Polifonia: a digital harmoniser for musical heritage knowledge, H2020

D1.3: Pilots development – collaborative methodology and tools (V0.1)

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Project Information

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POLIFONIA Consortium

No.	Short name	Institution name	Country
1	UNIBO	ALMA MATER STUDIORUM - UNIVERSITÀ DI BOLOGNA	Italy
2	OU	THE OPEN UNIVERSITY	United Kingdom
3	KCL	KING'S COLLEGE LONDON	United Kingdom
4	NUI GALWAY	NATIONAL UNIVERSITY OF IRELAND GALWAY	Ireland
5	MiC	MINISTERIO DELLA CULTURA	Italy
6	CNRS	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	France
	SORBONNE	SORBONNE UNIVERSITE (LinkedTP)	France
7	CNAM	CONSERVATOIRE NATIONAL DES ARTS ET METIERS	France
8	NISV	STICHTING NEDERLANDS INSTITUUT VOOR BEELD EN GELUID	Netherlands
9	KNAW	KONINKLIJKE NEDERLANDSE AKADEMIE VAN WETENSCHAPPEN	Netherlands
10	DP	DIGITAL PATHS	Italy

Project Summary

European musical heritage is a dynamic historical flow of experiences, leaving heterogeneous traces that are difficult to capture, connect, access, interpret, and valorise. Computing technologies have the potential to shed a light on this wealth of resources by extracting, materialising and linking new knowledge from heterogeneous sources, hence revealing facts and experiences from hidden voices of the past. Polifonia makes this happen by building novel ways of inspecting, representing, and interacting with digital content. Memory institutions, scholars, and citizens will be able to navigate, explore, and discover multiple perspectives and stories about European Musical Heritage.

Polifonia focuses on European Musical Heritage, intended as musical contents and artefacts - or music objects - (tunes, scores, melodies, notations, etc.) along with relevant knowledge about them such as: their links to tangible objects (theatres, conservatoires, churches, etc.), their cultural and historical contexts, opinions and stories told by people having diverse social and artistic roles (scholars, writers, students, intellectuals, musicians, politicians, journalists, etc), and facts expressed in different styles and disciplines (memoire, reportage, news, biographies, reviews), different languages (English, Italian, French, Spanish, and German), and across centuries.

The overall goal of the project is to realise an ecosystem of computational methods and tools supporting discovery, extraction, encoding, interlinking, classification, exploration of, and access to, musical heritage knowledge on the Web. An equally important objective is to demonstrate that these tools improve the state of the art of Social Science and Humanities (SSH) methodologies. Hence their development is guided by, and continuously intertwined with, experiments and validations performed in real-world settings, identified by musical heritage stakeholders (both belonging to the Consortium and external supporters) such as cultural institutes and collection owners, historians of music, anthropologists and ethnomusicologists, linguists, etc.

Executive Summary

Short summary to clearly explain the objectives and contents of the deliverable (e.g. a brief statement of the problem or proposal covered, background information, concise analysis and main conclusions)

Document History

Version	Release date	Summary of changes	Author(s) - Institution
V0.1	30/04/2021	First draft released	Enrico Daga (OU)

Table of contents

1 Introduction

This deliverable presents the methodology and tools for the collaborative development of the pilots of the Polifonia project. It describes the scope and role of the Technical Board, established for coordinating the technical development and ensure the quality and consistency of the technical outputs. The first objective of the Technical Board was to define a collaboration methodology, following the spirit of agile software engineering methodologies, which combines a two-fold approach. On one hand, developers and domain experts are joined in sessions dedicated to specific research themes, and develop ideas on how to approach specific problems, at the micro level. On the other hand, Work Packages and Task leaders participate in those sessions with the aim of developing connections to the objectives of the project, at the macro level. A variety of different types of assets are expected to be produced by the co-creation process. Those include not only software libraries, data, services, and user interfaces but also information to make sense of them: stories, representing requirements in the forms of scenarios, tutorials, and how-to. The components of the Polifonia Ecosystem are designed as interlinked assets for supporting the development of innovative tools for musical cultural heritage study, preservation, and exploitation. These components constitute the technical backbone of the pilots, which combine them in useful applications targeting scholars and citizens. Developers will pick and mix components of the ecosystem in complex pipelines, composing interesting applications. However, the Polifonia Ecosystem does not start as a blank sheet. Consortium members bring expertise and technical solutions that can already be employed in such modular approach. Therefore, background technologies relevant to the ecosystem are presented. Finally, the project has already implemented key actions to bootstrap the development activities, including dedicated spaces on a collaborative development platform (GitHub) and a live text chat system (Discord). We conclude the deliverable with a provisional timeline.

2 Pilots and Web Portal

Enrico: Move to the end?

This section provides an introduction to the Polifonia pilots and Web portal to provide the context to the collaborative methodology and tools.

2.1 Web portal: an aggregator of digital musical heritage collections

Enrico: Shall we move this into a separate section?

The Polifonia Web portal is designed to be the main access point to data collections produced in the pilots. The objectives of the portal are threefold: (1) to provide user-friendly interfaces and let the general public access valuable information on musical heritage, (2) address exploratory and analytical tasks targeted on specific scholarly groups, and (3) provide access and foster reuse of data sources.

The design and development of the Web portal is iteratively informed by activities carried out by working groups, namely:

- Data layer requirements (WP1, WP5, TB)
- Software solutions (WP7, TB)
- Infrastructure requirements (TB, project coordinator)
- Sustainability plans (TB, project coordinator, third-parties)

Data layer requirements. The socio-technical roadmap (see Deliverable D1.1) offers an overview of *contents* relevant to pilots. It identifies shareable metadata, multi-modality aspects, and linking between data sources to be produced by project members and sources already available on the web. The roadmap provides us with the big picture of content requirements, possible overlaps between data created by pilots, and whether the development and access to certain data sources must be prioritised.

Interviews with scholars participating in music research are carried out to by OU and UNIBO in order to frame the following aspects: (1) data-driven research questions, (2) *data-sense making activities*, and (3) metadata requirements. Domain experts involved in Polifonia pilots are asked to detail their research methods, whether sources are already digitised or not, and whether computer-aided tasks are in scope. Content analysis of transcribed interviews is performed to frame research methods into sense-making primitives and define requirements of the final web interfaces. The latter include tools for exploratory data visualisation (EDA), features of the search engine, and User eXperience (UX) aspects.

Software solutions. Software solutions that are part of Polifonia ecosystem (see section 5) are constantly surveyed by members of the technical board to frame the state of the art, and if needed, propose a intervention of Polifonia developers to fill the gaps. Software solutions include, among the others, (1) *ontologies and vocabularies* that Polifonia data sources rely on (data layer), (2) *software libraries* for Web development, data processing, and Linked Open Data manipulation, and (3) *standards* for music annotation.

A working group including representatives of pilots and the TB is dedicated to the development and maintenance of a *registry* of musical resources on the web. The work extends and optimizes the existing musoW registry (`https://musow.kmi.open.ac.uk/`). The objectives of this activity are the following: (1) to develop sustainable solutions for updating and maintaining the online registry with metadata about data sources produced by the project, (2) to allow supervised crowdsourcing of metadata of other data sources and tools relevant to Polifonia objectives and (3) to provide the final web portal with a strategy for harvesting up to date data collections.

Lastly, the activity is informed by the outputs of the Data Management Plan, which details *data publication and dissemination strategies*. Such strategies are iteratively refined according to data volume and long-term preservation purposes, and affect the way the web portal accesses the data layer.

Infrastructure requirements. The TB defines suitable hosting and deployment solutions to guarantee optimal usage of available resources. We expect infrastructure requirements to vary along with the evolution of data layer requirements. Our work is inspired by previous works addressing similar situations [1, 2], namely: distributed systems leveraging data sources stored in different locations, systematically updated by providers, and served according to different access and licensing options.

Fig. 2.1 illustrates the high-level infrastructure of the mid-term/final version of the web portal and the dependencies with Work Packages that are involved.

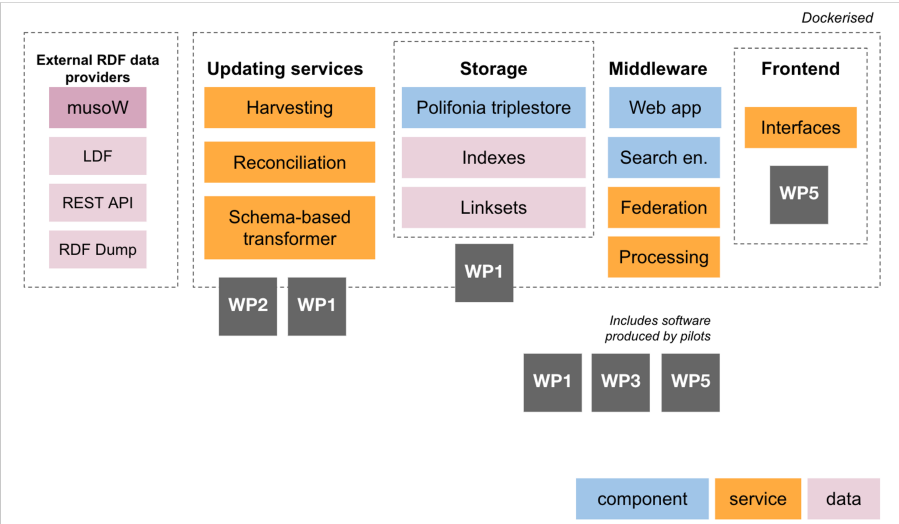

Figure 2.1: Overview of Polifonia Web Portal infrastructure

As shown in the picture, we expect data sources to be shared by partners and external data providers in different ways, including SPARQL endpoints, REST APIs, Linked Data Fragments, and RDF data dumps. Among the sources, the musoW catalogue acts as a centralised registry recording cataloguing data of sources that will populate the web portal.

The web portal back-end includes a dedicated triplestore, which stores selected information harvested from data sources in the form of indexes and linksets. Specialised services perform pre-processing (cleaning), reconciliation (deduplication), and transformation activities (according to a crawling schema).

The middleware consists of a fully compliant Model-View-Controller (MVC) application, which handles the search engine, federated queries to external sources (when applicable), post-processing of data, and serves data as views.

To deploy and deliver software quickly we use Docker.[1]

Sustainability plans The TB, in the person of the project coordinator, investigates sustainability plans for the Polifonia web portal. In particular, options for *long-term access, hosting, and maintenance*, of the web portal and data sources may involve third-parties interested in contributing with trusty solutions.

It is worth noting that one of the advantages of completely relying on Linked Open Data and Semantic Web technologies includes the usage of *persistent, dereferenceable HTTP URIs* for identifying resources, web documents, and data collections. That is, a end user will always be able to access web resources by using the same persistent URIs regardless their actual location and storage solutions. So doing, we plan to iteratively increment infrastructure requirements without affecting data access and reuse strategies.

2.2 [ORGANS] - A Knowledge Graph on History of Pipe Organs

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.3 [BELLS] - Preservation of Historical Bell Heritage: dependencies between tangible and intangible

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

[1] https://www.docker.com

2.4 [INTERLINK] - Interlinking of collections in digital music libraries and audiovisual archives

Technology provider(s): WP2, WP3, WP4. Beneficaries: KNAW, NISV, ICCD, ICBSA, UNIBO, IREMUS, NUIG; CLARIN, DARIAH, CLARIAH, Europeana (external)

Pilot objectives: INTERLINK seeks to connect collections in digital music libraries and audiovisual archives in a meaningful way by means of a Knowledge Graph. Within the Polifonia project the INTERLINK-pilot establishes the required infrastructure for the analysis of relations between musical heritage across different collection. By drawing on knowledge graphs (WP2) and music and text extraction technologies (WP3, WP4), this pilot will explicitly reveal and make compatible the entities and concepts hidden in digital music libraries and audiovisual archives.

Work thus far: A user story, 'William', (https://github.com/polifonia-project/stories) was drafted specifically for the INTERLINK pilot, in which specific attention was paid to the need for a Knowledge Graph based on catalogue metadata. More in depth analysis of pitch, rhythm and other modalities of music could become a further part of the Knowledge Graph, after the more basic catalogue metadata has been linked. The MUSOW platform (https://musow.kmi.open.ac.uk/) functions as a registry for various music collections. Discussions are ongoing about how this platform can be improved upon, in terms of the data format used and the ease with which people can contribute new datasets to the platform. Finally, the option of using Github as the database for the registry is being assessed.

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.5 [FACETS] - Exploration of music scores collections through statistical features

Technology provider(s): WP3, WP4, WP5. Beneficaries: CNAM, Iremus, NUIG, BNF (external).

Pilot objectives: FACETS seeks to improve exploration and discovery of large collections of scores through the creation of a faceted search engine (FSE). It will rely on features extracted and identified in WP3 and WP4 (melodic, harmonic or rhythmic patterns, style, structure, instrumentation, metadata). This engine will be demonstrated in Neuma, and its code released in open source. Other score-oriented musical libraries for cultural heritage will benefit from the code, such as Royaumont and Gallica-BNF. Results will be reused by WP2 and WP3.

Work thus far: A PhD student, Tiange Zhu, started her work mid-February. She has so far worked towards getting familiar with the Neuma platform (Python/Django code, see http://neuma.huma-num.fr) and extending preliminary works on a search engine dedicated to musical scores. The search engine currently features an exact melodic search, or a transposed one. A rhythmic search and a lyrics search are developped, as well as some refinements for melodic patterns ("mirror search"). The migration of the source code on Github will happen in

the next few months, and a journal paper will be submitted in a similar schedule (extending the results of [3]).

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.6 [TONALITIES] - Modal and tonal classification of Western notated music from the Renaissance to the 20th century

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.7 [TUNES] - Tunes analysis and classification

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.8 [MUSICBO] - Knowledge graph of Bologna Musical Heritage

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.9 [CHILD] - Exploration of musical heritage for scholarly enquiry: a case study on Music and Childhood

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.10 [MEETUPS] - Musical Meetups: the European musicianship flow

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

2.11 [ACCESS] - Making musical performances accessible to people who are Deaf or hearing impaired

Please provide a summary of the pilot objectives, beneficiaries, and a description of the work done so far, with particular reference to collaborative work and exchange of expertise.

3 Technical Board

To support the collaborative development of the Pilots (Task 1.3), the project consortium established a Technical Board (TB), composed of representative members of the partners expecting to contribute on the development of the technical outputs of the project. The role of the TB is to support the coordination of the technical activities and facilitate the interaction and collaboration. In particular, the TB monitors technical developments fostering the sharing of expertise with the objective of maximising reuse of knowledge, skills, and resources. Members of the TB are responsible of ensuring the quality of the technical outputs, both from the point of view of good practices of software engineering and from the perspective of providing guidance and support to users, developing and curating documentation, tutorials, and user guides. In addition, the TB supervise the curation of resources for developers, so to maximise the reuse of the outputs by third-party organisations of the cultural heritage sector and industry. The TB establishes the methodology and tools for collaboration. The present document provides details of the methodology and tools setup so far, which will be evaluated regularly and possibly changed to adapt to the concrete needs of the pilots. Of particular importance is the dissemination of project outputs, which the TB aims at maximising by recommending the delivery of Open Source software published with a commercial-friendly Apache Licence 2.0, and asking consortium members to provide substantial arguments in case they require alternative policies.

The project coordinator appointed Enrico Daga (OU) as Technical Director (TD), whose responsibility is the coordination of the Technical Board. The currently appointed members of the TB are listed in Table 3.1. Partners are free to change the appointed person by communicating it to the Technical Director. However, the TB follows an inclusive and open approach to discussion, inviting all developers, technologists, researchers, and interested people within the consortium to join TB meetings and participate. By default, TB meetings are open to all project members and we expect to organise closed meetings for exceptional reasons only.

More on this in the Methodology section?

More on this in the Methodology Section

@All Please check and complete the table

Add what the TB did so far (see minutes) (Enrico)

Table 3.1: Technical Board appointed members

Member	**Partner**	**Pilots**
Enrico Daga	OU	CHILD, MEETUPS, ACCESS
Johan Oomen	NISV	Interlink
Raphaël Fournier-S'niehotta	CNAM	FACETS
Mathieu d'Aquin	NUIG	
Assistant Prof (hiring in process)	UNIBO	MUSICBO, INTERLINK, MEETUPS, BELLS
Albert Meroño	KCL	INTERLINK, FACETS
Peter van Kranenburg	KNAW	ORGANS, TUNES
Fiorela Ciroku	UNIBO	MUSICBO, INTERLINK, MEETUPS, BELLS
Marilena Daquino	UNIBO	Web portal

4 Methodology

The methodology used for the development of the pilots and the Polifonia ecosystem is inspired by agile software development methodologies [4]. Similar to those, our methodology focuses on "discovering requirements and developing solutions through the collaborative effort of self-organising and cross-functional teams and their customer(s)/end user(s)"; in Polifonia, these cross-functional teams are organised by the various technology-oriented WPs (WP2 –knowledge graphs–, WP3 –music pattern discovery–, WP4 –text pattern discovery– and WP5 –user interfaces–); while the customers/end users are represented by the various Pilots (WP1). Therefore, WPs and Pilots interact in an orthogonal way.

This distributed, self-organised approach has several advantages, especially when confronted with a more traditional, waterfall-based model [5]:

- Does not enforce specific non-functional requirements to any of the development teams, such as programming languages, libraries, or frameworks; therefore minimising the chances of writing large, monolithic systems that are hard to document and maintain (especially after the end of the project)
- Identifies and reduces dependencies between different Pilots
- It is feature-driven, and puts the requirements from the Pilots at the forefront of the development process
- Allows for incremental and frequent software releases under the open-source mantra "release early, release often"
- Increases decoupling and independence of components, since each component has autonomous value and can be used by and combined with other components (e.g. the Pilots and the Web Portal)
- Increases opportunity for reuse of technical and scientific artefacts
- Allows for a decentralised quality assurance process, where project-global metrics can be implemented in component-specific ways

@all: add something about long-term sustainability? E.g. innovation task force in WP6

In addition to these well-known benefits, we extend the methodology with the following procedures:

1. **Sign-off release**. The release of new software components into the ecosystem must follow a code review, involving one or two code reviewers from a different team from the one that carried out the development. More specifically, this happens when a *development branch* requests a *merge with its main branch* via a *pull request*; such a pull request must include a code review request to the aforementioned external reviewers
2. **Component development life-cycle**.

@all: check this is how we want to do it?

3. **Bottom-up approach**. Component development, and especially the gathering, documentation and maintenance of requirements for such components, are managed through the Polifonia *maninpasta* sessions. This is a hackathon-like, grassroots approach that periodically ensures interaction between requirement providers in the Pilots, and software development teams in the technological WPs.
4. **Top-down approach**. WP leaders and TB members ensure that the bottom-up approach is aligned and converges, to the extent possible, to the goals established by Polifonia GA. This includes the establishment of WP checkpoints (e.g. previous to a milestone or a deliverable); and explicit breakdowns and plannings of how features, commits, releases, etc. align with the planning of WPs and their tasks. The TB synchronises and complements this top-down upservision in conjunction with the WP and Task leaders.

Outline

WP and Pilots are Orthogonal Goal: identify and reduce dependencies Increase opportunity for reuse (scientific / technical)

Agile, feature-driven

Incremental releases: "release early, release often”

Decoupling / independence (each component has an autonomous value but *can* also be used with others, as exemplified in Pilots and Web Portal)

Quality assurance

Sign-Off release process, involving one or two code reviewers from another team

Component development lifecycle

Methodology Two-fold: (a) Bottom-Up: Maninpasta / hackatons grassroots approach (b) Top-Down: Checkpoint during WP, relation with WPs, tasks, etc . . . / Checkpoint on TB

5 The Polifonia Ecosystem

Enrico: Background and motivation: we don't want to do a framework, frameworks are bad

The Polifonia Ecosystem is conceived as a collection of components which are both independent – they have some value on their own – and interlinked – they can be combined in order to satisfy specific end-user needs.

Data components types are the following:

- Registries – indexes of resources of interest to Musical Cultural Heritage. A preliminary example is the MusoW catalogue of Musical Resources on the Web. Other registries can be developed to fit specific needs (for example, the catalogue of resources useful to the CHILD pilot)
- Ontologies – produced in the context of the Polifonia project to support pilots and use cases, ontologies specify domain knowledge and are used for knowledge representation of Polifonia datasets
- Datasets – structured data offered following best practices in (Linked) Open Data publishing. When possible, data is published in the original format as well as Linked Data, using Polifonia ontologies.
- Knowledge Graph – a distributed but unifying view of musical cultural heritage knowledge, is a virtual composition of all the data objects produced to be reused for large scale integration, for example, to support unified indexes for exploration and discovery

  Enrico: To be discussed at the TB. We say that there will be 1 single KG aggregating everything, but I still think that the nature of the KG should be distributed and there can be one system which indexes the data to support some use cases such as discovery and reuse.
- Services / Web APIs – to expose reasoning and data processing capabilities, services are run by Polifonia consortium members and instantiate specific components to the Open Web. Among those there are Linked Data services such as SPARQL endpoints – live data services publishing the above components for querying with SPARQL.
- Software libraries – reusable code produced by the project to support pilot activities.Software libraries are used by programmers in their own applications
- CLI tools – ready-made tools to be used by developers in scripting data manipulation pipelines
- User interfaces – targeting domain experts, citizens, developed to support specific activities in the context of the Polifonia Pilots, user interfaces can be reused across similar applications targeting different data

- Stories – requirements from the world of Musical Cultural Heritage preservation, exploitation, and scholarship; stories are the starting point of the collaborative methodology and the *sense-making* layer of the Polifonia Ecosystemm, giving context and purpose to the components
- Tutorials – a showcase of the Polifonia Ecosystem through end-to-end tutorials, inspired from the Pilots and displaying the capabilities of the components in concrete applications. Tutorials are also an excellent starting point for developers.
- Web Portal (a KG view on Polifonia) – the aggregator of the Polifonia Knowledge, exploiting the Knowledge Graph as underlying integration method.
- Polifonia Ecosystem Documentation Website (GitHub) – The resource for accessing the Polifonia Ecosystem, browsing the components and the documentation, accessing the resources for developers, and joining the project team in building the next generation of tools for Musical Cultural Heritage.

These component types are *interlinked*.

Interoperation strategies: Web technologies (OpenAPI, SPARQL, Solid, URLs, . . .)

Publishing guidelines

- Life-cycle, Versioned Releases (on GitHub)

Software libraries:

- Code quality - Documentation - Tutorials - CLI

Services / Web APIs: “Towards an open Web experience, not a “Facebook” experience”

- Availability
- Good practices (e.g. OpenAPI specification)
- Documentation
- Tutorials

User Interface components:

- Good practices: (a) Linkable UI views; (b) Reusable snippets (Web Embed)
- Reusability of UI

Deployment strategies / Interoperability How tos / Demonstrators

- Recommendations and examples on how to reuse the components
- Recommendations on how to setup a docker components

Stories and Scenarios (linked to pipelines / demos / relevant components)

Web Portal (a KG view on Polifonia)

Polifonia Ecosystem Documentation Website (GitHub)

Publishing Polifonia Components: metadata

6 Contributions to the ecosystem

Introductory paragraph

Table 6.1: Technologies of consortium members that contribute to the Polifonia Ecosystem

Name	Links	Type	Champion	Relations to WPs / Pilots / Notes
LED	http://led.kmi.open.ac.uk Data available at http://data.open.ac.uk/sparql	Linked Data	Enrico (OU)	Mainly related to CHILD, MEETUPS, and WP4
MIDI LD	https://midi-ld.github.io	Linked Data	Albert (KCL)	Basis for WP2, useful for WP3. Large RDF KG and ontology of linked MIDI file contents from 500K MIDIs from the Web
SPARQL Anything	https://github.com/SPARQL-Anything/sparql.anything	Software library, CLI	Enrico Daga (OU)	Support tool to re-engineer non-RDF resources into Linked Data. Supports CSV, JSON, XML, HTML, ...
RAMOSE	https://github.com/opencitations/ramose	Software	Marilena (UNIBO)	Python API manager on top of SPARQL endpoints
Lucinda	https://github.com/opencitations/lucinda	Software	Marilena (UNIBO)	RDF browser based on JSON templates
OSCAR	https://github.com/opencitations/oscar	Software	Marilena (UNIBO)	RDF Search engine based on JSON templates
MusoW	https://musow.kmi.open.ac.uk/	Linked Data	Enrico (OU)	LOD registry of MH on the web to be expanded / enriched
ArCo	https://w3id.org/arco	Linked Data / software	Val (UNIBO)	Ontology network and LOD / XML2RDF for normative italian Cultural Heritage XSD
Lizard	https://github.com/anuzzolese/lizard	Software	Val (UNIBO)	Automatic generation of ontology-based APIs for querying knowledge graphs
Neuma	http://neuma.huma-num.fr	Platform: library/dataset	Raphaël FS (CNAM)	WP1: Pilot FACETS MEI corpus, REST API, vizualisation of scores, analysis/annotations.
Framester	https://github.com/framester/Framester	Linked Data / Software	Fiorela (UNIBO)	Frame-based ontological resource
Edwin	https://github.com/luigi-asprino/edwin	Framework	Fiorela (UNIBO)	Builds and analyses Equivalence Set Graphs
Cultural-ON	https://dati.beniculturali.it/cultural-ON/ENG.html	Linked Data	Fiorela (UNIBO)	Data on cultural institutes or sites
Multilingual Corpus LBC	http://corpora.lessicobeniculturali.net/en/	Dataset	Fiorela (UNIBO)	MusicBo
Unicittà Corpus	Available in July 2021	Dataset	Fiorela (UNIBO)	MusicBo
CultuurLINK	https://cultuurlink.beeldengeluid.nl/	Software	NISV	Open Source Tool for aligning vocabularies
Spinque Desk	https://spinque.com/	Software (commercial)	NISV/ Spinque	Integrate your data into a knowledge graph, design search solutions tailored to your needs and deploy them as APIs.
FindLEr	https://github.com/enridaga/led-discovery	Software	Enrico (OU)	Supports the retrieval of listening experiences in digitized books.
grlc	http://grlc.io https://github.com/CLARIAH/grlc	Software (OS)	Albert (KCL)	Supports automatic creation of KG APIs from shared SPARQL queries
CLOVER	http://arco.istc.cnr.it:8081/	Software	Val (UNIBO)	A prototype instance of OntoPortal for CH ontologies
SPICE Linked Data Hub	http://spice.kmi.open.ac.uk http://github.com/mkdf/	Software (OS)	Enrico (OU)	Example instance of a Linked Data Hub developed using the MK Data Factory suite. Supports data management (file repository, JSON streams), transformations to RDF (via SPARQL Anything) and publishing of SPARQL endpoints.

7 Collaboration Infrastructure and Timeline

GitHub
Discord
Timeline
Deliverable at M6
Methodology -> coherent with Socio-technical roadmap
Guidelines for developers (cookbook) -> coherent with DMP
The Ecosystem at a glance (component types and interaction methods)
Plan, timeline, etc...

8 Conclusions

Bibliography

[1] F. Kirstein, S. Dutkowski, B. Dittwald, and M. Hauswirth, "The european data portal: Scalable harvesting and management of linked open data." in *ISWC Satellites*, 2019, pp. 321–322.

[2] F. Kirstein, K. Stefanidis, B. Dittwald, S. Dutkowski, S. Urbanek, and M. Hauswirth, "Piveau: A large-scale open data management platform based on semantic web technologies," in *European Semantic Web Conference*. Springer, 2020, pp. 648–664.

[3] P. Rigaux and N. Travers, "Scalable searching and ranking for melodic pattern queries." in *ISMIR*, 2019, pp. 801–808.

[4] K. Collier, *Agile analytics: A value-driven approach to business intelligence and data warehousing*. Addison-Wesley, 2012.

[5] H. D. Benington, "Production of large computer programs," *Annals of the History of Computing*, vol. 5, no. 4, pp. 350–361, 1983.