TimeSide

un framework, un web service et un player open source d'analyse et d'annotation sonore

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Séminaire Archives Sonores et humanités numériques - 04/05/2023 - Corte, France

Outline

- Introduction
- History
- Core
- Server
- Player
- Perspectives

TimeSide

Context

- **digization** > big data > platforms > algorithms > **listeners**
- more **data sets**, databases, formats, algorithm versions, open DSP libraries & **communities**
- difficulties to **port and scale some algorithms** on production platforms (DSP at scale)
- **computer science** needs human data, **digital humanities** need computers
- **collaborative workflows, citizen sciences** through the web
- **temporal description** of sound and musical events

Constraints

- sustainable digital archiving
- reproducible research
- copyrights, dissemination
- open source, open standards, Web, format evolution and abstraction
- continuous development, continuous integration
- version everything, access everywhere

Use cases

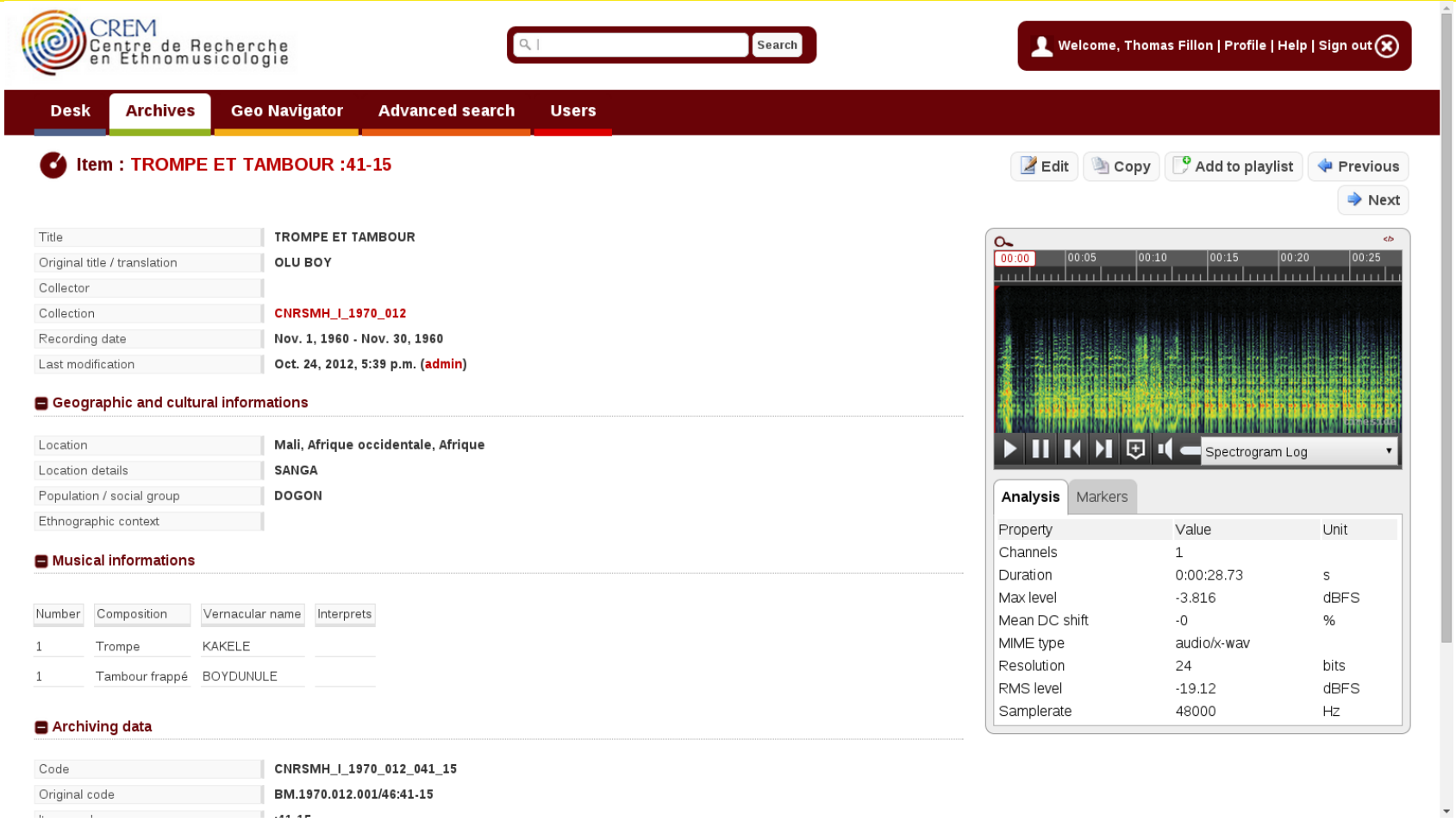
- MIR + archiving = MIRchiving
- digitization and media packaging services
- metadata enhanced streaming services
- music data based applications
- machine learning based applications

TimeSide

History

- 2007 : Telemeta developed for the sound archives of the CNRS / Musée de l'Homme
- 2010 : TimeSide separation as a autonomous library and then a framework with a plugin oriented architecture
- 2011 : Telemeta v1.0 released and https://archives.crem-cnrs.fr
- 2013 : DIADEMS project (ANR) : external plugins
- 2015 : TimeSide server and RESTFul API prototypes
- 2015 : KAMoulox (ANR), DaCaRyh (Labex) projects
- 2016 : WASABI (ANR), CREM-NYU-Parisson projects
- 2019-2023 : Fully embed into IRCAM WAM innovation team

Telemeta - CREM



https://archives.crem-cnrs.fr

Telemeta - CREM

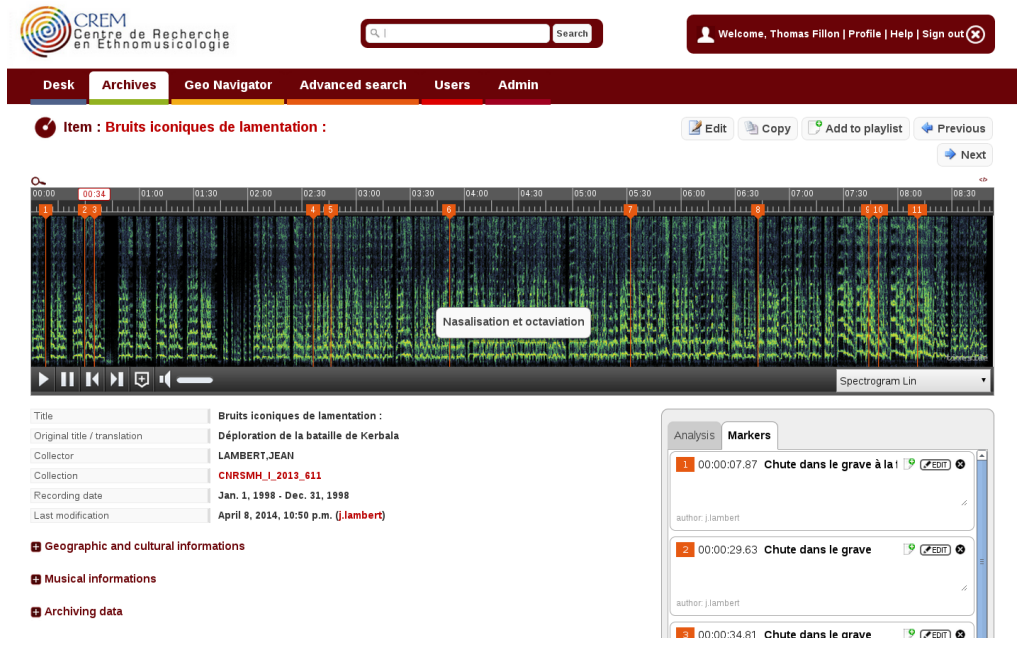
Telemeta / TimeSide integration

Collaborative multimedia asset management system

MIR + Musicology + Archiving = MIRchiving

Ecosystem

- 20 public partners
- 15 historical developers (6000 commits)
- 500 users (CREM)
- and thousands of developers! (open source community)
- mutualized development model



https://github.com/Parisson/Telemeta

timeside.core

TimeSide

Python audio processing framework and server made for the web

https://github.com/Ircam-WAM/TimeSide

Goals

- **Process** audio fast and asynchronous with **Python**,
- **Decode** audio frames from *any* audio or video media format into **Numpy arrays**,
- **Analyze** audio content with some **state-of-the-art** audio feature extraction libraries like **Librosa, Aubio, Essentia, Yaafe, VAMP, IRCAM descriptors** and pure python processors
- **Visualize** audio data with various fancy waveforms, spectrograms and other cool graphers,
- **Transcode** audio data in various media formats and stream them through web apps,
- **Serialize** feature analysis data through various portable formats (XML, JSON, HDF5)
- **Playback** and **interact on demand** through a smart high-level **HTML5 extensible player**,
- **Index**, **tag** and **annotate** audio archives with **cultural and semantic metadata**,
- **Deploy** and **scale** your own audio processing engine flawlessly through any infrastructure with **Docker**

TimeSide

Python audio processing framework and server made for the web

https://github.com/Ircam-WAM/TimeSide

Use cases

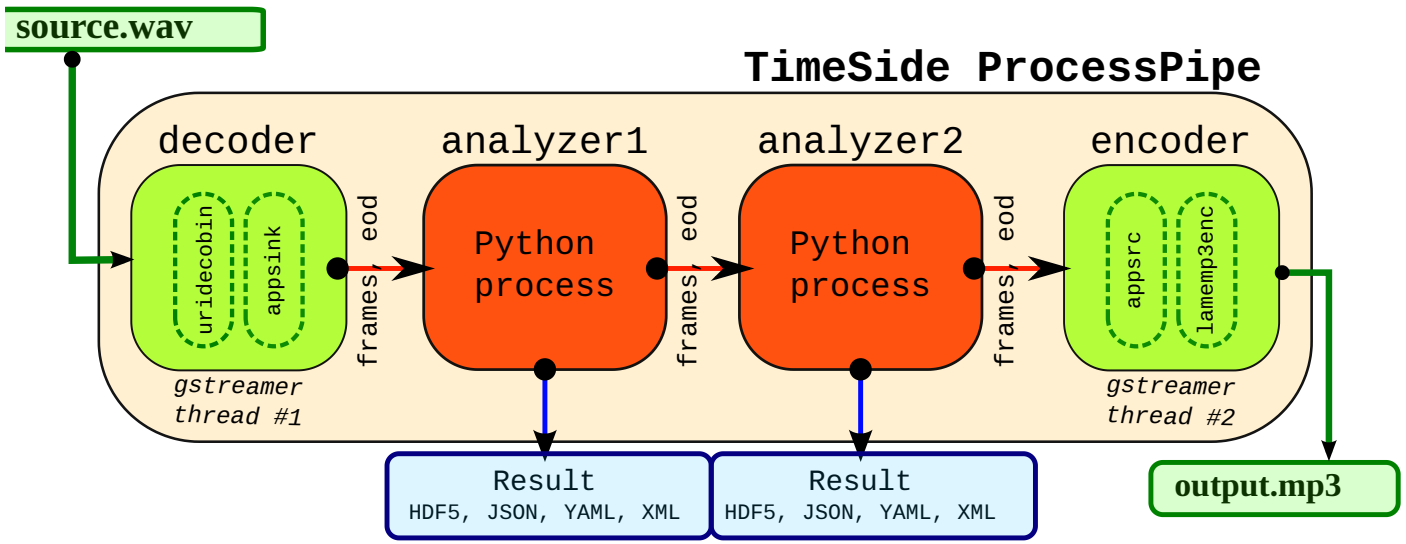
- Scaled audio processing (filtering, transcoding, machine learning, etc...)
- Audio process prototyping
- Audio dynamic visualization
- Automatic segmentation and labelling synchronized with audio events
- Collaborative annotation
- Audio web services

License: AGPL v2

timeside.core

API & architecture

- streaming oriented core engine
- data persistence




```
pipe = (decoder | analyzer1 | analyzer2 | encoder)
```

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API & architecture

- streaming oriented core engine
- data persistence
- processing API
- plugin architecture
- namespace

```python
class DummyAnalyzer(Analyzer):
    """A dummy analyzer returning random samples from audio frames"""
    implements(IAnalyzer)

    @interfacedoc
    def setup(self, channels=None, samplerate=None, blocksize=None, totalfram
        super(DummyAnalyzer, self).setup(channels, samplerate, blocksize, tot
        self.values = numpy.array([0])

    @staticmethod
    @interfacedoc
    def id():
        return "dummy"

    @staticmethod
    @interfacedoc
    def name():
        return "Dummy analyzer"

    @staticmethod
    @interfacedoc
    def unit():
        return "None"

    def process(self, frames, eod=False):
        size = frames.size
        if size:
            index = numpy.random.randint(0, size, 1)
            self.values = numpy.append(self.values, frames[index])
        return frames, eod

    def post_process(self):
        result = self.new_result(data_mode='value', time_mode='global')
```

timeside.core

API & architecture

- streaming oriented core engine
- data persistence
- processing API
- plugin architecture
- namespace
- ~500 unit tests
- docker packaged (Linux, OSX, Windows)

```
import timeside.core
from timeside.core import get_processor
from timeside.core.tools.test_samples import samples

wavfile = samples['sweep.wav']
decoder  =  get_processor('file_decoder')(wavfile)
grapher  =  get_processor('spectrogram')()
analyzer =  get_processor('level')()
encoder  =  get_processor('vorbis_encoder')('sweep.ogg')

pipe = (decoder | grapher | analyzer | encoder)
pipe.run()

grapher.render(output='spectrogram.png')
print('Level:', analyzer.results)
Level: {'level.max': AnalyzerResult(...), 'level.rms': AnalyzerResult(...)}
```

```
$ git clone --recursive https://github.com/Ircam-WAM/TimeSide.git
$ docker-compose run app python3 manage.py shell
$ docker-compose up
```

https://timeside.readthedocs.io/en/latest/index.html

timeside.core

Plugin examples

- FileDecoder, ArrayDecoder, LiveDecoder, AubioDecoder
- VorbisEncoder, WavEncoder, Mp3Encoder, FlacEncoder, OpusEncoder, etc.
- WaveformAnalyzer, SpectrogramAnalyzer
- AubioTemporal, AubioPitch, etc.
- Yaafe wrapper (graph oriented)
- librosa (function oriented)
- VampPyHost
- Essentia bridge
- ...

- Speech detection
- Music detection
- Singing voice detection
- Monophony / Polyphony
- Dissonance
- Timbre Toolbox

https://github.com/DIADEMS/timeside-diadems

timeside.core

Roadmaps

0.9 > 1.0 (2019-2021)

- 674 commits, 7 contributors
- Python 2.7 to 3.7
- Drop GStreamer for Aubio as default decoder and encoder
- Regroup all dependencies on pip requirements, drop Conda
- Add `Provider` object
- Add Provider plugins `deezer-preview`, `deezer-complete` and `youtube`
- Add loggers
- Improve Docker packaging and image building

timeside.core

Roadmaps

1.0 > 1.1 (2021 - 2023)

- Use the libav based aubio decoder by default (fastest audio to numpy array converter on the planet!)
- Add a VAMP based Analyzer and a few plugins like `VampFlatness`, `VampCrest`, `VampTempo`, `VampTuning`, `VampSpectralCentroid`, `VampSpectralKurtosis` and `VampSpectralSlope`
- Updated documentation https://timeside.ircam.fr/docs/

timeside.server

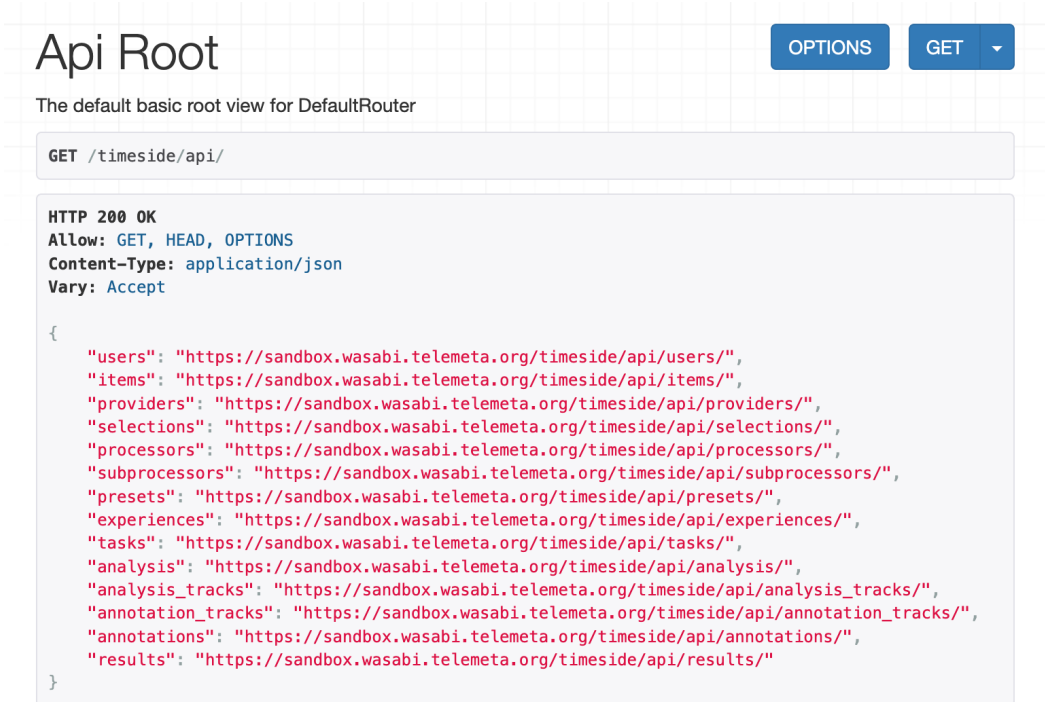
timeside.server

RESTful API built on TimeSide

👉 https://timeside.ircam.fr/api/

Use cases

- **Upload** audio tracks
- **Retrieve** audio tracks from remote providers
- **Stream** original or transcoded sources
- **Run** on-demand analysis
- **Customize** processors parameters
- **Collect** track's annotation to build audio corpora
- **Deliver** and share several types of results:
  - transcoded audio
  - serialized analysis as JSON or image
- **Export/import** an audio analysis dataset



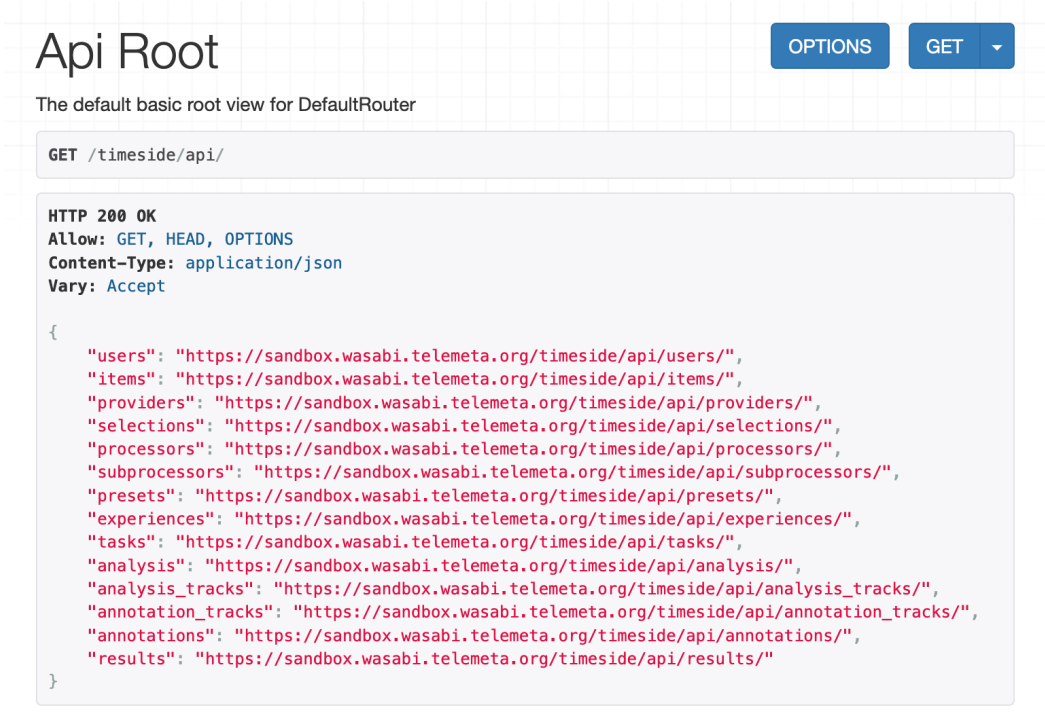
timeside.server

RESTful API built on TimeSide

👉 https://timeside.ircam.fr/api/

Server design

- Based on Django REST Framework (DRF)
- **Interoperability** between other servers or frontends and TimeSide instance and its data
- Object-relational **database** in order to store music tracks and processing results
- **Models**: define essential fields and behaviors of stored data
- **queue-worker architecture** enables to run tasks asynchronously



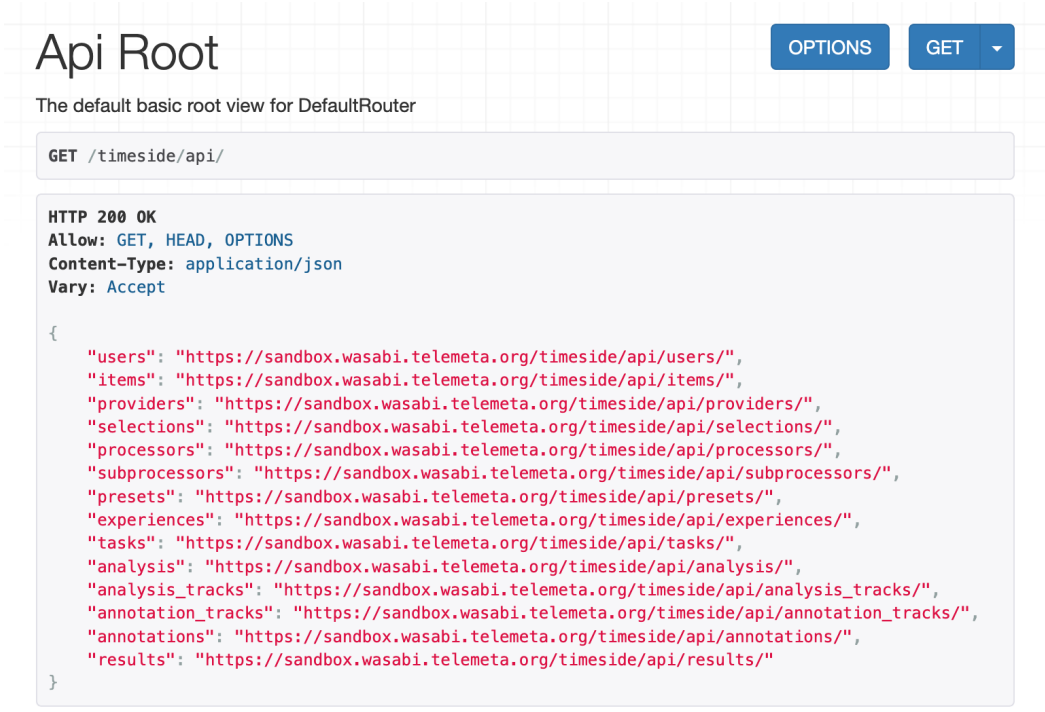
timeside.server

RESTful API built on TimeSide

👉 https://timeside.ircam.fr/api/

What's new on server?

- Add audio providers (Deezer, Youtube)
- Switch from MySQL to PostgreSQL
- Add a JWT authentication
- Make the API follow the OpenAPI specification
- Build a TypeScript SDK on the REST API
- Add several tools, views, models and serializers
- Improve server unit testing
- Fix few bugs
- Python, Django, DRF and Celery upgrades



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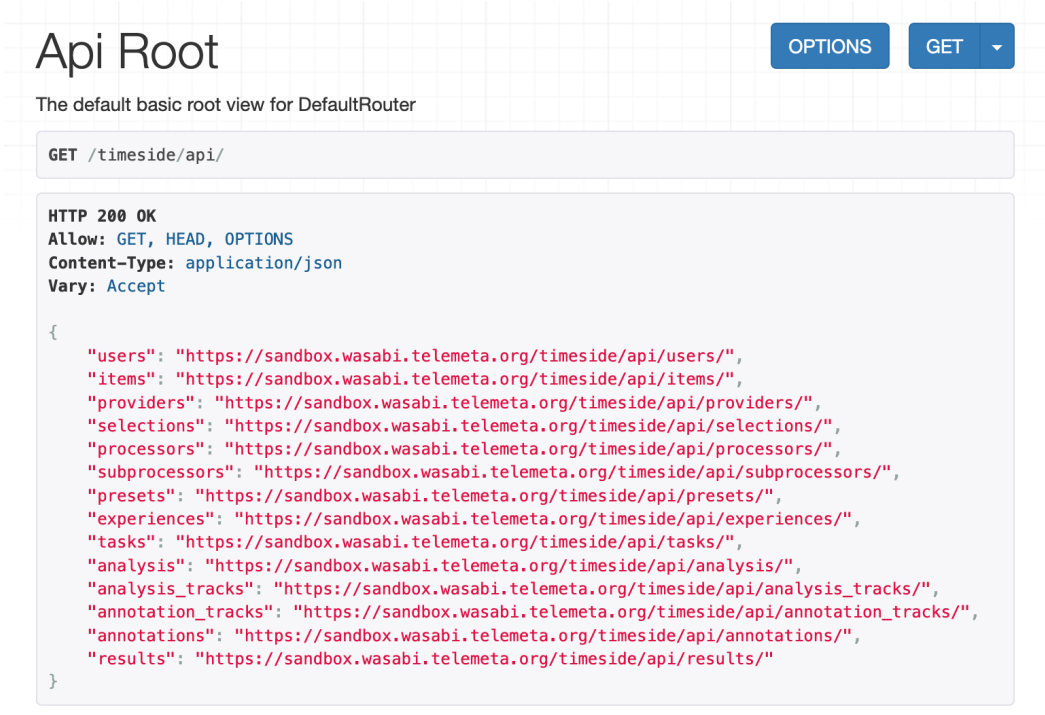
RESTful API built on TimeSide

👉 👉 https://timeside.ircam.fr/api/

Models

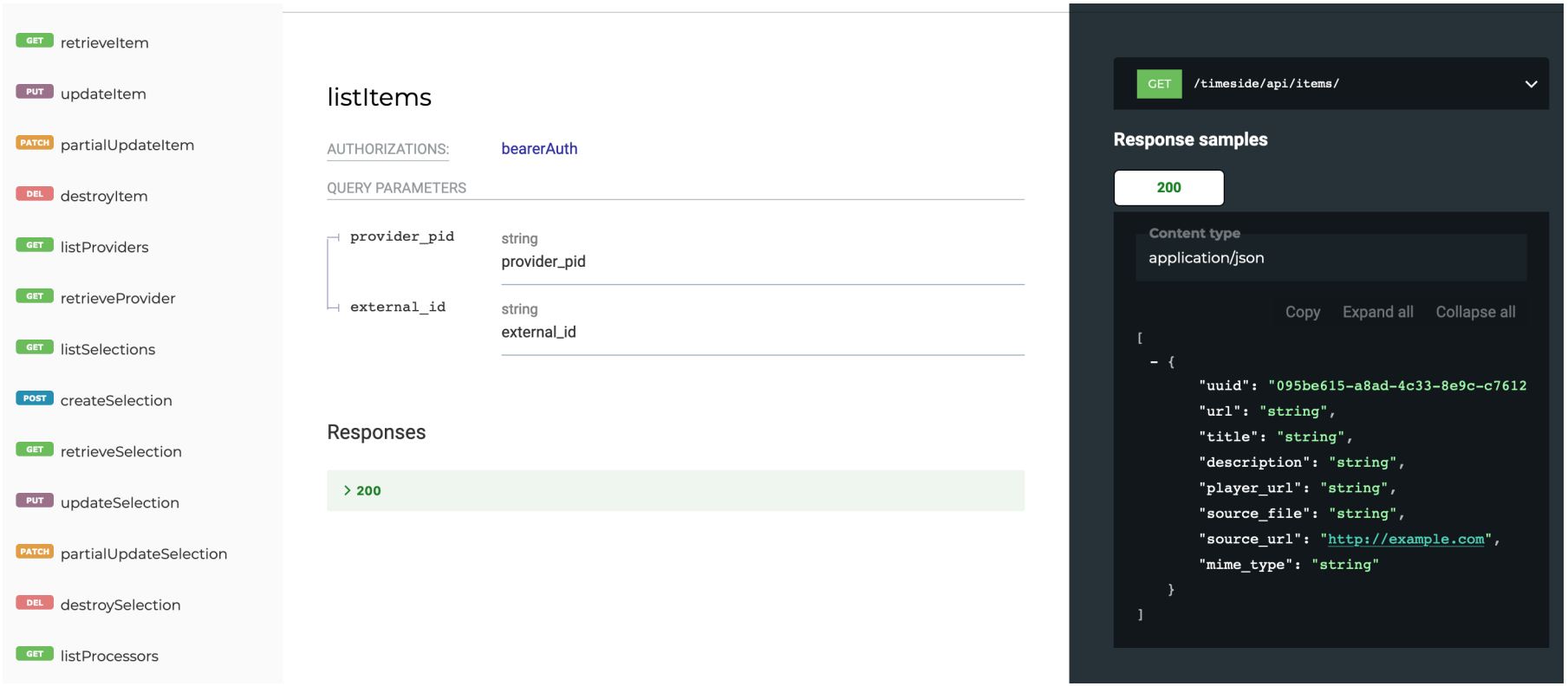
- `Item`: audio content and metadata (external id)
- `Provider`: provide audio from a given plateform
- `Selection`: list of items (corpus)
- `Processor`: plugins with version and default parameters
- `Preset`: processor and a set of parameters
- `Experience`: list of presets forming a pipe (reproductible)
- `Task`: an experience and a selection
- `Result`: transcoded audio or numerical outputs (hdf5 file)
- `Annotation`: label audio file on a given time or segment



timeside.server

RESTful API documentation

auto-generated thanks to ReDoc on top of OpenAPI 👉 👉 https://timeside.ircam.fr/api/docs/

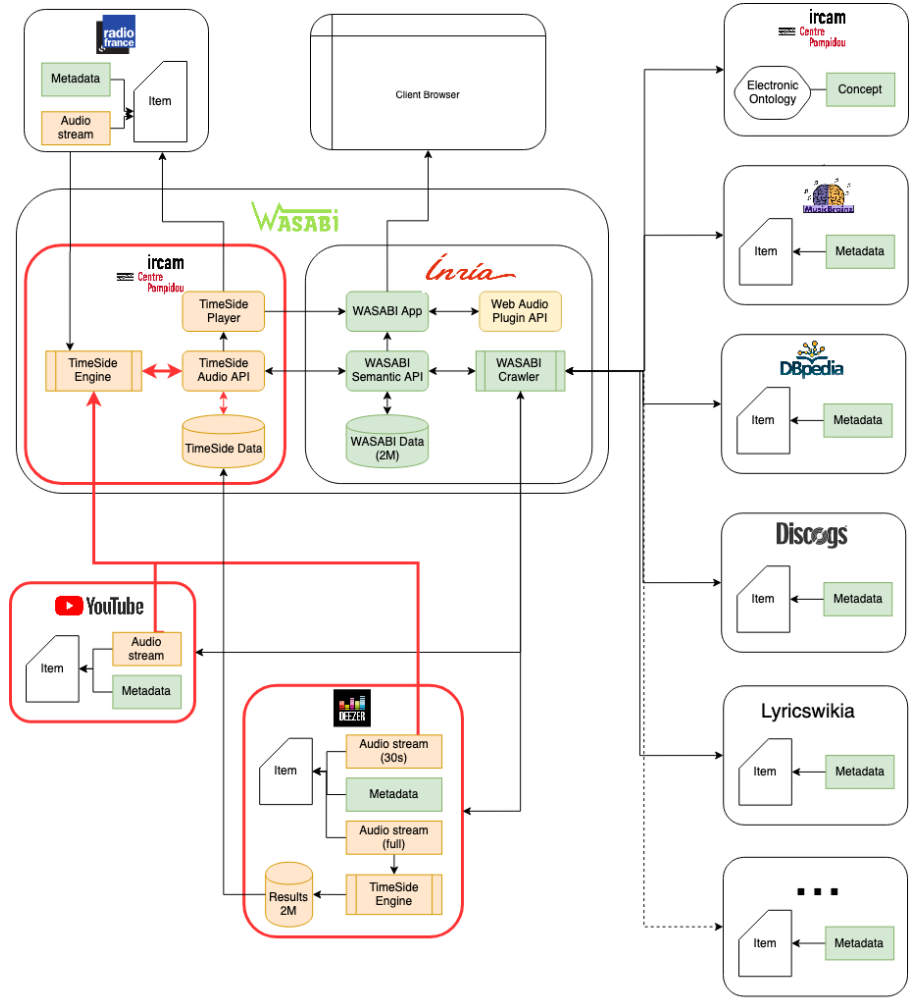


timeside.server - wasabi project

workflow examples in the WASABI platform

with providers

- Youtube
  - based on `youtube-dl`
  - must be adaptable to YouTube's changes
- Deezer 30 seconds long preview
  - consuming Deezer's API
  - find another solution to full contents



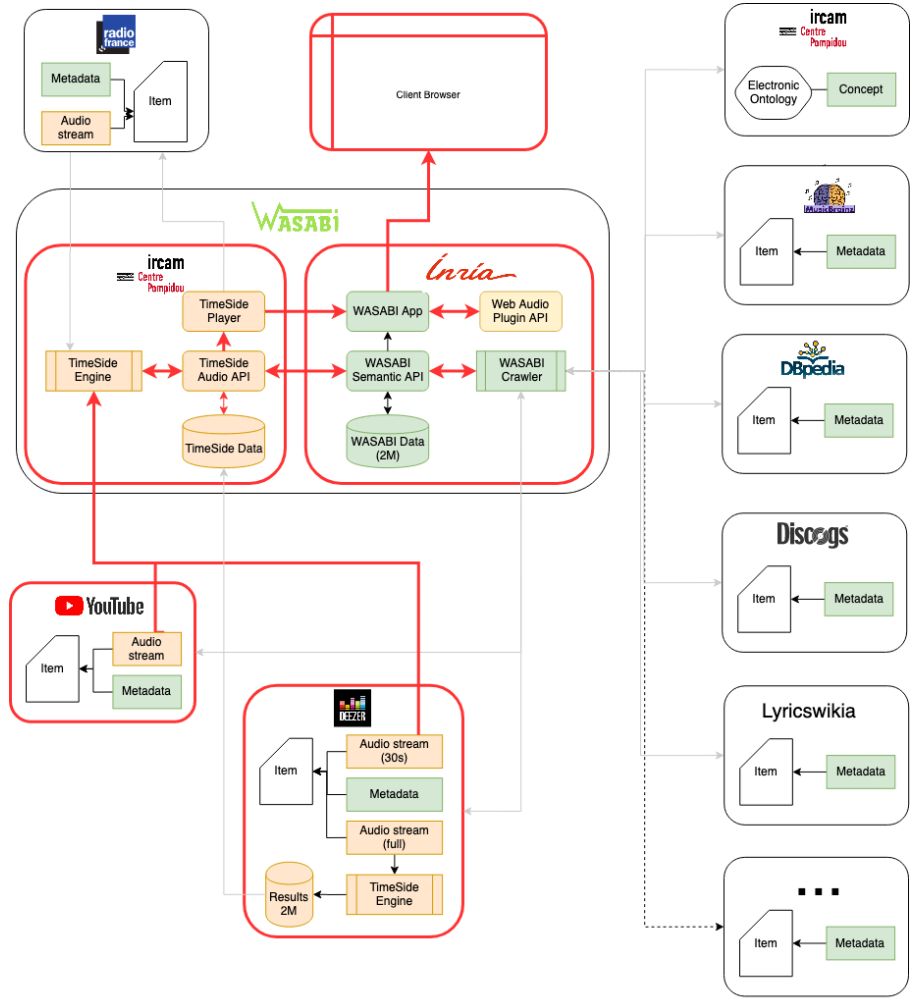
timeside.server - wasabi project

workflow examples in the WASABI platform

with server

POC of a webservice

- delivers audio analysis to another remote server
- enhance its musical metadata with results



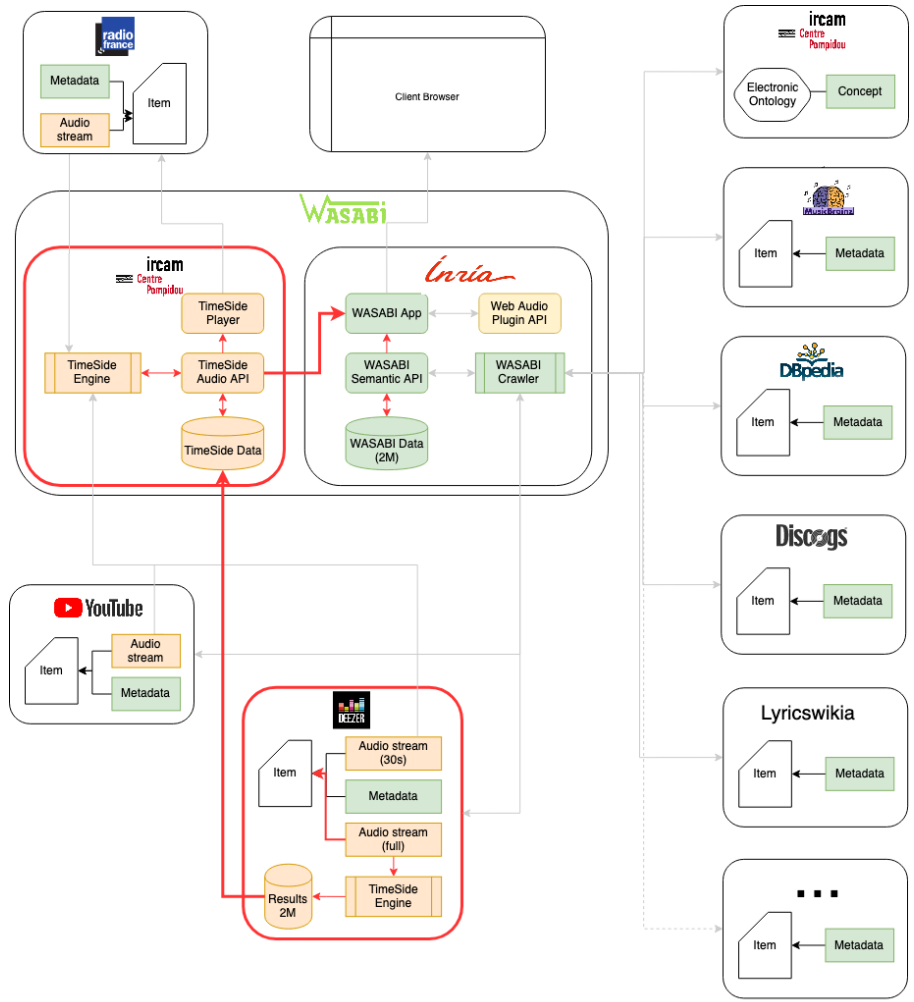
timeside.server - wasabi project

workflow examples in the WASABI platform

Import/export of a run on Deezer's infrastructure

POC of a sharing system of an audio analysis datasets

- easy deployment thanks to docker
- audio does not have to be shared



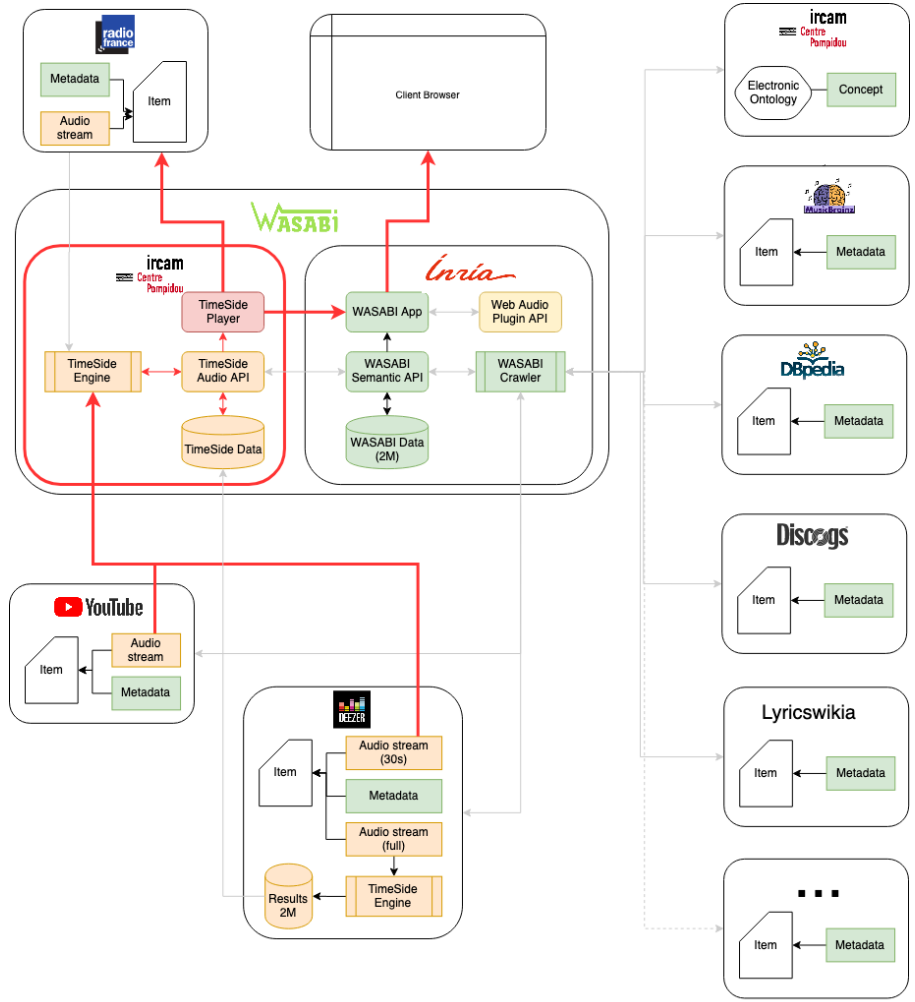
timeside.server - wasabi project

workflow examples in the WASABI platform

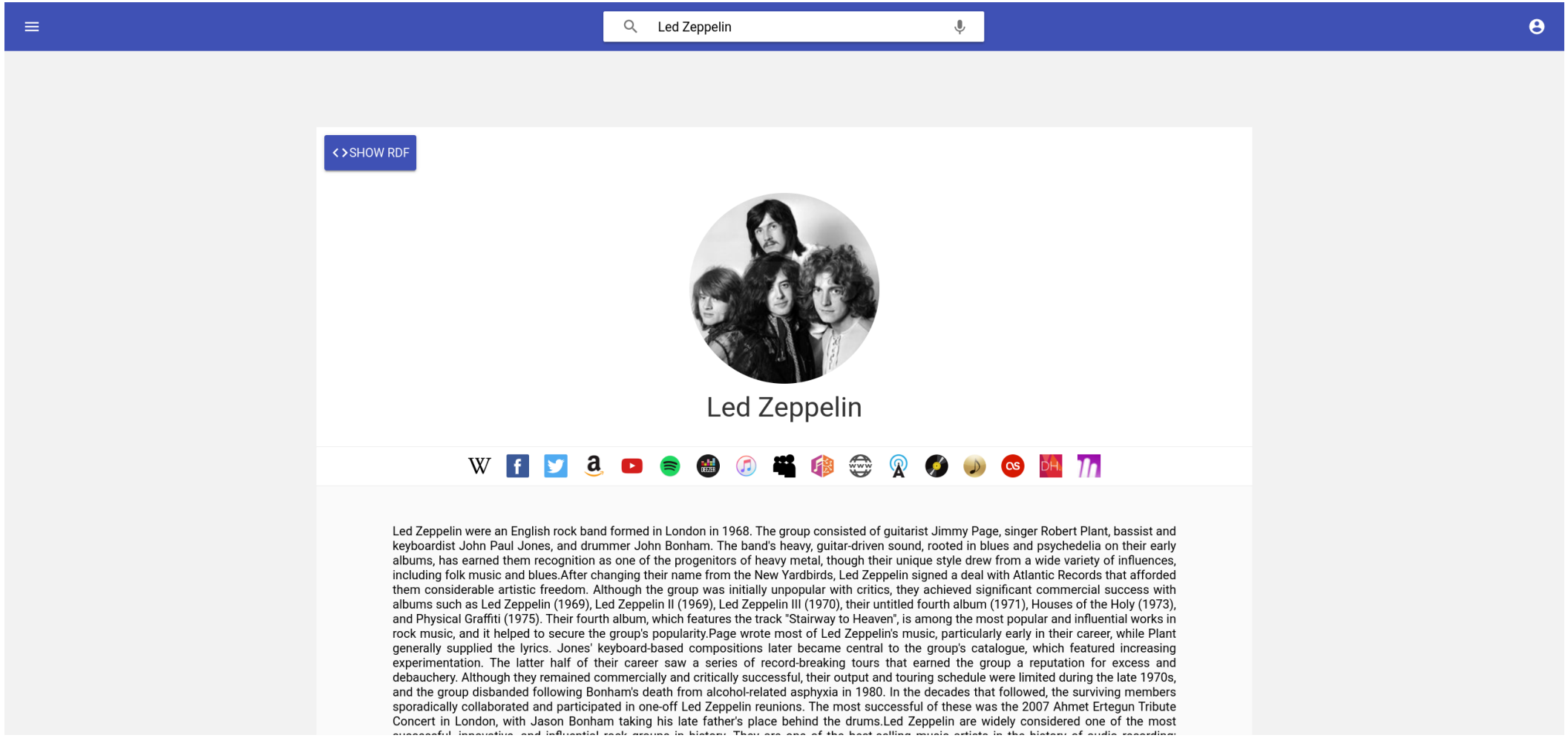
with a frontend player

POC of a JavaScript app that consume the Rest API

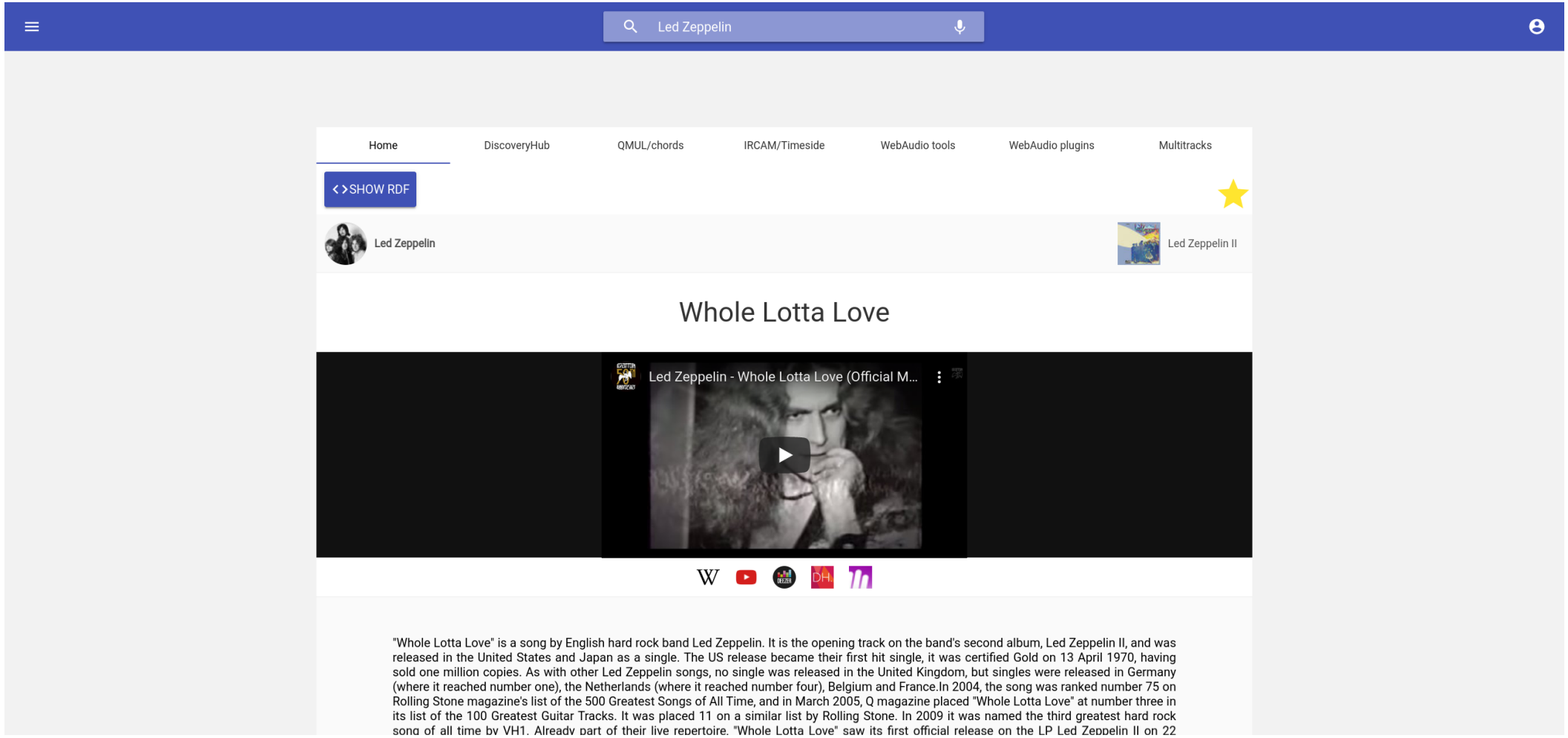
- serialize data as JSON or image
- deliver analysis track (spectrogram, waveform)
- deliver or get annotations on audio track



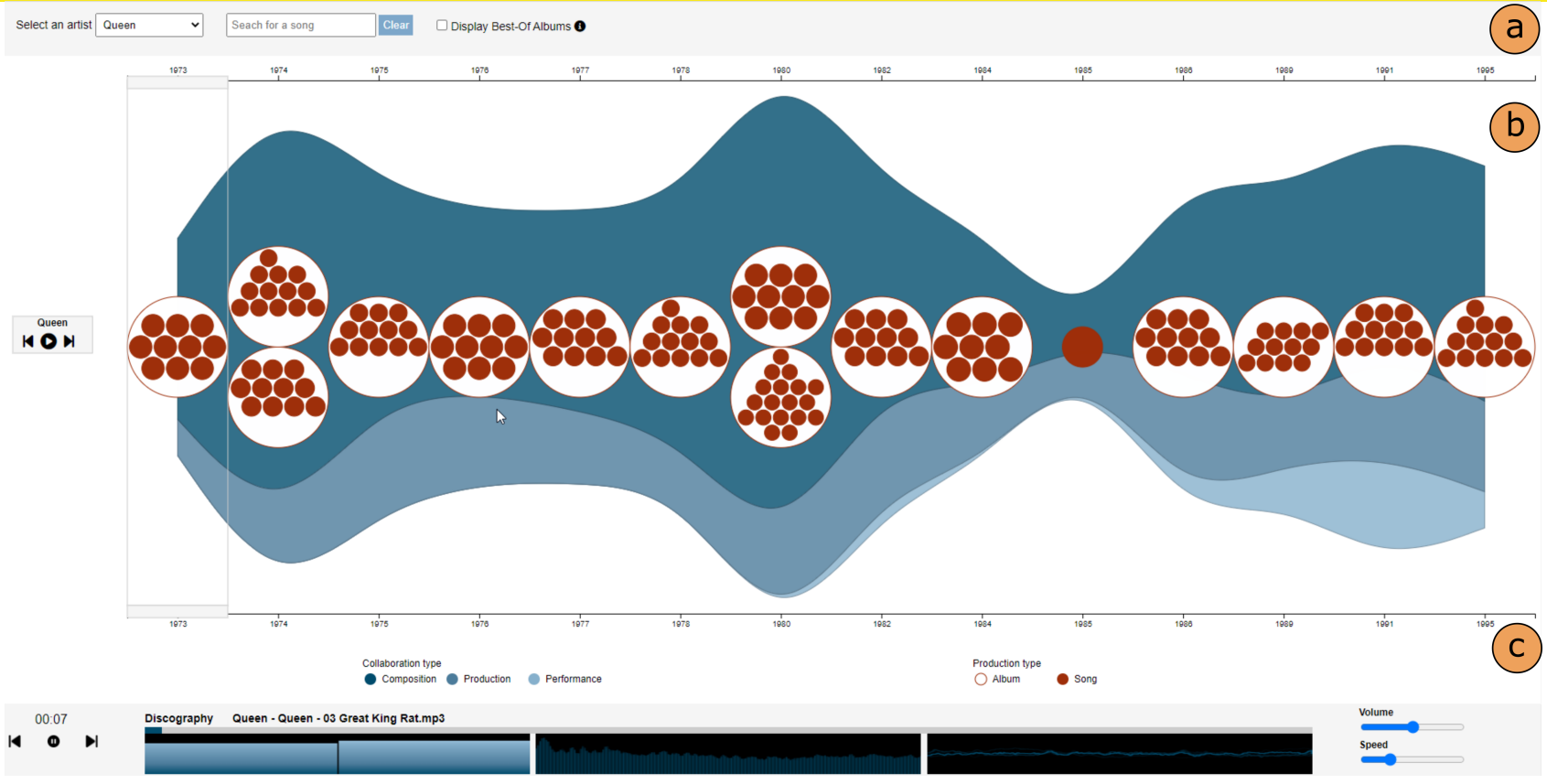
timeside.server - wasabi project (link)



timeside.server - wasabi project (link)



timeside.server - wasabi project (link)



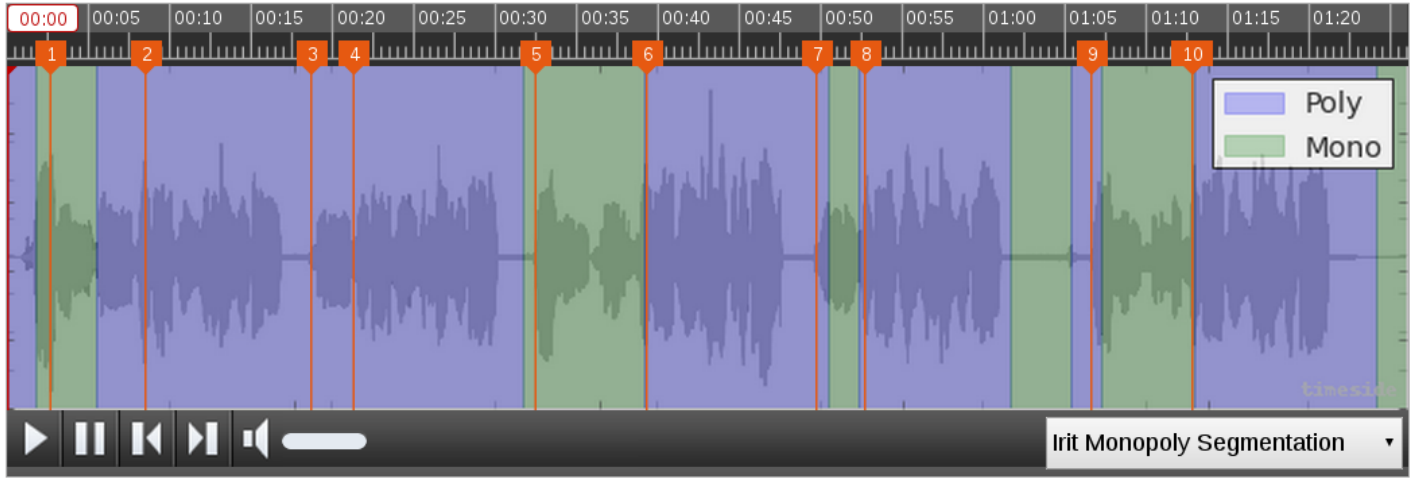
Aline Menin, Michel Buffa, Maroua Tikat, Benjamin Molinet, Guillaume Pellerin, Laurent Pottier, Franck Michel, & Marco Winckler. (2022, June 28). Incremental and multimodal visualization of discographies: exploring the WASABI music knowledge base. Web Audio Conference 2022 (WAC 2022), Cannes, France. https://doi.org/10.5281/zenodo.6767530

timeside.player

timeside.player - v1

Features

- full HTML through SoundManager2
- on demand processing and display
- simple marker annotation
- bitmap image cache only



timeside.player - v2

Constraints

- Handling multiple hours audio files
- Multiple user annotations and analysis tracks
- Vectorized
- Zooming
- Scaling

timeside.player - v2

API SDK (client library)

- Timeside API: 75 routes
- openapi-generator
  - Typescript
  - Fetch
  - OpenAPI v3 Schemas
- Improve schema support on DRF (PR)
  - Components
  - Customize default names
- Glue code
  - Authentication
  - Initialization on Browser / Node
- Documentation

```
/timeside/api/analysis/:
  get:
    operationId: listAnalysis
    parameters: []
    responses:
      '200':
        content:
          application/json:
            schema:
              type: array
              items:
                $ref: '#/components/schemas/Analysis'
```

- SDK: https://github.com/Ircam-WAM/timeside-sdk-js
- Scripts: https://github.com/Ircam-WAM/timeside-scripts

Opportunity: `openapi-generator` also supports Python, C/C++, Ruby, Go, Rust etc...

timeside.player - v2

HTML Player

🔧 Technologies

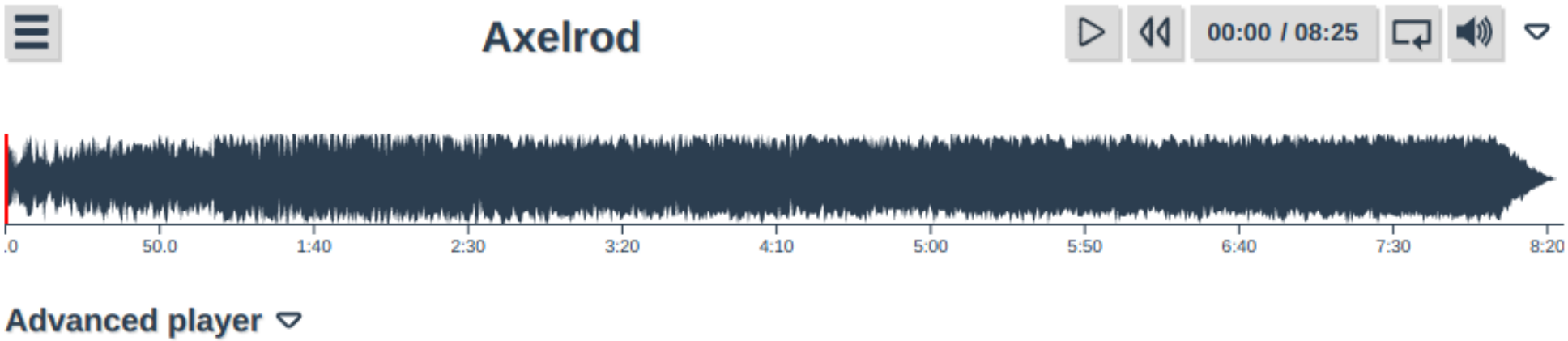
- Vue (composition-api): DOM Manipulation, Data reactivity
- D3 (SVG): Render waveform / Analysis
- HTML5 Audio / Web Audio
- Web Animations API
- Websockets
- Resize Observer
- GitHub Action for continuous test & deployment (npm, gh-page)
- https://github.com/Ircam-WAM/timeside-player

🚀 Usage

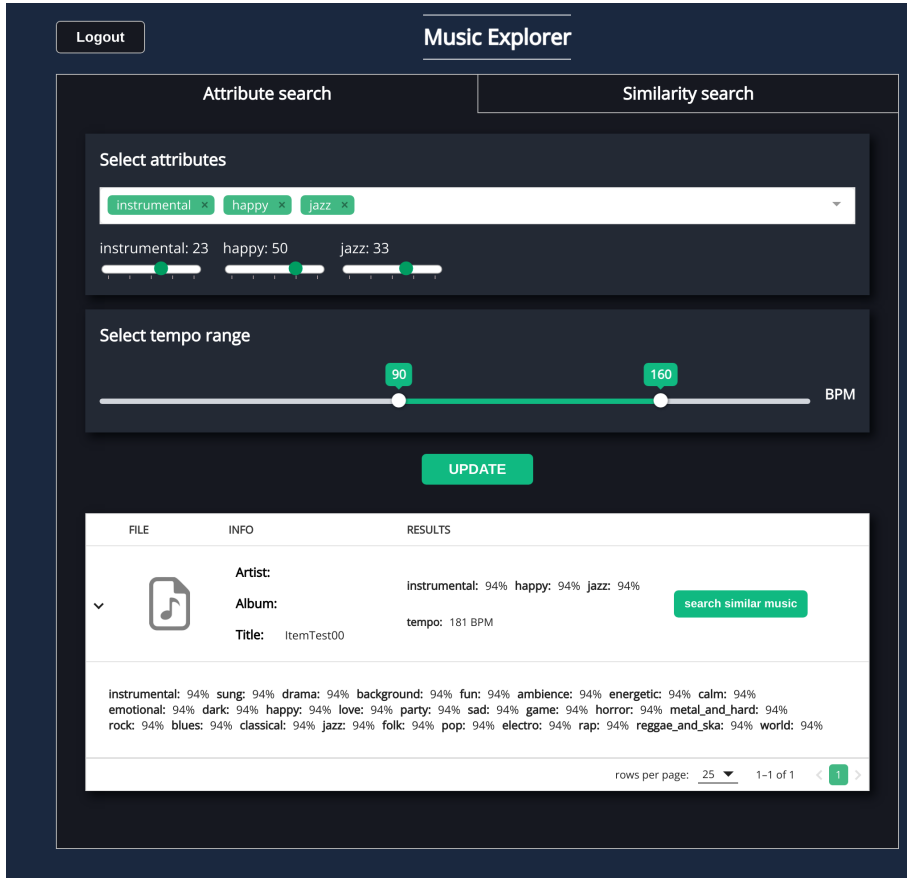
- Standalone app
- Web library
  - React
  - Vue
  - HTML

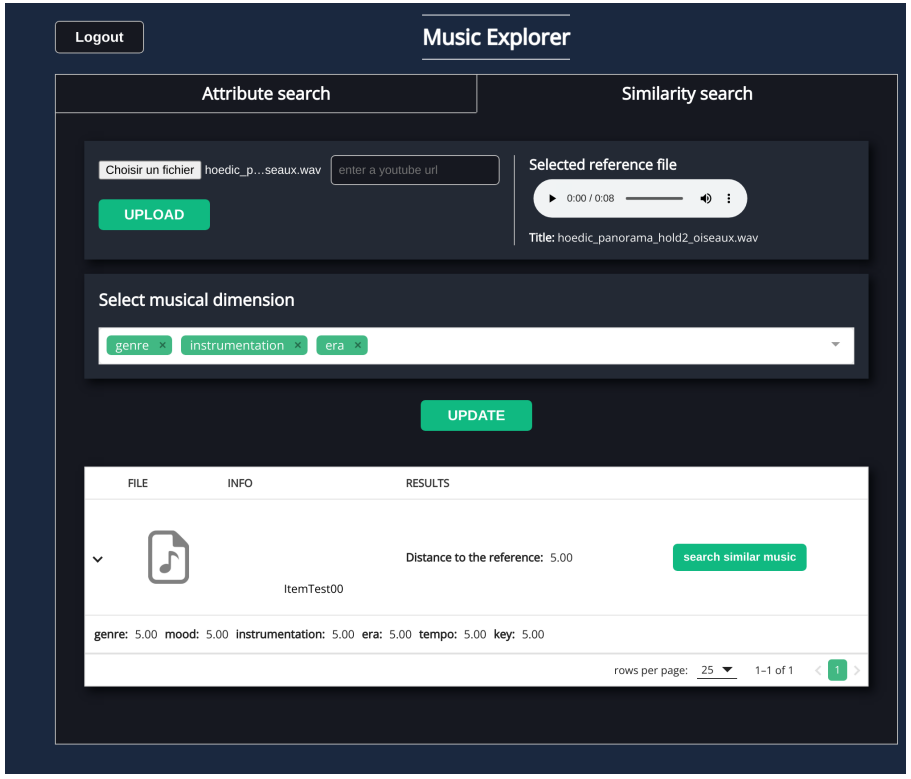
Demo time!

timeside - embed player



timeside - music explorer (AI4Media project)





TimeSide - roadmaps

1.0 > 1.1 (2021)

- composition
  - base image upgrades
- core
  - lib upgrades
  - VampAnalyzer
  - graphers are back
- server
  - upgrade deps
  - stabilization (worker)
  - API doc
- worker
  - full asynchronous
  - better YouTube provider handling
- player
  - embed design
  - better annotation editor
  - listing

1.1 > 1.2 (2023)

- core
  - parameters
  - switch to poetry (python package manager)
- server
  - extended API
- worker
  - websocket based monitoring
  - test Deezer provider at scale
- player
  - uploader
  - better listing
  - looping

Perspectives

Audio processing and annotation web service (SaaS)

TODO list

- vertical scales
- clustering and orchestration
- synchronous task status polling
- more plugins (VAMP host, source separation)
- test some JS MIR librairies (Essentia.js)
- easy upload
- audio cross comparison functions
- more embed experiences
- re-use of archives in contemporary music

Dual licencing?

- open source community release of the core framework (AGPL)
- proprietary (entreprise) release with specific plugins

New partnerships

- IRCAM Amplify
- BNF ?
- +CNRS ?
- LISA ?

Thank you and kudos to all contributors!

timeside.ircam.fr

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