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A pilot implementation for a taxonomic e-services and resources marketplace

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TETTRIs

TETTRIs

Transforming European Taxonomy through Training, Research, and Innovations

Deliverable 3.1

A pilot implementation for a taxonomic e-services and resources marketplace

WP 3/NATURALIS

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Abstract:

This document describes the pilot implementation of a marketplace for taxonomic e-services, designed to provide a curated, FAIR-compliant online catalogue for taxonomists, researchers, students and citizen scientists. It describes the objectives during implementation, the design process and the development process followed, as well as the final result and suggestions for further improvement. Aim of the pilot was to create a useful and accessible platform for connecting supply and demand of taxonomic e-services with focus on trustworthiness, interoperability, and open science principles, sustainable through CETAF. The service includes both a front-end application for user interaction and a back-end application for managing service descriptions and ensuring FAIR principles compliance. The pilot implementation supports the registration of a wide variety of taxonomic e-services to assist taxonomists with their daily job. The marketplace for taxonomic e-services is implemented as part of a CETAF marketplace (https://marketplace.cetaf.org/) that will also include a taxonomic expertise component, developed in another task in the TETTRIs project. The marketplace has a modern, responsive design with pages for searching, viewing, and suggesting e-services, styled in the TETTRIs theme, hosted and curated by CETAF. Its back-end is powered by Cordra, an open-source digital object store with built-in support for persistent identifiers utilising the Handle system. The data model was built using JSON-LD and aligned with schema.org and FAIR principles.

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INDEX

1. Introduction **6**
2. Objectives **6**
3. Design process **7**
4. Products **9**
4.1 Taxonomic e-service data model 9
4.2 Front-end 10
4.3 Back-end (Cordra) 11
5. Procedure for suggesting new taxonomic e-services **11**
6. User testing **11**
7. Maintenance and sustainability **12**
8. Future enhancements **12**
8.1 Quality Indicator improvement 12
8.2 Automation and use of LLMs 13
APPENDIX 1: Related documents **14**
APPENDIX 2: Supported Open Data Licenses **15**
APPENDIX 3: Design of calculated quality (confidence) indicators **16**
Service types and their classification 16
Confidence indicator for Downloadable Software 17
Confidence indicator for Online Software 18
Confidence indicator for Knowledge/data product 20
Confidence indicator for e-Learning service 21

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1. Introduction

This document describes deliverable D3.1: A pilot implementation for a taxonomic e-services and resources marketplace. The result of the deliverable is an online marketplace portal consisting of front- and back-end components, which together form the marketplace application. The front-end has a modern, responsive design, suitable for display on both desktops and mobile devices. The front-end is designed to provide access to e-services descriptions but also to include taxonomic expertise and reference collections later in the project. The back-end is based on Cordra, open source software designed for managing digital objects provided by CNRI, the provider of the Global Handle System; the infrastructure that is used for e.g. serving DOIs (Digital Object Identifiers). The back-end is configured to be used with an integrated Local Handle Server in production, to provide Handles as persistent identifiers for the service descriptions. The Handle records support inclusion of machine readable metadata to make the service descriptions machine actionable in line with the concept of FAIR Digital Objects. Handles generated for service descriptions have a prefix: 20.500.14547 and an opaque string as suffix, for example: 20.500.14547/1170b8b30e1b3ec39e48. The Handles are resolvable through https://hdl.handle.net/. In case the URL of a service description changes, the Handle can be adjusted so it still resolves to the relocated service description. This solves 'broken link' issues.

The marketplace is hosted by CETAF at: marketplace.cetaf.org. E-services can be added based upon user suggestions or requests. Users can suggest new service descriptions through a web-form, submissions can be curated and approved by a CETAF executive editor and contain provenance data. The web-form contains controlled vocabularies compliant with metadata standards, support for identifiers including automated lookup of research organisation identifiers (ROR) and a user-friendly anti-spam solution. The use of identifiers support machine actionability as well as enables the crediting of taxonomic service authors, developers and funders.

2. Objectives

Work package 3 in TETTRIs defines a set of objectives that relate to the development of the marketplace for taxonomic e-services and expertise. Task 3.1 is assigned to the e-services part. Based on the task description, the following criteria were followed for implementation:

- Create a marketplace that is useful and easy to find for taxonomists and researchers.
- Provide a CETAF curated catalogue that provides accurate information and can be sustained and updated in the future by piloting automated indexing of compliant service and resource descriptions to be served as FAIR Digital Objects.
- Focus on services and tools that are trustworthy and provide indicators for trustworthiness.
- The marketplace back-end is capable of providing FAIR Digital Objects.
- Create a structured and navigable index that is usable by different audiences.
- Connect demand and supply of taxonomic e-services in taxonomy.
- Work towards interoperability with existing service catalogues such as the EOSC Portal.

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- Provide user support through the DiSSCo helpdesk to serve a platform for users to get in contact with the e-service providers.
- Promote open science through focus on open source licensed software.

These criteria were met through the following:

1. **Accessibility and transparency**: The marketplace is easy to find through a simple to remember URL: marketplace.cetaf.org and acts as a central access point for both taxonomic e-services and (future) reference collections and expertise. The service can be used freely, can also be accessed from mobile devices (responsive design) and does not require a login, it is easy to access and open, promoting visibility of taxonomic e-services while being user-friendly for a wide audience.
2. **User-Centered Design**: The platform is tailored to meet the needs of taxonomic experts, institutions, and potential collaborators by collecting user stories and user feedback during design and development phases. A helpdesk is in place for user support.
3. **Functionality**: It incorporates features for showcasing expertise, connecting users, and facilitating collaboration or services in taxonomy-related projects. The service provides added value by making taxonomic services easy to find, by making it possible to advertise these services and by providing a service quality indicator. The service is automatically indexed and supports curation by CETAF executive editors through a Cordra backend. The interface provides full-text search and filtering capabilities for easy navigation of the index..
4. **Interoperability**: Service descriptions are stored as FAIR Digital Objects (FDOs) that are automatically assigned a persistent identifier (handle) resolvable through the global Handle infrastructure using a proxy like https://hdl.handle.net or https://doi.org. The descriptions are accessible both by humans (as HTML) and by machines (as JSON), with REST and DOIP APIs that allow integration with existing taxonomic and biodiversity infrastructures. Metadata schemas are based on schema.org, and were influenced by the now discontinued EOSC resource profile, with controlled vocabularies based on data.europe.eu, SPDX, ISO and other international standards and support for PIDs like ROR and ORCID. The FDOs support having an FDO profile (see design document) that can be registered in the future EOSC Data Type Registry to enhance machine actionability.
5. **Sustainability**: Hosting by CETAF as a network organisation ensures ongoing support, maintenance, and adaptability to future needs in taxonomy and biodiversity research. The metadata is focused on stable information to ensure accurate information and minimize maintenance, for example it does not store a last updated date for a service but a value describing the service as frequently updated or not. Using the CETAF brand helps in establishing a user base.

3. Design process

During the first TETTRIs All-Hands meeting in Brussels, project partners representing stakeholders discussed the fundamentals of the marketplace. It was decided to collect potential user stories based upon the objectives that could be discussed on relevance and importance. Based on the outcomes of the discussion, a list of user stories was created and considered the core of the marketplace's functionality. This provided consensus on what the marketplace should be and offer.

With the user stories, the team started on creating early mock-ups (visual representations of the marketplace) in a Design Document and started discussing these in the regularly

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scheduled task 3.1 meetings with project partners. Each meeting, the mock-ups were a bit more refined, moving from stale lines and shapes, up until a fully interactive Prototype with a navigable index. The prototype spurred valuable discussions regarding the technical architecture and ownership of the marketplace application. It was decided and agreed that CETAF would take responsibility for hosting and maintaining the application, shaping the architecture to ensure it aligns with CETAF's current technical resources.

The final Technical Architecture adheres to all of the critical design specifications, which include the management rules set by CETAF, as well as the original user stories and feedback received from the work package team. It describes two separate applications: a front- and back-end, running in the same online environment. The Front-end Application allows users to interact with the marketplace via a Graphical User Interface (GUI). It is custom built using the React JavaScript library and acts as a one page application which asynchronously interacts with the Application Programming Interface (API) of the back-end. The Back-end is constructed using the Cordra software, a kind of object store with a GUI on top. It both offers a good API as well as an internal handle server for creating persistent identifiers that are globally unique and resolvable.

Handle generation is an important requirement of the task as persistent identifiers are fundamental to the Findable, Accessible, Interoperable and Reusable (FAIR) part of the application. Local handles in the Cordra software have been assigned a prefix through the registration services of CNRI to create globally unique identifiers. The Handle.net infrastructure makes these globally resolvable. This makes all e-service descriptions findable and easily accessible. The marketplace handle server has been registered at CNRI and received the prefix of: 20.500.14547. New e-services will receive an identifier starting with this prefix and ending with twenty random numbers or letters, for example https://hdl.handle.net/20.500.14547/29ad027a1daf80f2433f. An opaque string without semantics is necessary to achieve persistence of the identifiers. The handles support multiple redirects (they can redirect both to the service detail page in the marketplace GUI and to a json object) and they support having kernel metadata in the handle record. This promotes machine actionability since this metadata can be described in a machine readable FDO profile and can include a description of allowed operations, which can be stored in the future EOSC Data Type Registry under development in the FAIRCore4EOSC project.

It works as follows: hdl.handle.net resolves the handle to the handle record, which then automatically redirects to one of the URLs defined as default in the handle record through a special attribute: 10320/loc. This can be seen by adding a noredirect attribute, for example: https://hdl.handle.net/20.500.14547/29ad027a1daf80f2433f?noredirect. A machine can specify to which URL the handle should redirect, for example https://hdl.handle.net/20.500.14547/29ad027a1daf80f2433f?locat:view=json. The urls can be changed while keeping the handle, so content can move to another location while keeping the PID, broken links can be prevented and if necessary repaired by updating the handle record.

The GUI of Cordra allows logged in users to directly add, edit or delete taxonomic e-services and tools. In collaboration with CETAF, it was decided to leave these actions to its staff and call them admins. Marketplace users will be able to suggest new e-services through a Form in the marketplace front-end without the need to register or login. Suggested services are directly posted to the marketplace back-end, which, based on the provided information, creates draft records. Following this, CETAF staff will review the

created records, act as the executive editor and decide whether the suggested resources are suitable to be published to the marketplace catalogue. Published records are visible for all users. If records are rejected, they will remain in the system but will not become public. Records can be deleted in the case of spam, but we implemented an anti-spam measurement in the google form using user validation, provided by Friendly Captcha.

Concluding, the design process resulted in a variety of individual products which together form the marketplace as an e-service.

4. Products

The different products forming the marketplace are listed below and provided a short description stating their purpose.

4.1 Taxonomic e-service data model

A taxonomic e-service record is built using a specially designed Data Model. The model uses mainly terms of schema.org, and is constructed using JSON-LD. The terms use controlled vocabularies where possible, for example for licenses and service types. It also includes support for persistent identifiers for people, organisations, funders and licenses. The service type dictates which metadata should be provided. The model includes support for markup in descriptions and for images. The structure is partly impacted by the now discontinued EOSC resource profile and contains all basic terms that define a taxonomic e-service in the context of the marketplace. The model contains one term from the Open Digital Specimen (ODS) definition called: topic discipline to aid users in searching for relevant services. It describes which topic discipline the taxonomic e-service relates to, for example: botany or zoology.

A few design choices that are worth mentioning:

Open Data Licenses for services that are knowledge products were included from the licenses listed by the EU in https://data.europa.eu/en/training/licensing-assistant. These were mapped to SPDX identifiers pointing to machine readable license descriptions where possible (unfortunately these are not all in SPDX) to support machine actionability. Appendix 2 contains an overview. For **software licenses** the model supports the full list of SPDX licenses.

A shortlist of **languages** is included to support easy addition of languages to service descriptions. Other languages can be added if required. Languages are stored as 2-letter language codes using the IETF BCP 47 standard (ISO 639-1 2-letter language code or ISO 639-2 3-letter language code). In the shortlist are included:

- the 24 EU languages: Bulgarian, Croatian, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hungarian, Irish, Italian, Latvian, Lithuanian, Maltese, Polish, Portuguese, Romanian, Slovak, Slovenian, Spanish and Swedish;
- Ukrainian, Russian (these are in top-10 most spoken languages in Europe);
- Luxembourgish and Turkish, these are the only two official languages of EU member states that are not official languages of the EU.

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A controlled list of **App stores** to provide for describing mobile apps: Google Play Store, Apple App Store, Amazon Appstore, Aptoide, Huawei AppGallery, Samsung Galaxy Store, Cydia, F-Droid, AppBrain App Market, Appland, Baidu, GetJar.

A controlled list of **payment models** for services: Free, License-Based payment, Usage-Based payment, Freemium, Ad-Based, Value-Based or Voluntary payment, Hybrid model.

The data model has extensively been reviewed by members of the task team and has seen additional additions and amendments after the first milestone.

4.2 Front-end

The front-end application, built using React in the JavaScript programming language, functions as the main user interface to discover service descriptions in the marketplace. The front-end has a responsive design so it can also be used with mobile devices. This application contains search functionality allowing for free text search as well as filtering, it displays results and offers a form to suggest new services. The form was significantly improved since the milestone and integrated in the Front-end, see changes for deliverable. For consistency with other TETTRIs services, the front-end has been styled in the theme of TETTRIs, taking inspiration from the main TETTRIs website and the general style guide.

Some screenshots to present a look at the application:

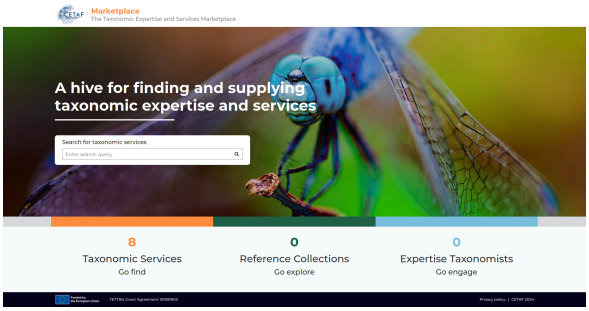

Figure 1: Marketplace homepage

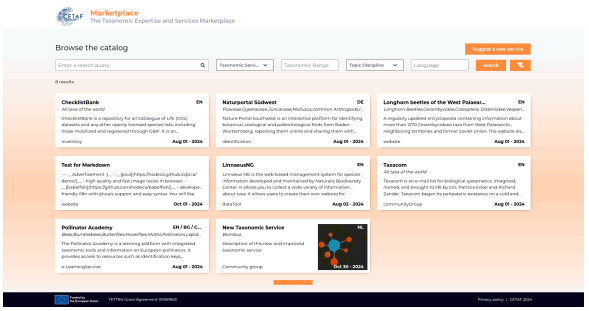

Figure 2: Marketplace search page

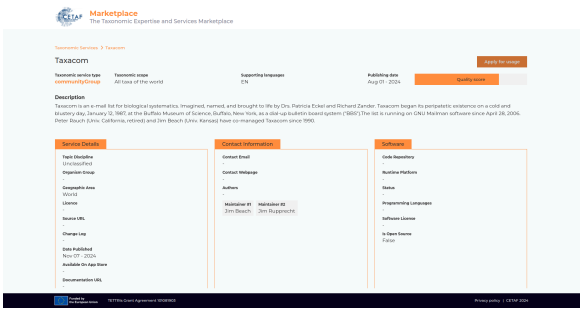

Figure 3: Marketplace detail page

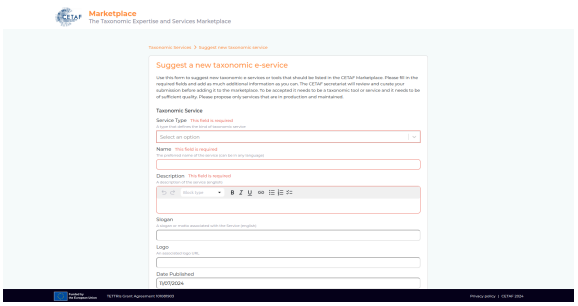

Figure 4: Marketplace suggestion form page

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4.3 Back-end (Cordra)

The back-end application is built using Cordra, a digital object store with an exposable API. No real code is required to run this application, instead it provides a GUI, making it easy to use for non-technical users. Creating new taxonomic e-services is supported by completing the e-service form in Cordra, which then automatically handles the submission to the marketplace catalogue. Another advantage of Cordra is that it provides an internal, local handle server. Generating Handles is a prerequisite for FAIR digital objects. The internal handle server exposes its own API, which is registered at Handle.net, completing the registration process for these Handles to become globally unique identifiers. All objects created in Cordra receive the same Handle prefix and the Handle resolves to a service description in marketplace.cetaf.org.

Some screenshots to present a look at the application:

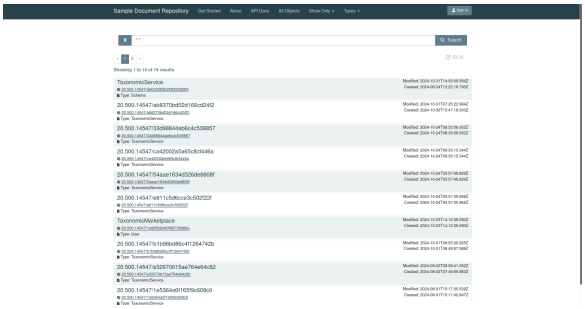

Figure 5: Cordra all digital objects

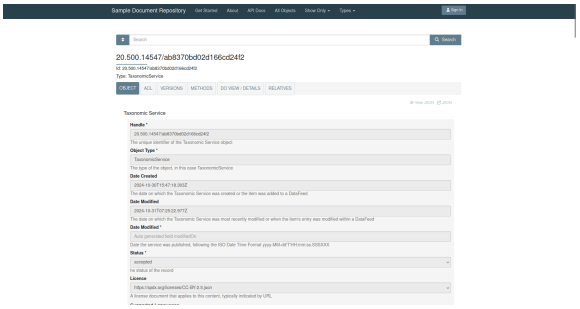

Figure 6: Cordra taxonomic e-service

5. Procedure for suggesting new taxonomic e-services

It is possible to add new taxonomic e-services to the marketplace catalogue in the future, either by adding them manually in Cordra by an admin, automated through the Cordra API, or via the suggestion form in the front-end application. This form grants every user of the marketplace the ability to suggest new e-services. Adding new e-services to the marketplace is of value for the diversity of the catalogue to keep it fresh and updated.

When a user suggests a new e-service via the suggestion form, it creates a new record in Cordra using the API. By default, this record is in a 'proposed' state. In order for it to be added to the public catalogue, it needs to be reviewed by a CETAF admin. If this review results in a positive score, the admin will change the state to 'accepted', after which the e-service can be publicly found in the marketplace.

The form for suggesting new e-services incorporates a couple of useful tools to determine values like: a Research Organisation Registry (ROR) identifier look-up, pre-defined lists for metadata like licenses, languages or app stores and Friendly Captcha to prevent spam requests.

6. User testing

The marketplace as a whole was thoroughly tested during an online test session (virtual workshop) on the 13th of November 2024, with attendees from work package 1, 2, 3, and 6. As a user test session, tasks were given to the attendees that needed to be completed using the different functionalities in the marketplace. The attendees would execute a task

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and leave their user experience as notes in a feedback document, whereafter this also would be openly shared as a small discussion.

The feedback from this session is valuable as it helped indicate flaws in the user experience design of the marketplace. Flaws that are often overseen during development become clear when actual users try to use an application. The received feedback was refined into a list of points to improve, which were taken into account during further development. Some could be included in the pilot implementation while others were put on the backlog for future development.

7. Maintenance and sustainability

To make the developed service sustainable, the marketplace will be hosted and maintained by CETAF, including the executive editing of the content. CETAF is the consortium of taxonomic facilities in Europe and providing information for and by its taxonomic facilities is at the heart of its mission. Naturalis has created a deployment guide and has supported CETAF to take over the pilot implementation after it was developed. CETAF hired a web developer to be able to maintain the tool. The code has been developed as open source with Apache 2.0 license and is available in a public repository.

8. Future enhancements

The deliverable is a pilot implementation and further enhancements would increase the usability of the e-services marketplace. We see two possible enhancements: improvement of the quality indicator for a service and automation for adding new services with usage of a LLM (Large Language Model).

8.1 Quality Indicator improvement

The marketplace pilot includes a quality indicator that guides the user with an indication of how trustworthy the service is. This is important as many taxonomic services are not well maintained or tested. Often these tools or services were created by a single researcher for a specific purpose, and the researcher may not be a qualified software developer. Such a service may not suit most users. The indicator may also stimulate service developers to increase the quality of their tools. In the pilot implementation an executive editor estimates the quality of the service and gives it a score, based on the provided information. It is not easy to give such a score, it may be biased and the criteria on which the score was based are not clear.

It would be an improvement if a quality indicator could be given on a calculated score based on the provided data. It will save work for editors, it will be transparent for the users and it will give an unbiased indicator. We have worked this out and came to the conclusion that it will require a lot of extra data to be captured. During testing, users have indicated however that the amount of data that needs to be provided to describe a taxonomic service is acceptable, but that it should not be more than in the current form. That means that calculated quality indicators require further automation of the process of suggesting new services to allow more data to be captured. A full design of calculated quality indicators can be found in Appendix 3. This would allow for up to 4 indicators depending on the service type:

- Confidence indicator for Downloadable Software
- Confidence indicator for Online Software
- Confidence indicator for Knowledge/data product
- Confidence indicator for e-Learning service

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It should be noted that automated quality indicators bear the danger of oversimplification. It was discussed with stakeholders that a community rating could help, however that would require user authentication which adds complexity and may be a hurdle to get the marketplace adopted by users. The current indicator could also be improved by including a comment that is managed by an executive editor to offer background information on potential flaws and strengths of the e-service. Such a metadata element is already included but currently only visible for executive editors.

8.2 Automation and use of LLMs

Taxonomic service descriptions cannot easily be added automatically to the marketplace. They need to be constructed by combining available information that is often present online but in an unstructured form. While there are some inventories online that provide lists of services of a specific type, there is no standard data exchange standard for such data and each inventory would need its individual implementation to ingest the data they provide, and many services are not present in these inventories. So these inventories are rather listed as a service themselves in the marketplace. An example is checklistbank that is listed as an inventory service rather than listing the individual species checklists provided in checklistbank. It has been discussed to create a community standard for service description and promote its implementation at the CETAF taxonomic facilities, but this was seen as not feasible. For taxonomic expertise it would be easier as there are tools like OpenAlex that could provide the necessary information.

The developed marketplace provides APIs for data ingestion so the tool itself would support automation. LLMs are a relatively new artificial intelligence solution that could be used to construct the needed data from information it knows (from online sources). However LLMs do not always provide trustworthy results, they may 'hallucinate' a result or provide the data in a format that is not exactly what was requested. A LLM could generate a lot of service descriptions but It would not be feasible for an administrator to check all results created by a LLM and make sure the provided information is correct. Also LLMs are usually not free and the cost is difficult to predict. That is a problem for organisations with limited budgets like CETAF. There are some options to tackle these challenges:

- A user could request a LLM to fill in the form for a specific service he wants to add, and the user checks the data before submitting the form.
- A LLM is used that was trained to provide factual information. Most LLMs were trained to be creative, for example the well-known ChatGPT but there are also LLMs that may provide more trustworthy results like perplexity.ai.

Including a LLM to help a user create a service description has the potential to provide a great user experience and would also enable to provide a more detailed service description as needed for the development of quality indicators.

APPENDIX 1: Related documents

ID	Reference or Related Document	Source or Link/Location
1	Marketplace for taxonomic e-services front-end	marketplace.cetaf.org
2	Marketplace for taxonomic e-services back-end	http://marketplace.cetaf.org/cordra
3	Design document	https://doi.org/10.5281/zenodo.14685996
4	Prototype design	https://www.figma.com/proto/wKjx4nFtya2QZkKtl0XZJi/TETTRIs-Marketplace?node-id=1-3&starting-point-node-id=1%3A3&t=ppWDrL30BMTj6RZR-1
5	Architecture and deployment	https://doi.org/10.5281/zenodo.14685996
6	MS6: Pilot with first service and descriptions available	https://doi.org/10.5281/zenodo.14685996
7	Manual for Marketplace executive editors	https://doi.org/10.5281/zenodo.14685996
8	Software code	https://github.com/DiSSCo/tettris-marketplace
9	Data model	https://marketplace.cetaf.org/cordra/#objects/20.500.14547/def2029f2b2593239293

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APPENDIX 2: Supported Open Data Licenses

Licenses based on https://data.europa.eu/en/training/licensing-assistant, mapped to SPDX or alternative urls.

In red are open data licenses listed in this resource that were excluded because either no url exists or the license was not relevant. Missing urls were reported to data.europa.eu and are listed here as the licenses could be added in the future once a url exists.

license	URL
all CC licenses	SPDX url
DL-DE-BY-2.0, DL-DE-ZERO-2.0	SPDX url
DL-DE-BY 1.0	https://www.govdata.de/dl-de/by-1-0
DL-DE-BY-NC 1.0	https://www.govdata.de/dl-de/by-nc-1-0
EUPL-1.0, EUPL-1.1, EUPL-1.2	SPDX url
FR-LO	https://www.etalab.gouv.fr/license-ouverte-open-license/
GFDL-1.1, GFDL-1.2, GFDL-1.3	SPDX url, include all licenses starting with GFDL
HR-OD	https://data.gov.hr/open-license-republic-croatia
IODL v1.0	No url exists, this one was excluded.
IODL v2.0	https://www.dati.gov.it/iodl/2.0/
NLOD	SPDX url, included both NLOD-1.0, NLOD-2.0
ODC-BY	SPDX url for ODC-By-1.0
ODC-ODbL	SPDX url for ODbL-1.0
ODC-PDDL	SPDX url for PDDL-1.0
OGL 1.0, OGL 2.0, OGL 3.0	SPDX url, included all licenses starting with OGL: OGL-Canada-2.0, OGL-UK-1.0, OGL-UK-2.0, OGL-UK-3.0
OGL-NC	No url exists, this one was excluded.
OGL-ROU-1.0	Url links to a pdf, used instead: https://data.gov.ro/pages/license
PSEUL	URL given by EU does not exist, this is the INSPIRE End User license, which is not relevant for the marketplace (it is for sharing spatial information), so it was not included. See also PSEUL.

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APPENDIX 3: Design of calculated quality (confidence) indicators

For each service type, determine whether it is a **data resource** (knowledge product), a **training resource**, **downloadable software** and/or **online software**. Services that are inventory or community services and services that are an app will not get an indicator.

Services that are inventories or community services cannot well be scored as it is more the services within the inventory or the communications within a community service which determine the quality or trustworthiness of the service. Apps are usually already trustworthy because they are offered through app stores which have an acceptance process. Also app stores already provide functionality to rate an app by users. Note also that some requirements for quality are already fulfilled when a service is described in the marketplace: it has at least a description and a website/url.

To keep things simple, the indicators will only use the provided descriptions as input. They will not include measurements like checking if urls are resolving or measuring code quality.

Service types and their classification

service type	category	software type
Reference collection	data resource	online
AI training dataset		
Data tool	software	online, download, app
Identification	software, data resource	online, download, app
Crowdsourcing	software	online, download, app
e-Learning service	training resource	online, app
Inventory of services		
Specimen dataset not in GBIF	data resource	online, download
Community group		
Website	data resource	online
Factsheet	data resource	online

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This classification of the service types allows for the following quality indicators:

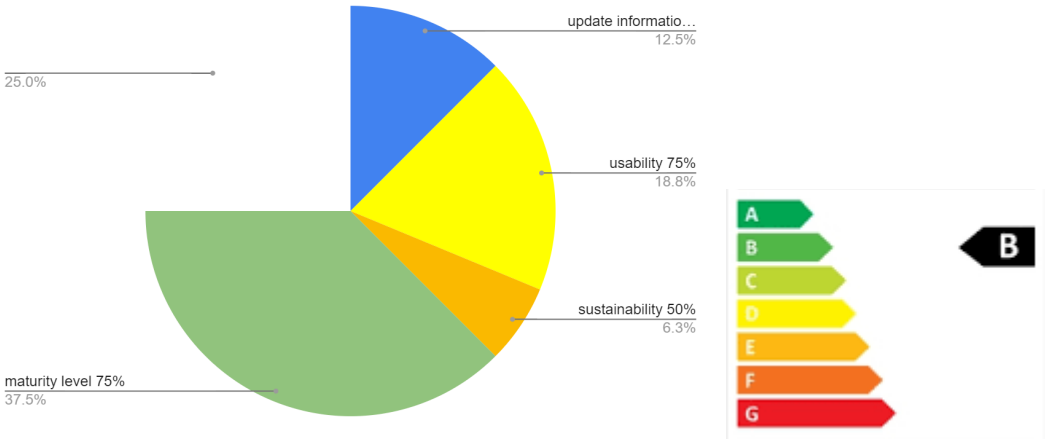
- Confidence indicator for Downloadable Software
- Confidence indicator for Online Software
- Confidence indicator for Knowledge/data product
- Confidence indicator for e-Learning service

A service type can have 0 to 4 indicators, for example if it is both an e-learning service, a knowledge product and online software it will have 3 indicators.

The Confidence indicator for a Knowledge/data product can be partly based on https://biodiversityknowledgehub.eu/guidelines-and-protocols/recommendations/general-interoperability-recommendations/

Each indicator needs its own categories to be scored such as "trusted source" and "interoperability" for a knowledge product and "performance" or "maturity" for an online software product. Each category can be scored against one or more values in the service description. The scores for each category can be displayed in a pie chart or a full score table in a detail page, while, the total score can be displayed in the service overview page similar to an energy label with A, B or C:

example for Confidence indicator for Downloadable Software:



Tables with features to score for each indicator are displayed below.

Confidence indicator for Downloadable Software

category	Feature to score	0	1	2	Max score
update information	Version/Last update information available	no	yes		1
update information	Description of functional updates	no	yes		1

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	since last version available				
usability	Terms of Service described	no	yes		1
usability	Software license available	no	yes		1
usability	Documentation available	no	one language	multiple languages	2
sustainability	Maintainer(s) described	no	yes		1
sustainability	Open source software	no	yes		1
maturity level	estimated user base	<100	100-1000	>1000	2
maturity level	number of platforms supported (operating system or programming language)	1	2	>2	2
maturity level	estimated development team size	1	2	>2	2
maturity level	support present	no support	only contact details	support helpdesk	2

max points: 16

Confidence indicator for Online Software

category	**Feature to score**	**0**	**1**	**2**	**Max score**

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Performance	public Monitoring status page (URL)	no	yes		1
Performance	Performance expectations described (guaranteed uptime)	no	yes		1
Performance	Uptime (past year)	unknown	>95%	>99%	2
update information	Version/Last update information available	no	yes		1
update information	Description of functional updates since last version available	no	yes		1
usability	Terms of Service described	no	yes		1
usability	Software license available	no	yes		1
usability	Documentation available	no	one language	multiple languages	2
sustainability	Maintainer(s) described	no	yes		1
sustainability	Open source software	no	yes		1
sustainability	support of open file formats	no	yes		1
maturity level	Feedback options	no	users can contribute	users can contribute and test feature changes	
maturity level	privacy policy present	no	yes		1

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maturity level	HTTPS used	no	yes		1
maturity level	estimated user base	<100	100-1000	>1000	2
maturity level	number of platforms supported (operating system or programming language)	1	2	>2	2
maturity level	estimated development team size	1	2	>2	2
maturity level	support present	no support	only contact details	support helpdesk	2

max points: 23

Confidence indicator for Knowledge/data product

category	**Feature to score**	**0**	**1**	**2**	**3**	**Max score**
Sustainability	Has preservation Policy	no	yes			1
Sustainability	has version control	no	yes			1
Interoperability	ID usage	no IDs	globally unique IDs	PURLs	PIDs	3
Interoperability	linkages	no linkages	linkage through data brokers like wikidata	links to biodiversity data infrastructures, for literature, molecular sequences, specimens, nomenclatur		2

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				e or analytics		
Interoperability	Compliance to community standards by using common terms, controlled vocabularies, data models	yes	no			1
Usability	Modalities of access*	1	2	>2		2
Usability	Provision of data in machine readable, structured format	no	yes			1
Trusted Source	Authors (scientific experts)	1	`2	>2		2
Trusted Source	Literature eferences available	no	yes			1

*Modalities of access:

- Web portal
- App
- API
- Download option
- Request for dataset

Confidence indicator for e-Learning service

category	**Feature to score**	**0**	**1**	**2**	**Max score**
information completeness	Duration of training given	no	yes		1

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information completeness	Target skill level given	no	yes		1
information completeness	Learning outcomes defined	no	yes		1
information completeness	Qualification received upon completion	no	yes		1
information completeness	Version /release date information present	no	yes		1
Maturity	Information shared on e-learning platform	no	yes		1
Maturity	Testimonials present from previous trainees	no	yes		1

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