2 The Travel of the Image and the Role of the Digital Humanities

2.1 Digital Methodologies for the Study of Similar Images

Last October (2023), during the workshop *Ähnlichkeit und Methode: Digitale Perspektiven für die Arbeit mit historischem Bildmaterial* organised at the Herzog August Bibliothek in Wolfebuettel, I had the opportunity to discuss with different scholars working on projects involving the recognition of similar patterns in digital visual material.[1] This interesting event organised by Dr Hartmut Beyer invited representatives of art history departments and visual studies as well as experts in AI and image-related Digital Humanities (digital and visual studies) to present their research and the new developments in this field. Thanks to a fruitful discussion, we reflected on the concept of similarity using AI recognition software, exploring the possible change in its meaning(s) from both a theoretical and practical perspective.

As the program stated, the search for similarities can be considered a fundamental method of Digital Humanities in the field of image analysis. Automatic image processing refers to the concept of similarity in many ways, and the development of AI-supported image recognition, along with the continuous expansion of digital image collections in the art historical field, stimulates the development of approaches using criteria of 'visual similarity'. In addition to image similarity searches for extremely heterogeneous databases, tools tailored to specific collections are emerging: they serve more specific research interests, such as the Lyon16ci database.

1 See https://www.hab.de/event/portapp/.

It is clear how the category of similarity is gaining new relevance due to current technical developments, insofar as machine analysis reveals a large number of similarities, the classification of which is only possible through comprehensive consideration of the possible relationships between images, their meaning and their interpretation.

Some of the following questions were addressed in the workshop, which is useful to report here: can traditional similarities between images be traced using information technology methods? How can machine-determined similarities be explained using image technology? Which visualisation methods support image scientific evaluation? How can transfers between visual media and artistic techniques be handled? How can similar images be recognised despite additions, revisions, and variations?

These and other interesting issues arise when we are working with the integration of AI-supported approaches to art historical research, such as automatic object recognition or digital form/style analysis, whose digital possibilities are growing at a fast pace. As for the workshop organised in Venice (see previous chapter), the need was clear to build a platform of scholars and experts working with similar methodologies although with different materials – from sixteenth-century illustrations to ancient Greek imagery, from auction houses catalogues to the classifications of plants and flowers in seventeenth-century books.

The discussion focused on the new possibilities opened in the realm of digital art history, outlining the limits and benefits for scholars to use these digital technologies in terms of access and discovery of the collections, collaboration, and shared research.

One of the fundamental questions is how to interrogate this data and to structure the methodology of research both in quantitative and qualitative terms, because we – as scholars – think about our material in much more critical ways when we use the digital version of our corpus of images, as these become part of a system of their own, in terms of digital collection and in terms of the world they are embedded into, that is the semantic web, a system of relations to different entities.[2]

Given that the digital opens up new ways of 'seeing the unseen', and granted that the digitized object will never be a substitute of the material object itself (e.g. the illustrated book), these new methodologies enrich the research and generate new data to be critically analysed. The *Biblissima* project offered an interesting case study in this direction, not only for the use of the Warburg database as a digital collection of images, but also for what concerns the collaboration with the Visual Geometry Group at the Department of Engineering Science at the University of Oxford. We know that research questions in the Digital Humanities often develop iteratively. In the case of the Lyon project, the collaboration started to investigate the reuse of similar/same images in different editions/books. The outcomes of this collaboration were in fact a point of departure for exploring these questions.

2.1.1 Finding, Seeing and Comparing: The Collaboration with the Visual Geometry Group

One of the central questions at the beginning of the Lyon project was in which contexts book illustrations were reused, in which publications, and for which purposes. The Warburg database was not specifically built to answer these questions. Therefore, we looked for new possibilities in the emerging field of the Digital Humanities.

Thanks to Prof. Richard Cooper, we managed to start a collaboration with the Visual Geometry Group in Oxford di-

2 On this topic, see the works of Jaskot 2019; 2020; Zweig 2015; Grau 2016.

rected by Prof. Andrew Zisserman.[3] The group utilises for several research projects the VISE software, an automatic image retrieval software that allows users to automatically trace the reuse of images.[4] With the help of the senior research software engineer Dr Abhishek Dutta, in 2019 we created a first demo called Lyon16ci [fig. 7], which is publicly accessible and accepts contributions of new illustrations and metadata from experts and research scholars interested in early modern printed illustrations.[5] It contains a selection from the collection of around 10,000 images.

The VISE software has already been utilised for different projects on book illustrations, among which the project directed by Cristina Dondi on fifteenth-century illustrations and the chapbooks project by Dr Giles Bergel.[6] It proved especially useful in order to retrieve images used in different editions of the same books as well as in different publications.

In the Lyon16ci, we included all the illustrated pages we possessed without worrying about the repetition of images, as we could not do in the Warburg database, in which the reuse of an image had to be inserted in "Further details", and creating new files including images with identical iconographies that repeated themselves was justifiably discouraged. An already structured database, not specifically built for one type of images (namely book illustrations), necessarily presents structural boundaries which we do not encounter when we decided to use our own demo. In this respect, the corpus could be (and was encouraged to be) enlarged, as the point of the visual search is exactly to look for similar/identical images in a large corpus of digital files.

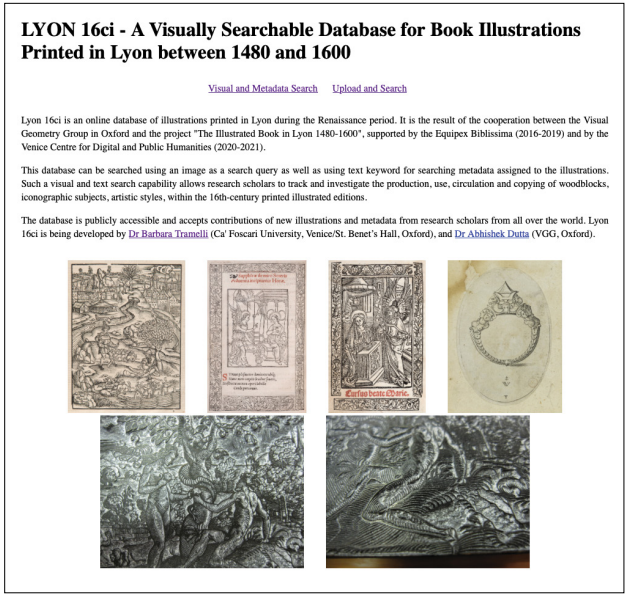


Figure 7 The Lyon16ci database homepage (https://www.robots.ox.ac.uk/~vgg/research/16ci/lyon/)

The visual search in these databases is intuitive and can be easily done: images matching the initial query are found by searching for images that share a large number of similar features with the query one. Features are represented and stored in a way that allows fast lookup and comparison. Visual content in each detected region is denoted by a feature vector (i.e. sequence of numbers like 67, 82, 9, 15, …, 33, 59); these feature vectors can summarise visual content of the region in such a way that

3 See the Visual Geometry Group homepage: https://www.robots.ox.ac.uk/~vgg/.

4 See https://www.robots.ox.ac.uk/~vgg/software/vise/. The list of research projects and the build demos which utilise the Imagematching software can be found at the following address: https://www.robots.ox.ac.uk/~vgg/demo/.

5 See the Lyon16ci database website: https://www.robots.ox.ac.uk/~vgg/research/16ci/lyon/.

6 For Prof. Dondi's project see http://zeus.robots.ox.ac.uk/15cillustration/home; for Dr Bergel's project see http://ballads.bodleian.ox.ac.uk. On the project see Bergel, Dutta, Zimmermann 2021; Dondi et al. 2020.

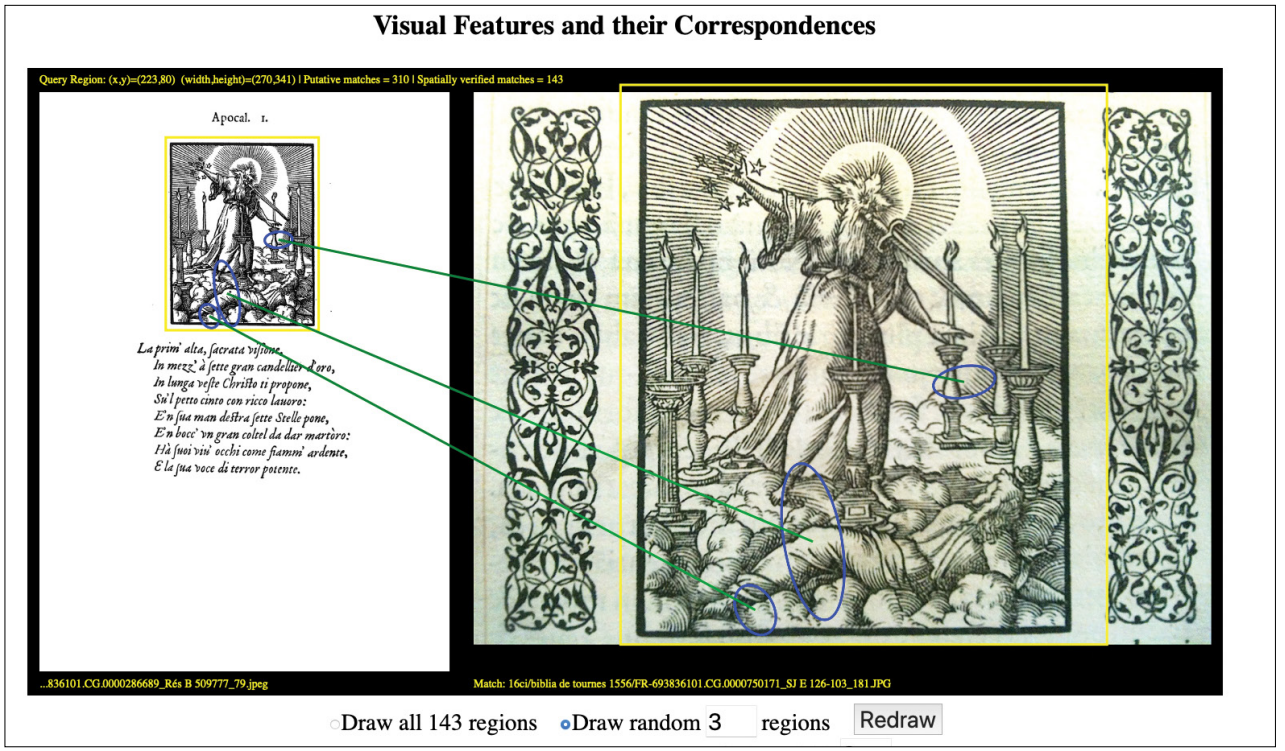


Figure 8 Feature vectors in the Lyon16ci

two regions having similar visual content produce similar feature vectors [fig. 8]. These regions can be consistently detected even when the image content is scaled, rotated or translated, or there is an illumination change or slight change of viewpoint, making the search very flexible for the user [fig. 12].[7]

After the Lyon16ci, we established a collaboration with Dr Matilde Malaspina (University of Copenhagen), whose work included a substantial corpus of fifteenth-century images, among which many illustrated editions of Aesop, which resulted in the second demo, called the 1516 database.[8] We wanted to see whether the combination of the two corpora was possible, and which results we could obtain. The combination of these two projects required some work in terms of harmonisation of metadata, for example, and part of the filenames of the Lyon corpus had to be

7 Dondi et al. 2020, 841-69.
8 See the 1516 project website: https://www.robots.ox.ac.uk/~vgg/research/1516/.

changed from the USTC to the HPB number for reasons of coherence with the MEI number of the fifteenth-century corpus.

This collaboration was compelling in many respects. The database is currently publicly accessible. The 1516 project took the established database of the existing 15cillustration database as a starting point, which is based solely on illustrations printed in the fifteenth century. The possibility of searching together images printed in the fifteenth and in the sixteenth centuries represents a natural and novel step forward, as woodblocks and iconographic themes travelled well beyond chronological boundaries.

2.2 Visualisation Methods and Image Search

Both the Lyon16ci and 1516 projects use VGG Image Search Engine (VISE), which is a purely academic, free and open-source software for visual search of a large number of images using an image as a search query.[9] The databases can combine different types of searches: instant search (using visual regions), metadata search (using textual metadata, bibliographic and descriptive), and comparative search (uploading the user's own image to search correspondences in the database).

Some examples of search queries are the following:

Metadata Search

- Show all the images that have 'Aesop' keyword in their bibliographic and descriptive metadata.
- Show all the images that have keywords beginning with 'Aesop*' (e.g. Aesop, Aesopus...).
- Search for images with 'Aesop AND Dog' keywords in their bibliographic and descriptive metadata.
- Search for images with 'Aesop AND Dog OR Bird' keywords in their bibliographic and descriptive metadata.
- Group all images by their ISTC identifier or by year.

Visual Search examples

- Search using a full image (matches border frames).
- Search using an image region.

For the metadata search, the database includes the Heritage of Printed Books number (HPB), an internal file ID, the filename constituted by the formula: '16ci/short title, printer, date/HPB_inventary number_page, complete title, format, place and year', as the example shows:

File Id 2

Filename
16ci/Biblia sacra de tournes1554/FR-693836101.CG.0000262161_ Rés 808229_1024.jpeg
HPB Id. FR-693836101.CG.0000262161
Title
Biblia Sacra ad optima quaeque veteris, vt vocant, tralationis exemplaria summa
diligentia, pariq[ue] fide castigata
Format 8°
Place Lugduni (apud Ioan. Tornaesium)
Year 1554[10]

9 See the VISE software homepage: https://www.robots.ox.ac.uk/~vgg/software/vise/.
10 The source is the 1516 database website.

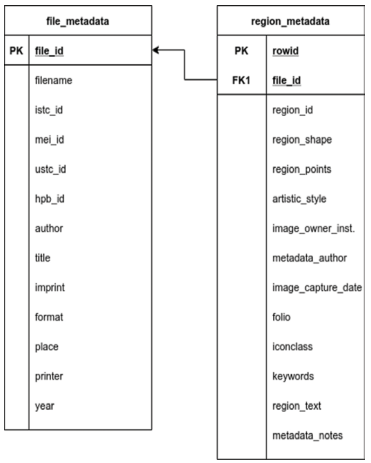


Figure 9 SQLite database schema for 1516 project

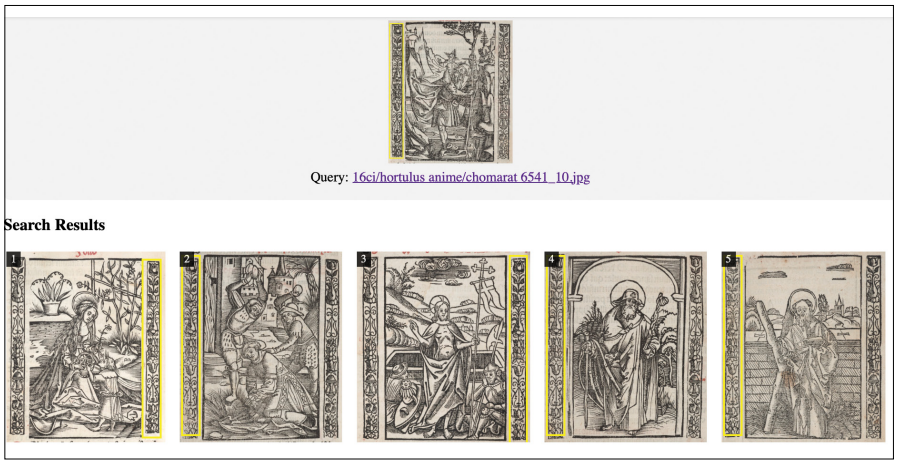


Figure 10 Example of a search query in the Lyon16ci selecting decorative frames

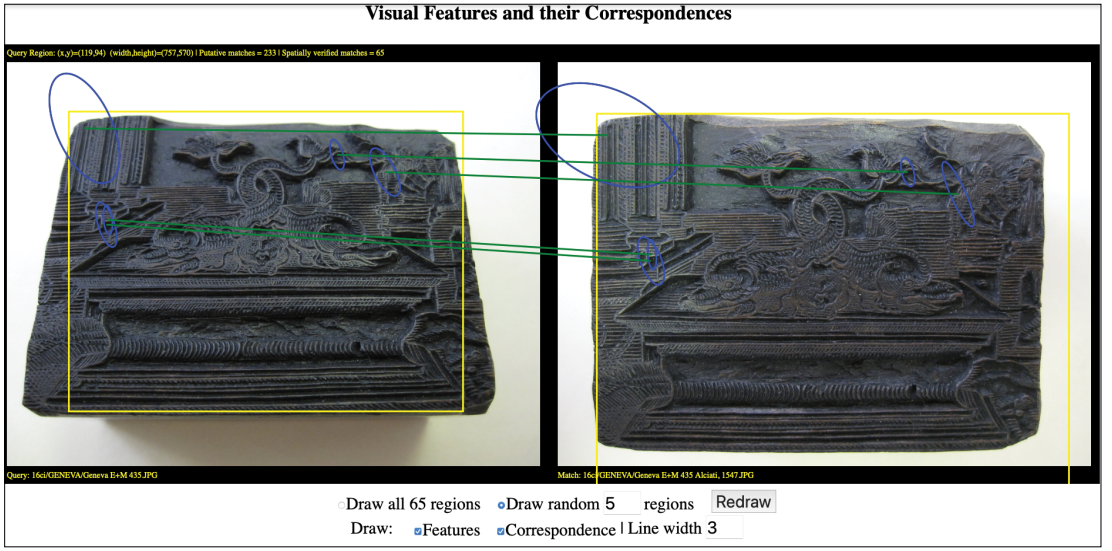
The visual search can be easily experimented with, as it is the most intuitive and immediate search on the corpus of images. The user can select with the part of the digitized image which is of interest (for example a decorative frame [fig. 10]) and the software can retrieve all images that are identical and/or to a chosen degree similar to the search query. Though the degrees of similarity can vary, the software is very effective in retrieving identical images. Users can therefore explore the corpus independently, and they can also search by metadata, which is still be implemented. Finally, they can take an active role in updating their own images in the database in order to look for similar images in the corpus. The versatility and intuitiveness of the Lyon16ci in the search and visualisation of items allow the visual research to be free and, in a way, 'customizable', as it is up to the researchers to build up the corpus of images which they are interested into and to create their collections.

For this purpose (visual annotation) different tools exist, including free ones, some of which are very well made and quite advanced on the AI side, and it would be interesting to understand which are the most accurate; it is not certain that the answer is univocal, in the sense that depending on the type of images or on the type of annotation one could perform better than the other. In any case, it is interesting to note how a system can identify similar visual aspects, if and how profitably it can be used to automate part of the annotation process on a large scale.[11]

Visual image search involves using an image as a search query – instead of keywords common in text search –, and

11 I thank Dr Daniele Fusi for suggesting tools other than the VGG image annotator (https://www.robots.ox.ac.uk/~vgg/software/via/) which I list here: https://mosaicdatascience.com/2021/02/17/open-source-annotation-tools-for-computer-vision-review/; Visual Object Tagging Tool (VoTT), https://github.com/microsoft/VoTT; Computer Vision Annotation Tool (CVAT), https://github.com/opencv/cvat.

Figure 11 After Bernard Salomon, *Adam and Eve*. Detail. Sixteenth century. Woodblock, 5 × 8 cm. Lyon, Musée de l'Imprimerie et de la Communication Graphique



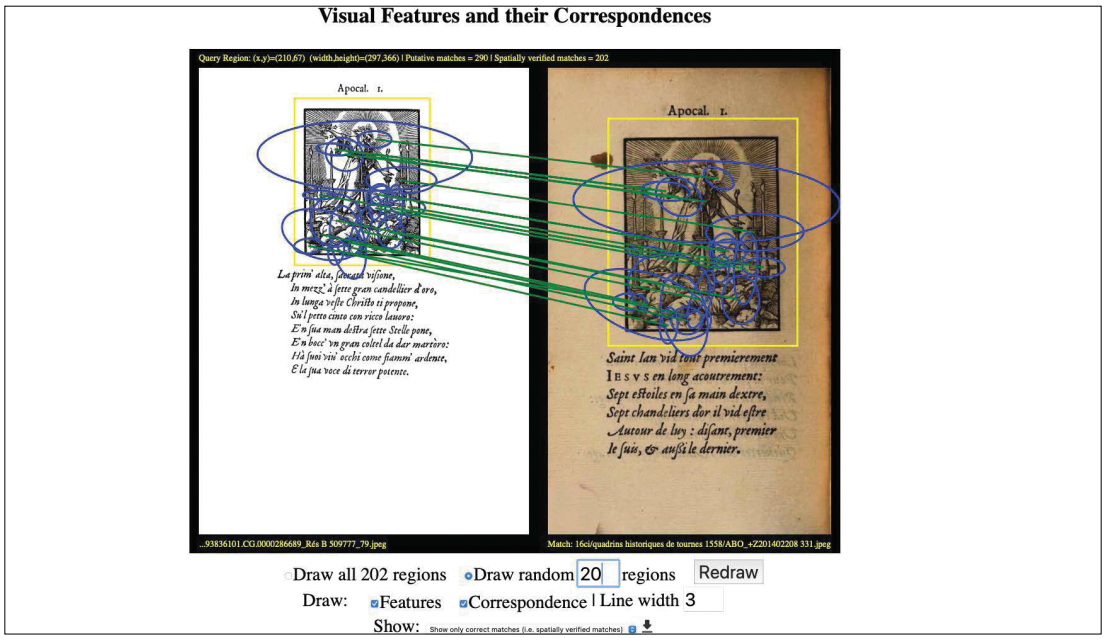


Figure 12 Example of automatic image retrieval in the Lyon16ci using a matrix

Figure 13 Example of similar regions selected by the Imagematching software in different books

the search operation results in a set of images that have visual content similar to the search query. The VGG Image Search Engine software provides such a visual search capability to instantaneously search through a database of thousands of illustrations included in this Lyon16ci project. The VISE software performs visual search by finding and matching image regions that can be consistently detected even when the image content is scaled, rotated or translated, or when there is a change due to hand-illumination or a slight change in viewpoint. These are the variations that we observe when photographing an object or an illustration from different viewpoints or under different illumination conditions [fig. 12]. Thanks to this software, we are able to automatically retrieve images with different degrees of similarity, from identical to lower rates. It will create new metadata on the corpus of digital images inserted, which will range from the late fifteenth to the mid-seventeenth centuries.

Working with a digital model for printed illustrations is challenging and at the same time it opens up new opportunities: the digital image is embedded in a world of its own, the so-called 'semantic web', a system of relations to different entities in which the image never stands alone. In this case, the system allows the user to see what could not be seen before, changing the ways in which we think about images *per se*, as we become more aware of the path of the image through different publications. The Lyon16ci is a format that makes the most of the digital medium, including rethinking the relationship between text and image and between images.

During the digital part of the project we were also able to experiment with including the digital images of matrices we collected [figs 11-12]: this inclusion constitutes a turning point in the study of printed illustrations because, as we mentioned earlier, for a comprehensive study of printed images, surviving cut woodblocks convey essential information which the final product cannot offer, concerning (but not limited to) artists' techniques and ways of working the material. These matrices are now available in the database for analysis and automatic comparison between them, and the next step will be to compare a matrix with the final illustration.[12]

Once more, the main aim of using the VISE software was to be able to trace more efficiently the reuse of identical images between roughly 1470 and 1650 in different editions as well as in different books [fig. 13], retrieving all the similarities between the images compared. As researchers such as Kräutli, Lockhorst and Valleriani (2012) showed in their research, by identifying and analysing images that recur in different publications, the success of certain imageries over others can be understood, with different implications. Moreover, tracing the reuse of images helps to understand the trends and shifts in popularity of certain types of images over others (Kräutli, Lockhorst, Valleriani 2012, 165).

2.2.1 The Collections in the Lyon16ci and 1516 Databases: Future Perspectives

The methodology of digital art history was defined for the first time twenty years ago as a discipline in its own right (Schreiban, Siemes, Unswort 2004). As scholars working with digital models in our area of expertise, we are aware of the liabilities and uncertainties of the upcoming developments: models are created at a fast pace – through digitization projects, archival production prototypes, virtual rendering, image study, metadata production and classification schemes, to name only the most visible elements of the digital landscape. As recent scholarship puts it, there are many ways in which we can utilise different digital visual analysis techniques not only to reveal the unseen in

12 I thank Dr Giles Bergel for the many interesting discussion and for the collaboration with the VeDPH during the past years.

art historical objects, but also to reconsider the use, display and future preservation of the objects themselves.[13]

Digital tools for the cataloguing and visualisation of the cultural heritage in all its forms are constantly evolving, and they benefit from not only technological but methodological advances in Digital Humanities. Concretely, the different methodologies adopted by humanists in recent years have provided various opportunities to rethink the creation and management of new databases and repositories such as the Lyon16ci and the 1516 databases, which from 2019 also benefited from the expertise of the members of the Venice Centre for Digital and Public Humanities at Ca' Foscari University in Venice.[14]

The new digital contexts are opening new possibilities in order to make research results public and to follow new lines of investigation, using the growing number of online repositories not only to consult, but to retrieve, visualise and analyse digital images in new ways. For the illustrated book in Lyon project, we found relatively new digital ways to address different research questions. Firstly, we gathered a corpus of images to be described in detail in the already well-established Warburg iconographic database. Secondly, for what concerns the reuse of images, we collaborated with the VGG to create a new online database which allows direct search and comparison of similar images from the collected corpus. Thirdly, we started a collaboration merging similar but different corpora of fifteenth and sixteenth-century book illustrations to create the 1516 database, as a coherent evolutionary step of the Lyon16ci.

These databases are still a work in progress and, as living creatures, they are meant to be actively used by scholars who want to search through these digital collections, not only passively analysing the search results, but becoming active contributors to these resources. As is often the case with conceptual and methodological theorisations about new digital tools, we started with a case study in order to unveil the theory under it. It is therefore essential to gain feedback from the users of these digital resources, as well as to find spaces for discussion on the various digital database projects, to confront the methodological frames and to envision the possible evolutions, disseminations, future uses and long-term maintenance of these digital resources. These are issue that all research projects with a digital aspect face.

As for what concerns the technical advancements of the databases Lyon16ci and 1516, one key point would be to build an online interface to allow research scholars to add, edit and delete descriptive metadata without mediation from the managers of the database. Also, the search query should be developed for more advanced search and add the possibility to combine text and metadata search with visual search. Lastly, we need to keep the collection growing, adding new images to the collection which are relevant to the scope of the database. These are the main challenges concerning the structure of the resource itself, while other challenges concern the theoretical framework of the digital resources.

Now the metadata exist in different forms (doc, CSV, XML, SQL), according to their sources. In the future, they should ideally be harmonised in form, as well as the descriptive metadata. At present, metadata source for sixteenth century printed books are not harmonised, that is we do not have a standard such as the MEI database possesses for the fifteenth century, in which all the incunabula correspond to the Incunabula Short Title Catalogue (ISTC) number.[15] From the Universal Short Title Catalogue (USTC) numerization we switched to the HPB (Heritage of Printed Books) in 2020, but this database is al-

13 I quote here only some of the most recent works in these directions: Drucker 2013; Grau 2016; Pfisterer 2018; Impett 2023.

14 See the VeDPH homepage: https://www.unive.it/pag/39287.

15 For the MEI database see https://www.cerl.org/resources/mei/main.

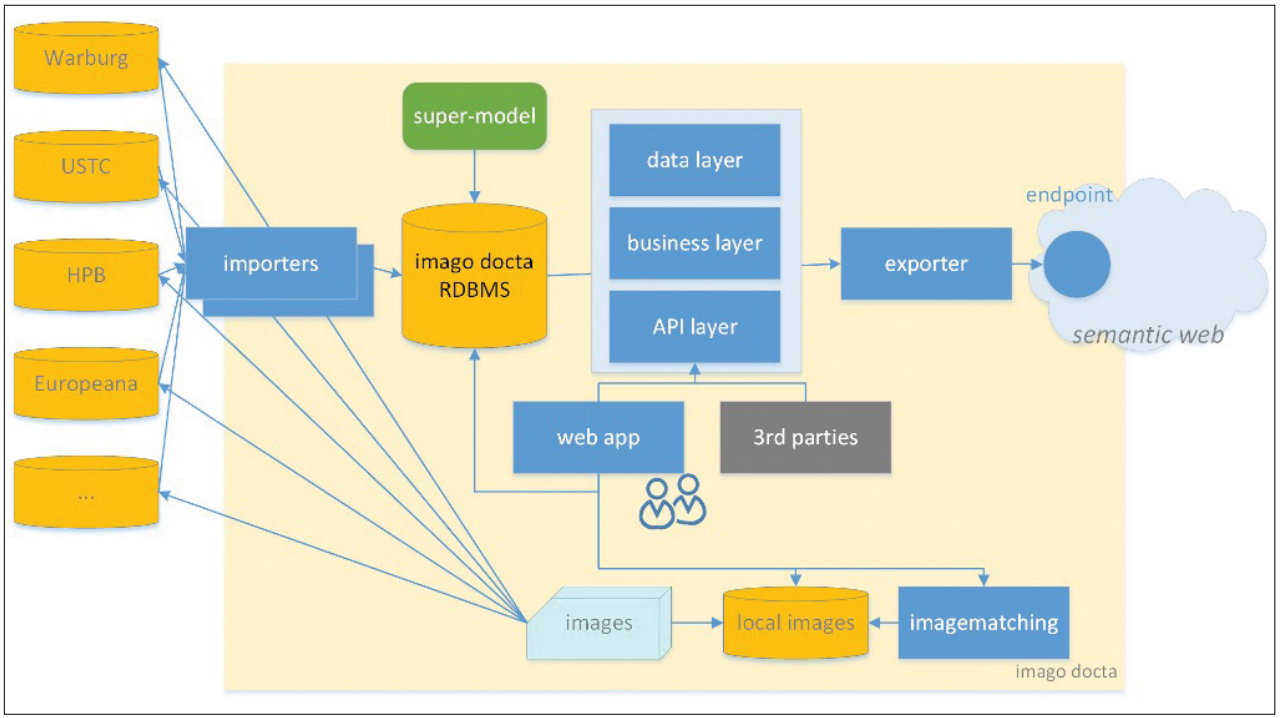


Figure 14 Scheme of the structure of the envisioned model

so in progress.[16] Metadata should always be harmonised but when there are no unique standard this is always a question of envisioning the future of this harmonisation.

The same goes for iconographic metadata, which we discussed in the previous chapter. Finding standards such as Iconclass for the iconographic indexation of images requires choosing a system which we hope will provide enough stability to the metadata inserted. Some steps towards this direction have already been taken together with Dr Daniele Fusi from the VeDPH, in which we envisioned a possible development of the Lyon16ci and 1516 databases, summarised in the scheme below [fig. 14]. In this model, several differently modelled sources are collected by a set of software importers, each adapting the subset of the input models to the target super-model, embracing all the features designed to be compatible with all the relevant data found in its sources. All these data will converge into the project's new database, implemented after the super-model.

In this process, input data can variously be discarded, remodelled, and be given more granularity as required. Then, a set of software layers would handle these data and the corresponding functionalities to a publicly available API. This will be consumed by the project's web application, which not only publishes the work, but also allows contributors to step in and provide their own data and images, thus enriching the repository in a community-driven, yet controlled effort. Other third-party projects could leverage the same API for their own purposes too. Also, a relevant subset of the project's data is automatically remodelled into a triple store and made available in the semantic web using an exporter component, reflecting the ontologies devised in designing the super-model. As for images, they could be collected in this hub from both external and internal sources, the latter being enriched by the community.

Such a structure would allow us to take images from different sources and with different standards (HPB, USTC, Europeana and so forth) and harmonise them in the new database with a high degree of interoperability from the users. This would be a community-driven project, in which collaboration with people and institutions is essential in order to carry out the implementation and research on the collection. At the moment, this is one possible idea on how to develop these digital resources in a way that complies with the FAIR principles.[17]

Having explained the digital aspect of the project, in the next chapter we will focus on the corpus of illustrations which the project analysed, and the context in which these images were produced.

16 For the HPB database see https://www.cerl.org/resources/hpb/main.

17 See https://www.go-fair.org/fair-principles/.