



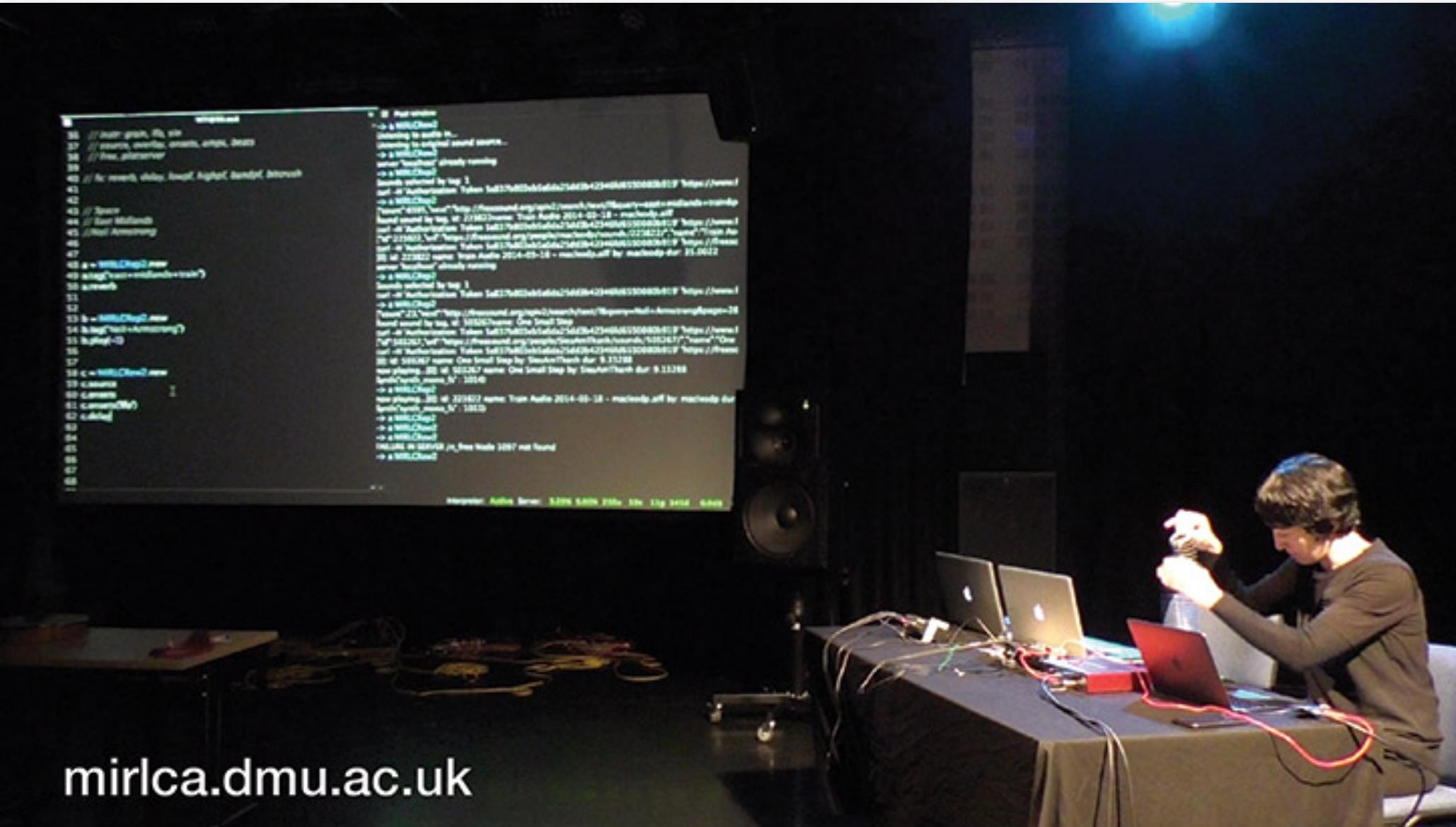
Online Workshop: "Performing with a virtual agent: machine learning for live coding"

Day 2

Anna Xambó

Music, Technology and Innovation - Institute for Sonic Creativity (MTI²)
De Montfort University

Leicester Hackspace 27.1.2021



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

Partners: IKLECTIK, Leicester Hackspace,
L'Ull Cec, Phonos, MTI²

Collaborators: TOPLAP Barcelona, FluCoMa, Freesound

Awarded with an EPSRC HDI Network Plus Grant

Partners

IKLECTIK [off-site]



phonos



Collaborators

toplaphbcn



freesound

Online Workshop Performing with a virtual agent: machine learning for live coding

London (IKLECTIK)

7/9/11.12.2020 - 19:00-21:00 (GMT)

Barcelona (L'Ull Cec)

11/13/15.1.2021 - 19:00-21:00 (CET)

Leicester (Leicester Hackspace)

25/27/29.1.2021 - 19:00-21.00 (GMT)

More info at:

mirlca.dmu.ac.uk/workshops

Materials / Working Tools

- **SuperCollider Extensions:** <http://tiny.cc/LHS-SC-extensions>
- **Working doc:** <https://pad.riseup.net/p/online-workshop-lhs-keep>
- **Zoom / Zoom chat**
- **GitHub repo (tutorials, tickets):** <https://github.com/mirlca/leicesterhackspace-workshop>
- **Tutorials:** <http://tiny.cc/LHS-tutorials> (or under the Github link)
- **Project website:** <https://mirlca.dmu.ac.uk>
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Schedule

- **Recap (all) - 10'**
- **Project presentation 2nd part: task 1 (Anna) - 15'**
- **Tutorial FluidMLPClassifier (Anna) - 10'**
- **Tutorial MIRLCa performance (Anna) - 15'**
- **Comfort break - 10'**
- **Hands-on MIRLCa performance (breakout rooms) - 20'**
- **Tutorial MIRLCa training (Anna) - 15'**
- **Hands-on MIRLCa training (breakout rooms) - 15'**
- **Plenary and closing (all) - 10'**

An introduction to machine learning in live coding and task 1: Train an agent to assist meaningful querying to Freesound.org

Learning Outcomes

- Get a sense of the practice of live coding (music live performance using code) by manipulating online crowdsourced sounds and the automatic use of feature descriptors obtained from freesound.org.
- **Get insight on a participatory design approach to designing a prototype for live coding performance.**
- **Get familiar with the application of neural networks, in particular a multilayer perceptron used as a classifier, to improve the practice of live coding with crowdsourced sounds.**
- **Be exposed to the main steps to solve a problem using machine learning techniques: the creation of a dataset, training a model, testing the model, and performing with / evaluating the model in an iterative cycle.**
- Understand how to combine different technologies in SuperCollider to build a prototype for live coding performance.

At the end of the workshop you will be able to...

- Use SuperCollider and the MIRLC2 library to retrieve sounds from Freesound.org based on a live coding approach.
- **Use a trained model using the FluCoMa library to retrieve sounds that are based on personal musical taste.**
- **Train your own model using the FluCoMa library to retrieve sounds that are based on your personal musical taste.**
- Analyse how to define a virtual agent that can react to the live coder inputs using the FluCoMa library.
- Explore creative strategies to perform with a virtual agent using machine learning for live coding.

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
-> a MIRLCRep2
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.freesound.org/api/sounds/?tag=morse&count=7'
-> a MIRLCRep2
{"count":7,"next":null,"results":[{"id":47487,"name":"sw-13.wav","tags":["electronic","morse","noise"]}]
found sound by tag, id: 47487 name: sw-13.wav
curl -H 'Authorization: Token 5a837b803eb5a6da25dd3b42346fd6550080b919' 'https://www.freesound.org/api/sounds/47487'
{"id":47487,"url":"https://freesound.org/people/galeku/sounds/47487/","name":"sw-13.wav","tags":[]}
curl -H 'Authorization: Token 5a837b803eb5a6da25dd3b42346fd6550080b919' 'https://freesound.org/api/sounds/47487'
[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.

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.

[Buy Digital Track](#) name your price
[Send as Gift](#)

[Buy the Full Digital Album](#)

from [noiselets](#), released January 8, 2018
List of sounds used from [Freesound.org](#) coming soon.

© all rights reserved

peterMann



Share / Embed Wishlist

[https://carpal-tunnel.bandcamp.com/
track/n02-petermann](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**?

How?

1. Identify ML tasks.
2. Implement the ML tasks with suitable tools.
3. Test the implemented ML tasks.

1. Identify ML Tasks

Identify ML Tasks

- **Two tasks identified (supervised learning):**
 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.**

Identify ML Tasks

- **Two tasks** identified:
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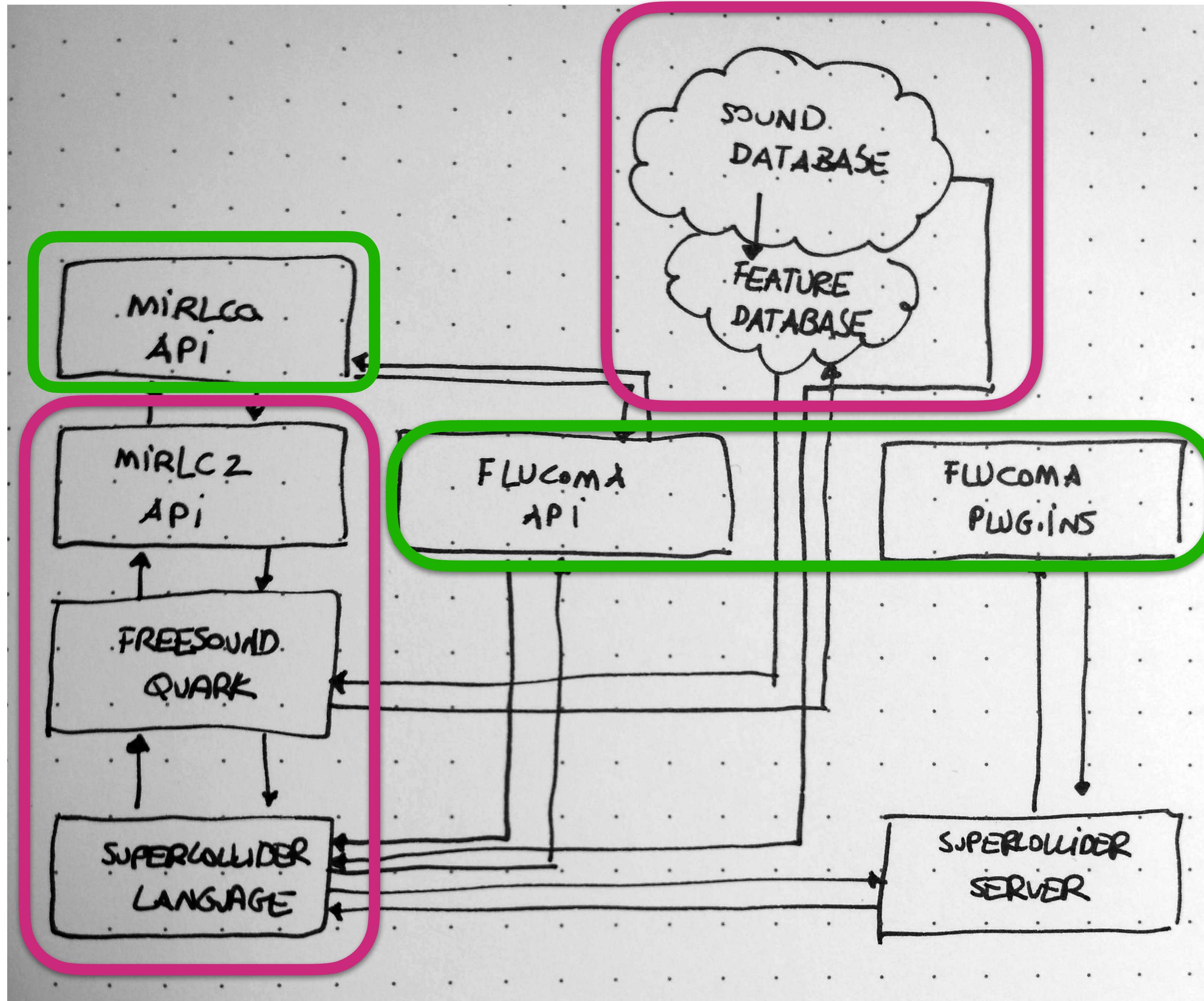
NN-1: Learning my musical taste

1. Creation of a dataset.
2. Identifying suitable feature descriptors that describe the sound.
3. Training a suitable machine learning model => *this results in a file that you will try in the tutorial.*

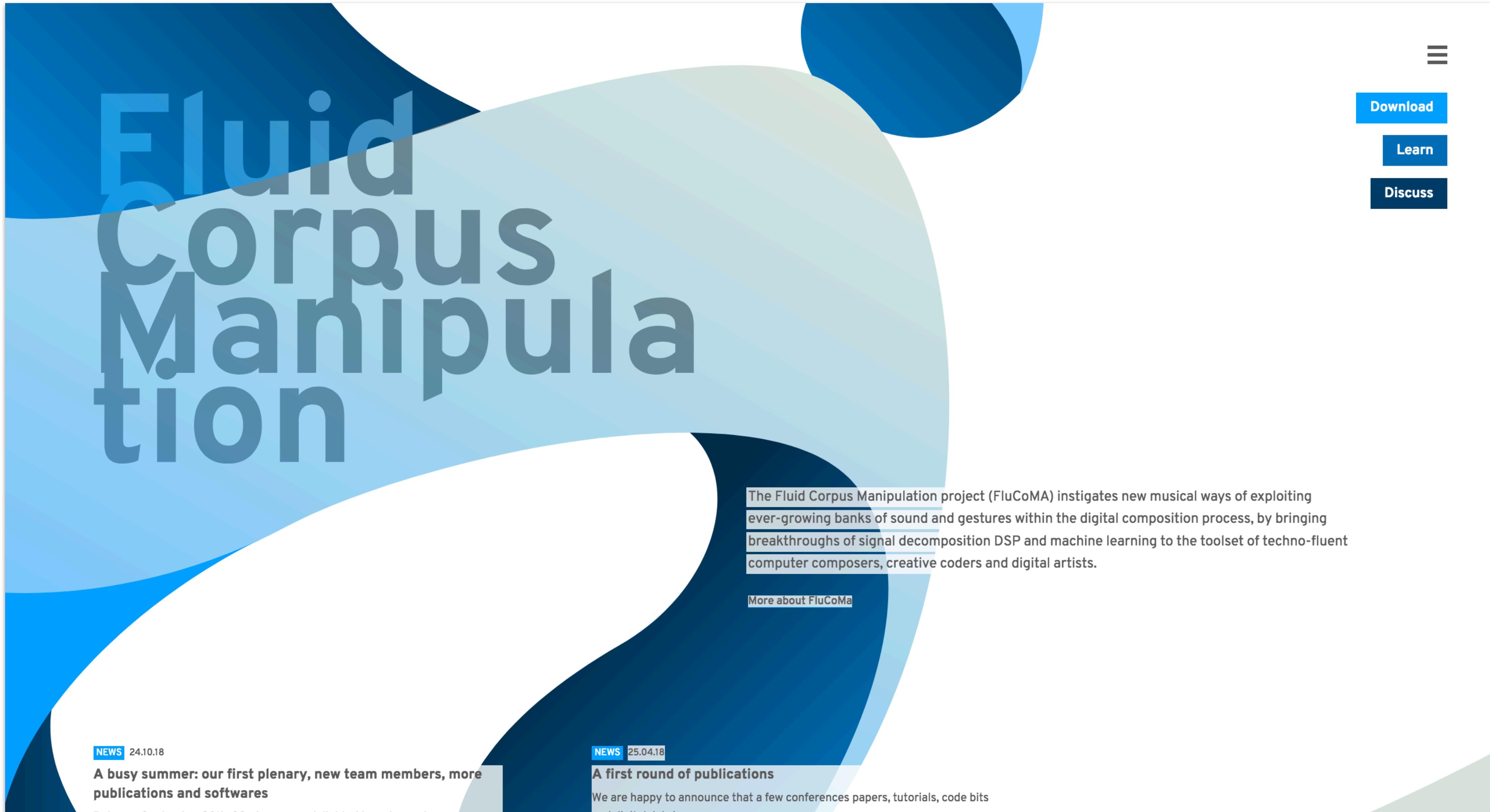
<https://mirlca.dmu.ac.uk/posts/towards-learning-my-musical-taste/>

2. Implement the ML tasks with suitable tools

Day 1
 Days 2 & 3



System's architecture



The Fluid Corpus Manipulation project (FluCoMA) instigates new musical ways of exploiting ever-growing banks of sound and gestures within the digital composition process, by bringing breakthroughs of signal decomposition DSP and machine learning to the toolset of techno-fluent computer composers, creative coders and digital artists.

[More about FluCoMa](#)

NEWS 24.10.18
A busy summer: our first plenary, new team members, more publications and softwares

NEWS 25.04.18
A first round of publications
We are happy to announce that a few conferences papers, tutorials, code bits

☰

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<https://www.flucoma.org>

[all categories ▶](#)[Categories](#)[Latest](#)[Top](#)

Category

Topics

Code Sharing

This is a place where you can share your proudest code gems, ideally using the toolbox.

97

New Ideas

This is a place where blue sky ideas of what the toolbox could do for you, how it could be stirred or extended, from an aesthetics/musical and/or a technological and/or a workflow standpoint.

87

Usage Questions

This is a place to ask any question from a usage perspective: a task you want to discuss the different ways to achieve.

88

Learning Resources

This is a place where you can share any good resource you found out there in the world that explained clearly a concept or a technology linked to corpus manipulation.

29

Latest

  Fluid Corpus Manipulation Toolbox (was Fluid Decomposition) v.1.0.0 Release Candidate 1 is here!

25

May 11



   Welcome to Discourse

2

Nov '19

 Francophone members: a superb presentation of Jacob's work on Rodrigo's work, at the Journées d'Informatique Musicale

2

22h



 Mellite -> Negatum genetic programming of synthetic sounds

0

2d





Fluid Corpus Manipulation

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Olivier Pasquet: Herbig-Haro (HH)

170 views • 9 months ago



Lauren Sarah Hayes: Moon via Spirit

723 views • 9 months ago



Owen Green: Race to the Bottom

156 views • 10 months ago



Leafcutter John: Line Crossing

250 views • 10 months ago



Rodrigo Constanzo: Kaizo Snare

707 views • 11 months ago



REACTIVE FLOWS

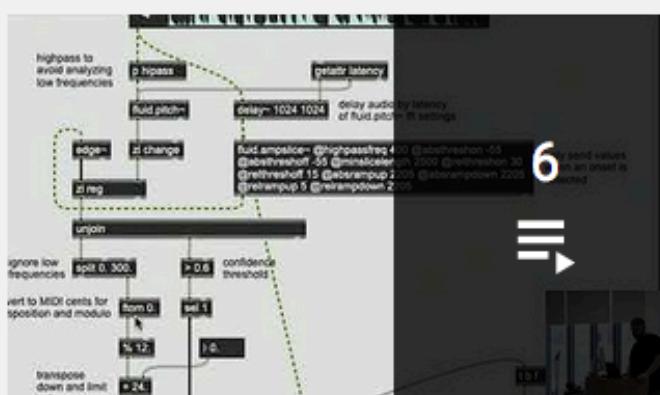
Presented by the FluCoMa project
Huddersfield Contemporary Music Festival
21 November 2019
Bates Mill, Huddersfield

4:33

Reactive Flows - Presentation

286 views • 1 year ago

Created playlists



Plenary 3 Presentations: Traces of Fluid Decomposition

[VIEW FULL PLAYLIST](#)



Plenary 3 Presentations: Creative Coding Guests

[VIEW FULL PLAYLIST](#)



Reactive Flows

[VIEW FULL PLAYLIST](#)



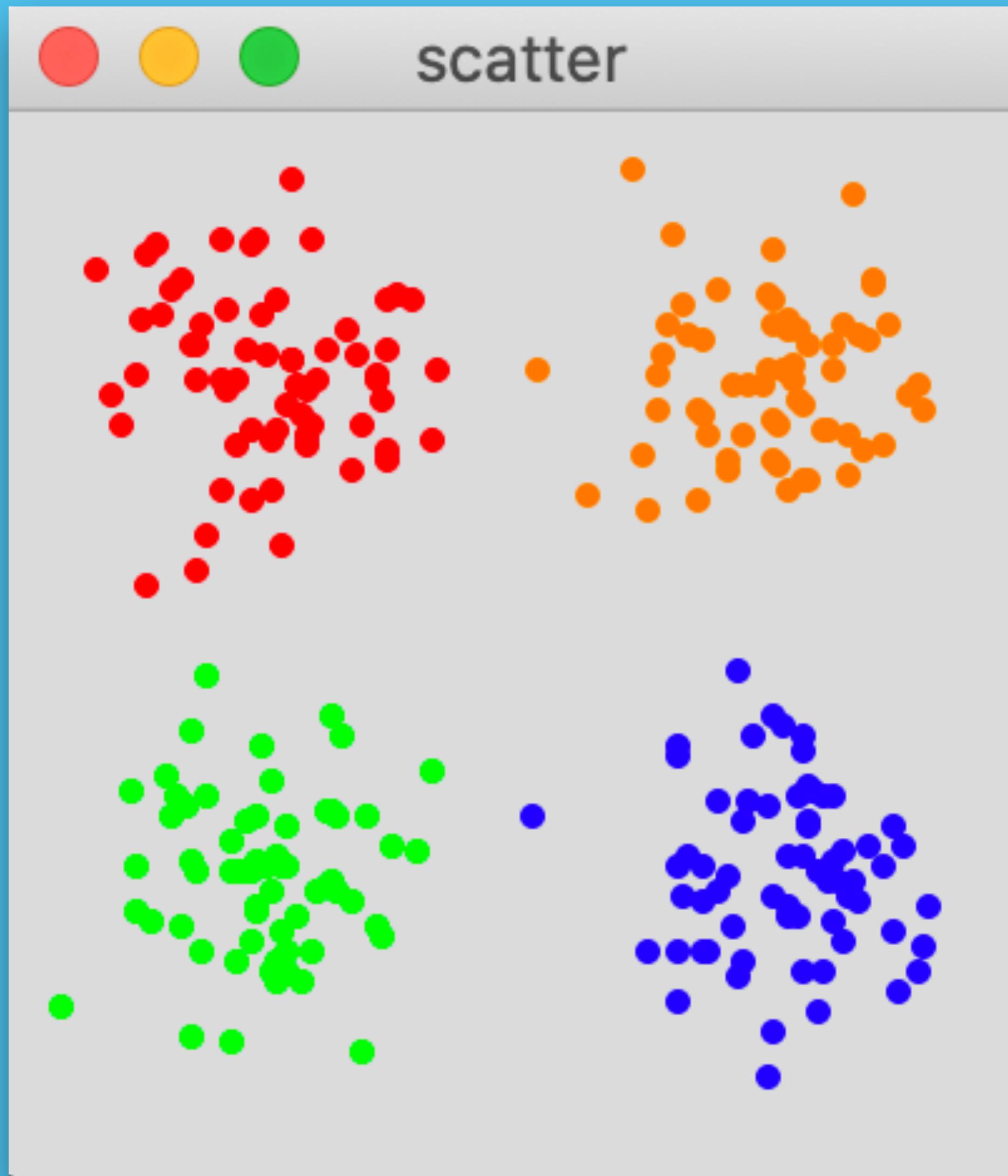
Plenary 1 Presentations: Creative Use of Music Technology

[VIEW FULL PLAYLIST](#)

Fluid Corpus Manipulation YouTube channel:

<https://www.youtube.com/channel/UCw44GjWHPQs0PKnj2OJmWCA>

Flucoma Multilayer Perceptron (MLP) neural network (NN)



- **FluidMLPClassifier:** Perform classification using a MLP NN (we are using it for the NN-1 task).

FluidMLPClassifier

: FluidRTDataClient : FluidDataClient :

FluidManipulationClient : Object

Classification with a multi-layer perceptron

Source: FluidMLP.sc

See also: [FluidMLPRegressor](#), [FluidDataSet](#)

Perform classification between a [FluidDataSet](#) and a [FluidLabelSet](#) using a Multi-Layer Perception neural network.



Class Methods

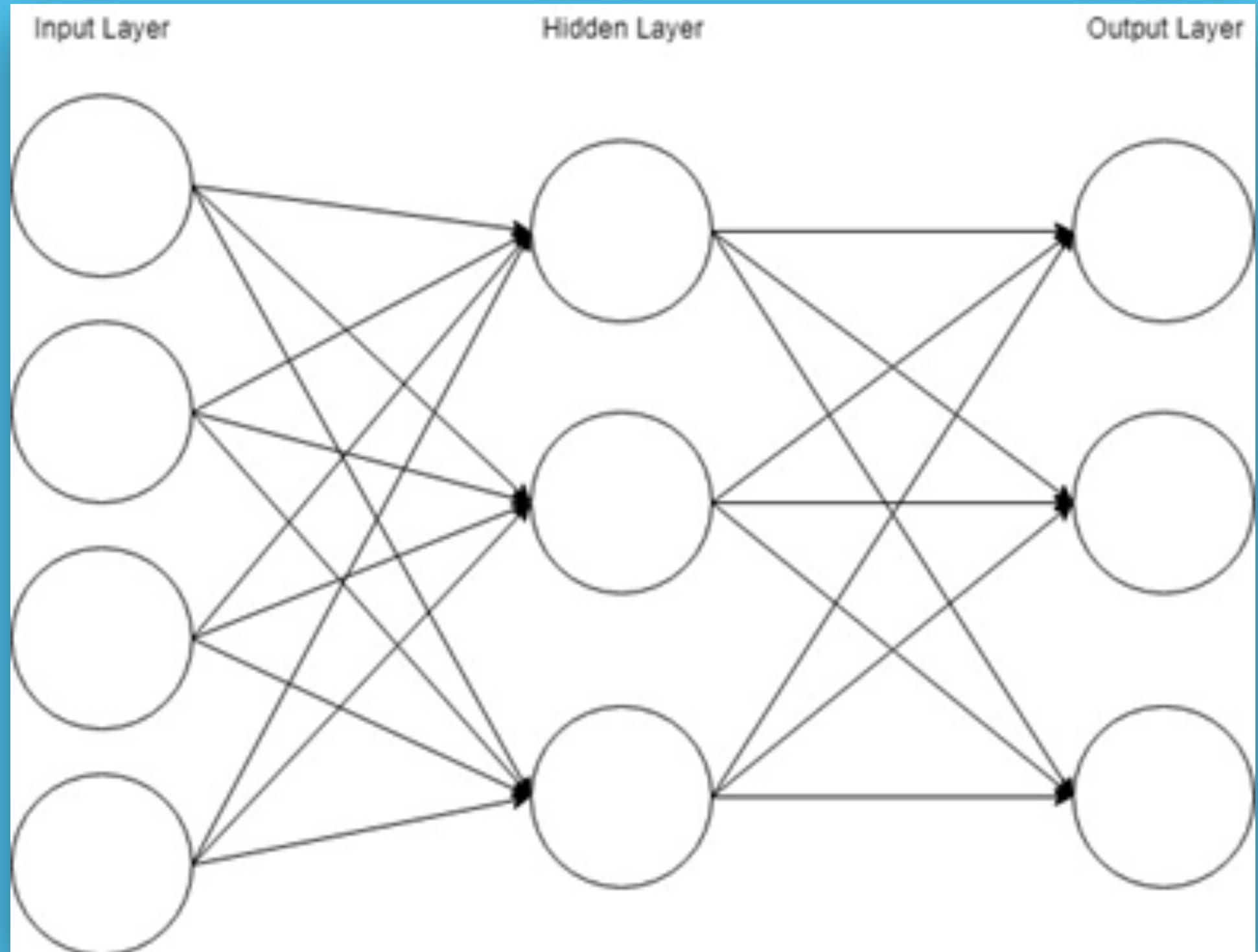
```
FluidMLPClassifier.new(server, hidden: [ 3, 3 ], activation: 2,  
                      maxIter: 1000, learnRate: 0.0001, momentum: 0.9, batchSize: 50,  
                      validation: 0.2)
```

Creates a new instance on the server.

Arguments:

- server** The [Server](#) on which to run this model.
- hidden** An [Array](#) that gives the sizes of any hidden layers in the network (default is two hidden layers of three units each).
- activation** The activation function to use for the hidden layer units. Beware of the permitted ranges of each: relu (0->inf), sigmoid (0->1), tanh (-1,1).
- maxIter** The maximum number of iterations to use in training.
- learnRate** The learning rate of the network. Start small, increase slowly.
- momentum** The training momentum, default 0.9
- batchSize** The training batch size.
- validation** The fraction of the DataSet size to hold back during training to validate the network against.

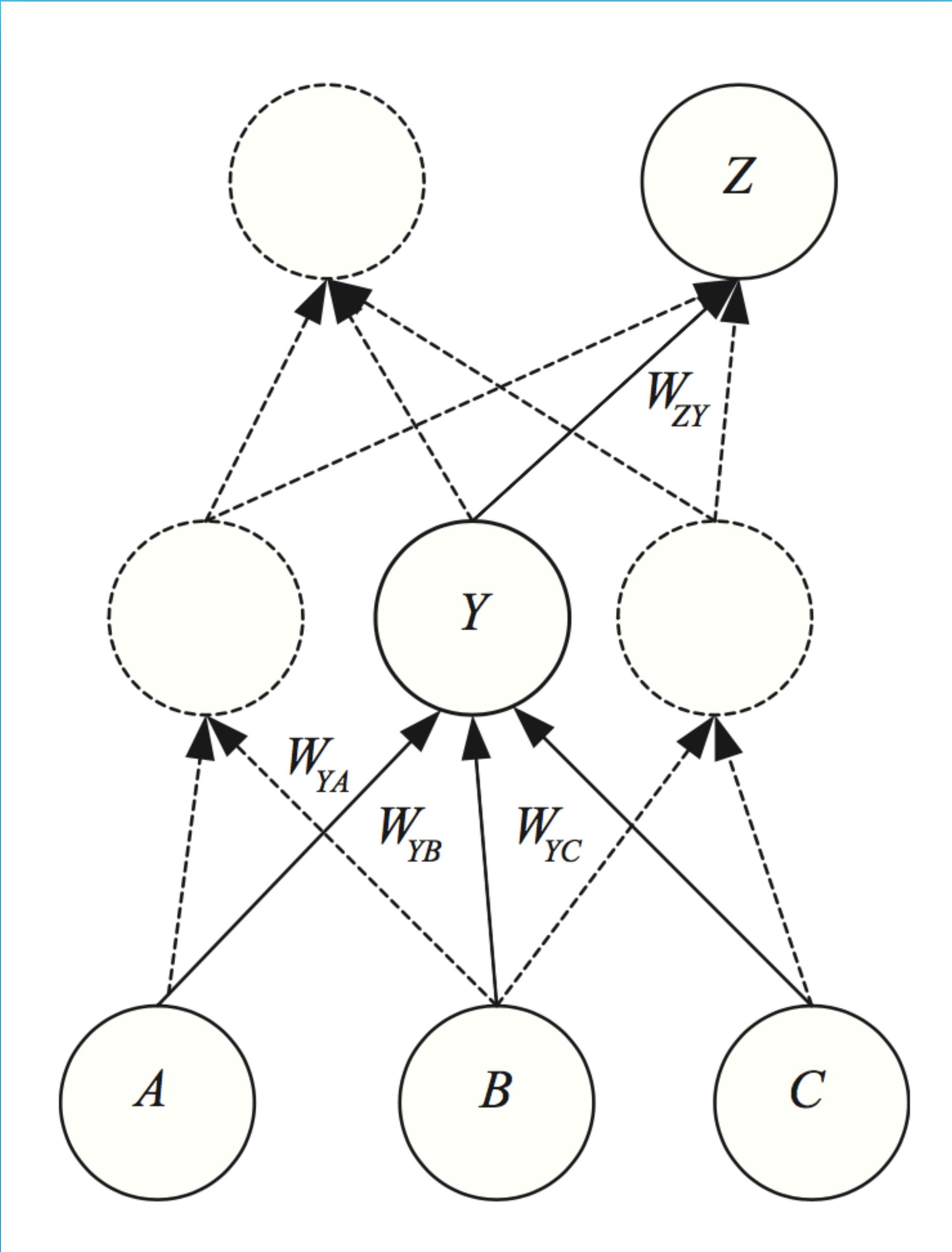
Multilayer Perceptron



- 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](https://deepai.org/machine-learning-glossary-and-terms/multilayer-perceptron)

Neural Networks



- Left: example of a neural network (NN) with neurons and synaptic connections.
- Check the glossary file under <https://github.com/mirlca/leicesterhackspace-workshop>

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

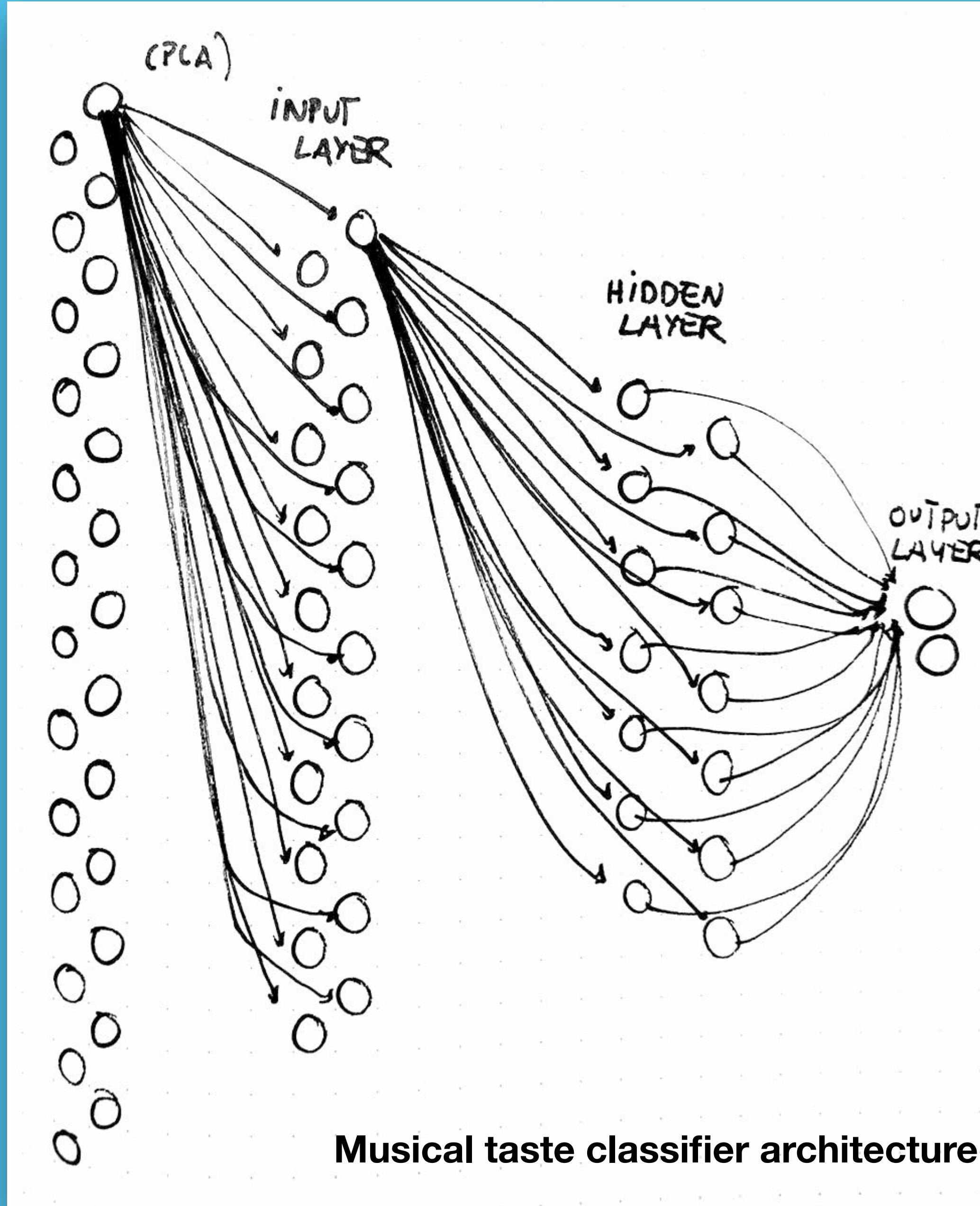
**3. Test the implemented ML
tasks...**

NN-1: Learning my musical taste

Steps in the training process ...

1. For creating the dataset, choose a set of sounds and relevant sound descriptors that characterise the sound samples from Freesound, e.g.:
 - Approach 1: pitch, rhythm (bpm), brightness (spectral centroid), noisiness (spectral flatness)
 - Approach 2: MFCCs
2. Label each sound with “good” or “bad” in an evenly manner.
3. Map these sound descriptors to input layers of the NN and define different parameters for the training.

Detailed blog post at: <https://mirlca.dmu.ac.uk/posts/towards-learning-my-musical-taste/>



MIRLCA - CREATING A MODEL

creation of the datasets
(training, testing)

Flucoma
Fluid dataset
Fluidlabelset

Loading the training and
testing datasets for
training / testing

Read datasets
Prepare data for training
(1 Fluid Dataset
1 Fluid Label set)
& testing
(1 Fluid Dataset
1 Fluid Labelset)

Flucoma
FluidsStandardize
• fit transform
• transform

Normalize/standardize
datasets for
training / testing

Flucoma
FluidPCA
• fit transform
• transform

Principal Component
analysis (CPGA)
(dimensionality reduction)

Flucoma
FluidMLP
classifier
• fit
• predict

Classifier setup &
fit the classifier &
run prediction on test data

Accuracy ?

Creating a model

Best Descriptors...

- **First round with 9 descriptors:**
 - pitch, bpm, centroid, flatness, **pitch_confidence** (mean and variance).
 - **73% accuracy with flatness and pitch_confidence (mean and variance)**
- **Second round with 26 descriptors:**
 - Mel-frequency cepstral coefficients (MFCCs) (mean and variance) + PCA
 - **76%-83% accuracy**

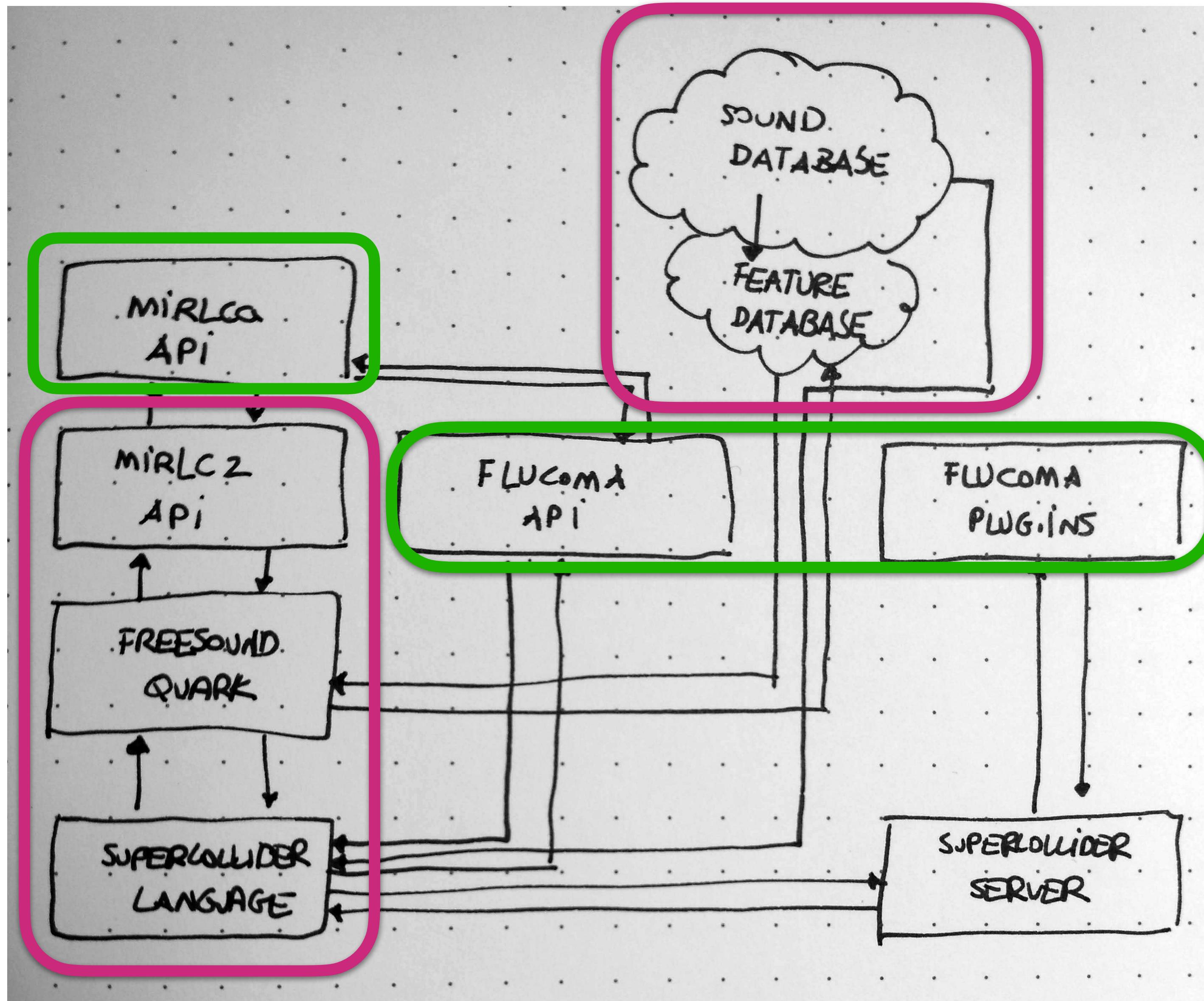
Next:

Tutorial FluidMLPClassifier

Tutorial MIRLCa Performance

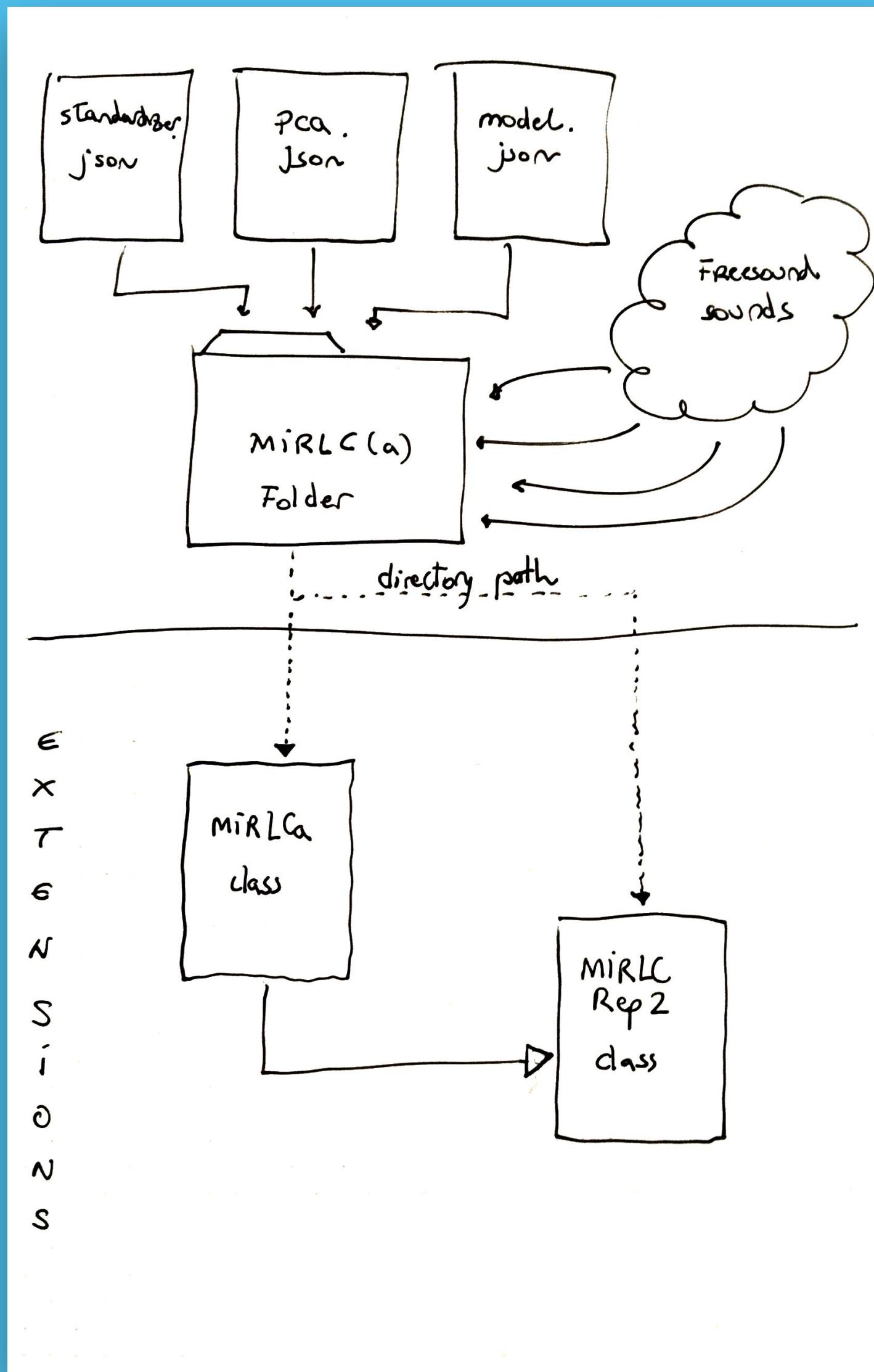
Tutorial MIRLCa Training

Day 1
 Days 2 & 3

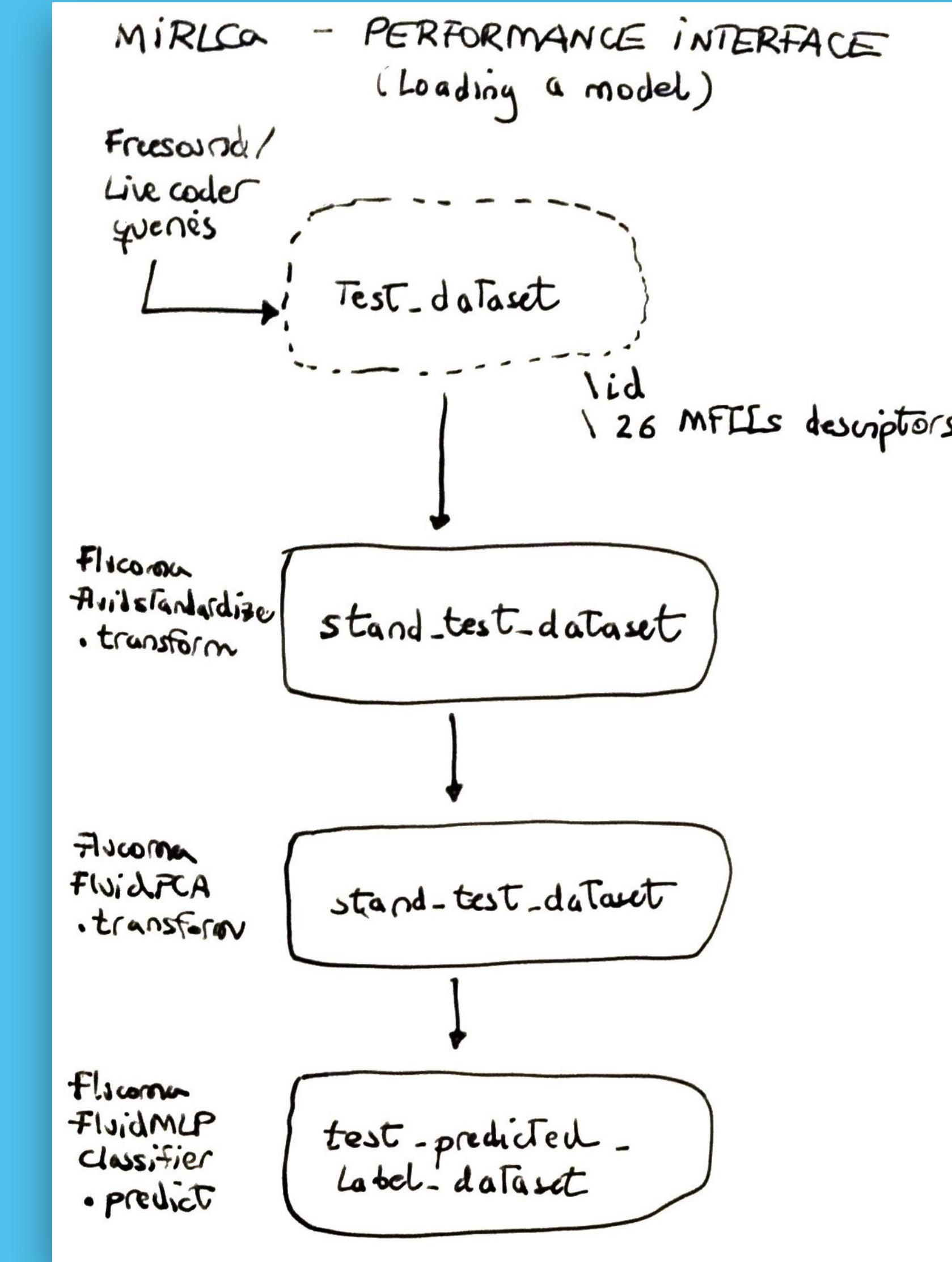


System's architecture

How to organise the files:

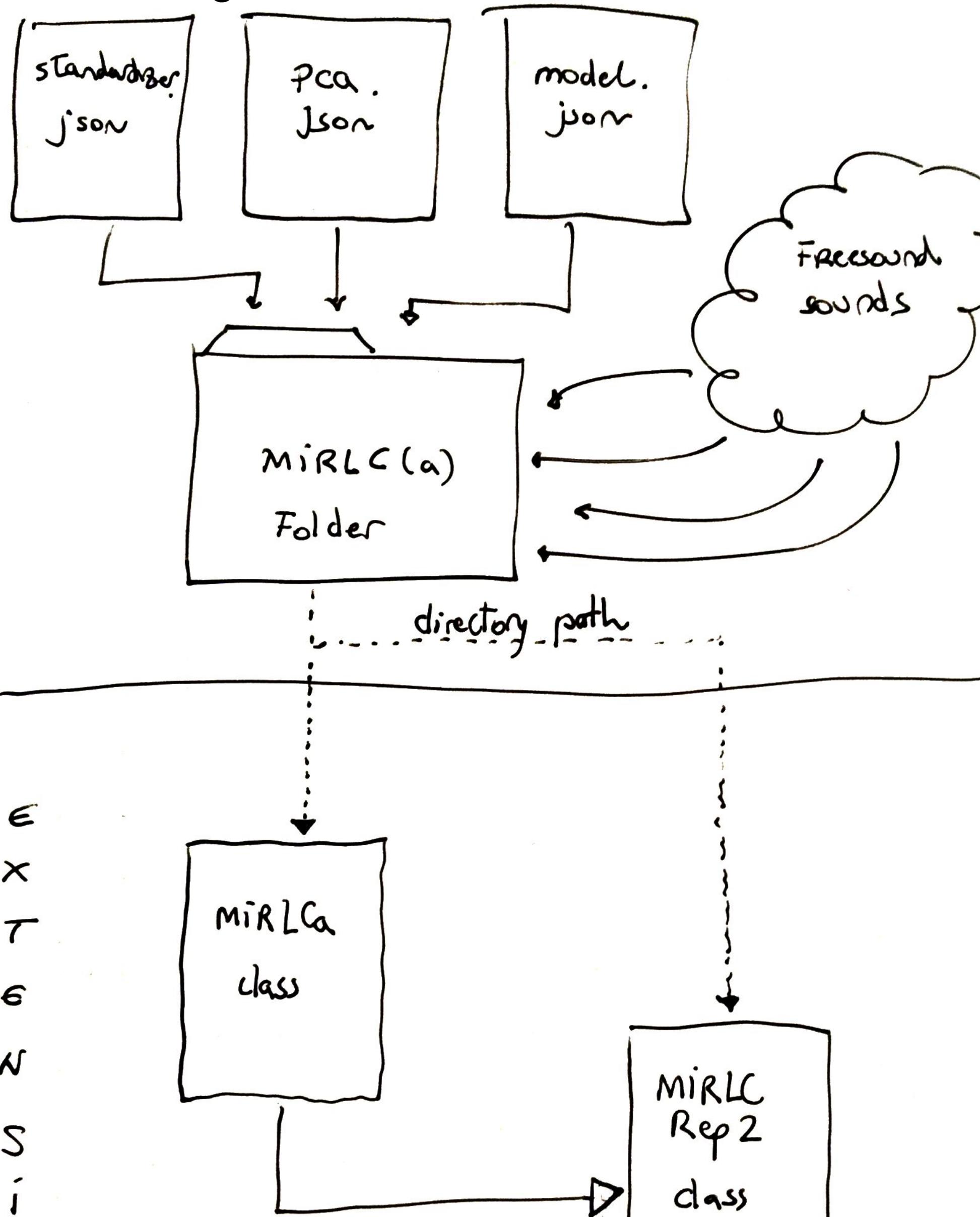


Behind the scenes...



For the Tutorial of MiRLCa Performance

How to organise the files:



es...

INTERFACE
el)

; MFCCs descriptors

t

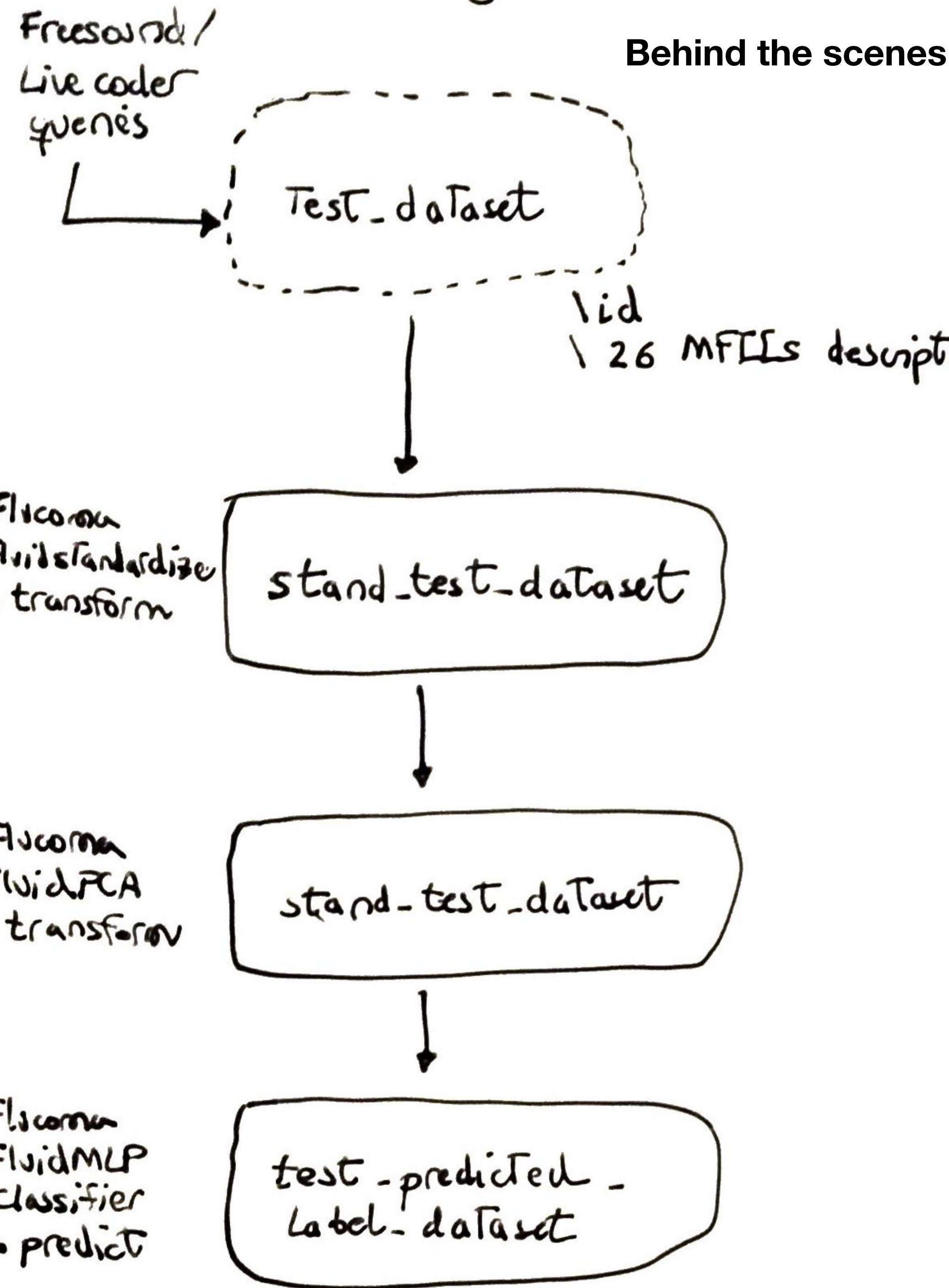
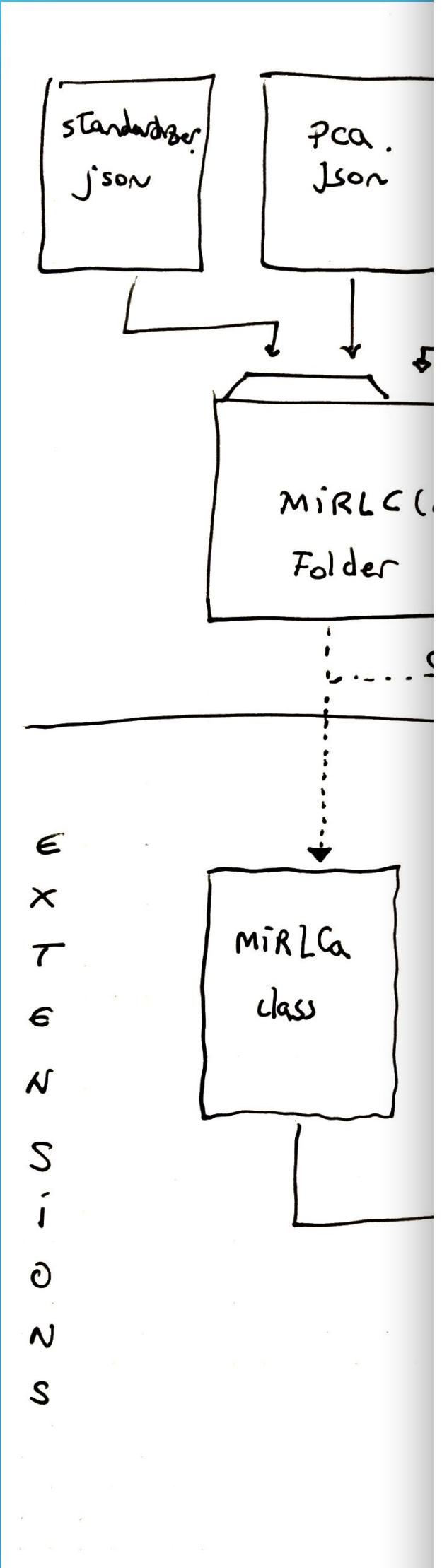
t

t

t

For the Tutorial of MIRLCa Performance

How to or



Behind the scenes...

nce

```
// 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)
```

group ~a

[sound1] [sound2] [sound3] [sound4] [sound5]
index 0 index 1 index 2 index 3 index 4

MIRLCRep

```
// 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)
```

group ~a

[sound1] [sound2] [sound3] [sound4] [sound5]
index 0 index 1 index 2 index 3 index 4

```
// 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)
```

References

- Great blog on ML: <https://machinelearningmastery.com>
- Alpaydin, Ethem. *Machine Learning: The New AI*. Cambridge, MA: MIT Press, 2016.