)



Thanks for listening!

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

mirlca.dmu.ac.uk