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chapter 30

The Use and Reuse of Printed Illustrations in 15th-Century Venetian Editions

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Abstract A presentation of the 15cILLUSTRATION database and website, a searchable database of 15th-century printed illustrations developed by the 15cBOOKTRADE Project in collaboration with the Visual Geometry Group (VGG) at the Department of Engineering Science of the University of Oxford, is the first comprehensive and systematic tool to track and investigate the production, use, circulation, and copying of woodblocks, iconographic subjects, artistic styles, within 15th-century printed illustrated editions. The paper illustrates the potential of the 15cILLUSTRATION website as a research support tool for art historians, book historians, philologists and historians of visual and material culture.

Keywords Manual image annotation. Visual image search. ISTC. Incunables. Illustration. Woodcut illustration. Woodcuts. Incunabula. Image-matching. Digital humanities. Printed images.

Summary 1 Introduction. – 2 Historical Background. – 3 15cILLUSTRATION Database. – 4 Different Stages of Development from 2014 to 2018. – 5 Illustrative Examples Showing the Use of 15cILLUSTRATION Database as Research Support Tool. – 5.1 Case 1. Search Using Database Images as a Query. – 5.2 Case 2. Search Using Metadata as a Query. – 5.3 Case 3. 'Upload and Search'. – 6 Computer Software Tools Powering the 15cILLUSTRATION. – 6.1 VGG Image Annotator (VIA). – 7 VGG Image Search Engine (VISE). – 8 Conclusions and Future Work.

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1 Introduction

At a time when the spread of printing facilitated the availability of books to wider sections of society, the images included in these books acted as a primary intellectual tool in the reading process. These images were not only meant to embellish the printed page but were also aimed at providing exegetic support to readers of any social level, thereby contributing to make the meaning of the text more accessible and to fix its content in the memory.

Printed illustration consists of the exact repetition of individual figurative statement in a book. With a technique that preceded the introduction of movable-type printing, images were carved into the surface of blocks of wood – hence the term woodblocks – leaving the printing parts in relief and removing the areas which were meant to remain white. In a minority of cases, these wooden matrices were substituted with metal ones (metalcuts).

The introduction of printed images in movable-type printed books was a gradual process. It started with the impression of engraved wooden borders on selected copies of a certain edition, typically to decorate the frontispiece or the margins of selected pages. The impression of those borders, called 'xilominiated' as they represent an intermediate stage between hand-crafted illuminations and decorations printed from a wooden (ξύλον) matrix, usually happened after the printing of the text had taken place.

The second stage of development was the insertion of more complex figurative representations, such as narrative scenes or vignettes; similarly to the xilominiated borders, these images would have been hand-printed in selected copies only, and after the printing of the text itself. In those early phases of evolution, printers did not have the technical means to insert woodblocks directly in the press forme together with the text.

The simultaneous impression of the images and text together in a single stage of the printing process represents the third and final development in the printing of illustrated incunables. As woodblocks began to be inserted in the same printing forme as the text, their use and occurrence throughout the edition necessarily had to follow the practical rules of composition of the printing forme.[1] Woodblocks soon became a fundamental part of printers' business capital, as much as types, paper, and the press itself were. They had an economic value, they could be loaned to other printers, they were

1 "When using a hand press each sheet of a book is printed from two formes (one for each side of the paper), the inner and outer formes. The outer includes the first page of the resulting gathering, plus those other pages necessary for the correct imposition of the appropriate format; the inner forme includes the remaining pages of the gathering" (Nash, *Forme*, 730-1).

exchangeable and they were marketable. And indeed, from the very beginning, many of the woodblocks which had been commissioned and prepared in order to illustrate specific 15th-century printed editions started to be copied or re-used in other editions, within the same iconographic cycle, or as single images, illustrating the same or a different text, by the same or by different printers, sometimes in different cities or even in different countries.

Unfortunately, documents establishing evident connections between names of artists and the design of specific sets of woodcut illustrations for single editions are scarce. The identification of those artistic personalities, in several cases miniaturists who shifted from the production of hand-painted decoration in books to the design of woodcuts, thus still very much depends on human recognition of stylistic similarities.

From a strictly bibliographical point of view, a more accurate and detailed system to track the circulation, use and reutilisation of early-printed illustrations (that is, of the woodblocks they came from, considered as material of impression, rather than for their pure iconographical content) will benefit different kinds of scholarship.

It will produce an exhaustive and easily accessible inventory of 15th-century printed images and of all the editions in which they occur, with a special focus on the cases of re-use and copying. It will also allow a survey of the illustration practice of every printer, and the analysis of otherwise obscure business relationships between different printers. Ultimately, it will allow philologists and art historians to increase their understanding of the transmission of texts and of different iconographic subjects in the years of the printing revolution, but also it will enable book-historians and historians of material culture to unveil and highlight the complex degrees of exchange and interaction between printers, authors and illustrators.

Over the last century, much has been discovered and said on how the role and the creative process of book decoration changed with the introduction of printing, and on the relationship between painting, illumination and the different stages of printed production and decoration. From the late 19th century, a series of fundamental resources on early-printed illustrations and illustrated editions were produced in various European countries. However, fundamental research questions on the topic have not yet been systematically addressed. These questions span three main research areas:

1. The circulation of images: how did printed images circulate in incunables? What were the different editions and texts in which they were printed? Who were the printers who used them? Is it possible to track the geographical movement of the blocks?
2. Printers' practice: how did printers use images? How did they have them made? What was the relationship between

the printers and the designers and cutters? How did they copy and/or exchange them?

3. Iconographic tradition: what impact did the introduction of printing have on the representation of a certain subject?

The way the same blocks were used in different editions and their conditions at the time of printing can provide valuable elements for establishing chronological and genetic relationships between the editions themselves. In early editions, images also have the added value of aiding in the reconstruction of the transmission of a literary work in print, particularly as they might help to identify links with the manuscript transmission of text and images, which in many cases preceded and often continued to coexist during the early years of printing.

The 15cILLUSTRATION website and database,[2] described in this paper, allows scholars to address the above mentioned research questions by providing them with a systematic and reliable tool for cataloguing and researching the production, use and circulation of 15th-century printed woodcuts.

The 15cILLUSTRATIOn database was conceived and developed between 2014 and 2018 and is the result of a close collaboration between the 15cBOOKTRADE team and the scientists of the Visual Geometry Group at the Department of Engineering Science of the University of Oxford. It is one of the digital tools developed within the 15cBOOKTRADE Project to open up the study of incunabula for historical research, along with the Material Evidence in Incunabula (MEI), TEXTinc and the visualisation software 15cV.

2 Historical Background

Any attempt to understand how book illustrations were used in the 15th century must be based on an in-depth knowledge of the bibliographical features of the editions in which they appear. In the definition of the bibliographic identity of an edition, the presence or absence of printed illustrations and the way woodblocks or metalcuts were used by printers throughout the book ought to be considered as relevant and meaningful as the other standard elements on which we normally rely such as 'author', 'title', 'place of printing', 'printing shop', 'year of printing', 'number of leaves', 'mise en page', 'type', etc.

The foundations of this methodology of researching the production and use of Italian early-printed illustrations were laid in the late 19th and early 20th century. Central in this sense were works such as Paul Kristeller's *Early Florentine Woodcuts* (1897), and the two rep-

2 URL `http://zeus.robots.ox.ac.uk/15cillustration/`.

ertories by Victor Masséna, Prince d'Essling. In 1895, Essling published his *Les Missels imprimés à Venise de 1481 à 1600*, followed in 1914 by the monumental *Les livres à figures vénitiens de la fin du XVe siècle et du commencement du XVIe*, a comprehensive catalogue of all known illustrated editions printed in Venice before 1530, where for each edition particular attention is devoted to the verbal description of figurative representations.[3]

Essling's example was followed in Italy by Max Sander, who in 1942 published a catalogue modelled on the same structure but with a shift of interest from editions printed in Venice to all those printed in Italy between the 15th and early 16th centuries, and then in Germany by Albert Schramm, with his *Bilderschmuck der Frühdrucke* (1920-43).[4]

The argument that research on woodcut illustration should be carried out within the framework of analytical bibliography was reinforced further by Wytze and Lotte Hellinga in the sixties, and has inspired a number of works and scholarly approaches in the past decades, such as the recent analysis conducted by Ina Kok in her *Woodcuts in Incunabula Printed in the Low Countries* (2013).[5] The works of Schramm and Kok are organised by printer and woodcut, rather than by edition, as were the earlier works mentioned above.

Meanwhile, the rise of digital technologies facilitated the establishment of new tools for cataloguing incunables, such as the ISTC online, and stimulated new developments of the work on early-printed images. In 1994, in the footsteps of ISTC, Lotte Hellinga launched the Illustrated Incunabula Short-Title Catalogue (IISTC), which made images from many early-printed editions available on a CD-ROM.

In more recent years, many projects have also been fruitfully testing the application of digital technologies to different kinds of images, including early-printed images. These efforts were often paired with substantial digitisation campaigns and with the creation and development of major digital collections such as those of the *Index of Medieval Art* at Princeton University, of the Warburg Institute Iconographic Database in London.[6] These projects, together with the creation of other online tools such as the database *Arkyves*, supported by the publisher Brill and contributed by partners such as the Dutch Rijksmuseum,

3 Kristeller, *Early Florentine Woodcuts*; Essling, *Les Missels imprimés à Venise*; *Les Livres à figures vénitiens*.

4 Sander, *Le Livre à figures italien*; Schramm, *Der Bilderschmuck der Frühdrucke*.

5 The Hellingas developed this idea as one of the fundamental methodological bases for their extensive research on printing types in the Low-Countries; Hellinga W., Helling L., *The Fifteenth-Century Printing Types*, I: xi-xiii in particular; Kok, *Woodcuts in Incunabula*, i-iv of the introduction.

6 URL `https://ima.princeton.edu/`; `https://warburg.sas.ac.uk/special-collections/photographic-collection/iconographic-database`.

the Netherlands Institute for Art History, the Herzog August Bibliothek, and the university libraries of Milan, Utrecht, Glasgow, and Illinois, suggest how much time and resources have been invested by cultural institutions to take advantage of digital technologies and to make large quantities of images available to scholars and the public.[7] Some of these efforts have particularly focused on early-printed images, in an attempt to overcome the weaknesses of the traditional ways of cataloguing illustrations with particular reference to the storage of images and their availability to scholars.

Among these, the project *Icono15*, developed between 1988 and 2000, consisted of an electronic census of illustrated French editions and a catalogue of illustrations of French incunables stored in Paris at the Bibliothèque Nationale de France. Icono15 was based on the model of the database Mandragore, storing images from the illuminated manuscripts owned by the BNF.[8] In the Icono15 system, each block appearing in one edition was assigned a unique identifier of the type 6532-04, where 6532 is a number arbitrarily linked to the block and 04 indicates that the same block had already been used three times before that appearance.

The description of every block was then structured according to a series of metadata fields which pertained to the number of its occurrences in one single edition, the leaf where it was printed, its position within the page, its measurements, a synthetic description of the scene that it represents (e.g. 'crucifixion'), and a series of descriptive keywords referring to figurative and iconographic elements of the representation.[9]

Although Icono15 represents so far the project that has come closest to the idea of a systematic work towards the creation of a database for printed images in incunables, this electronic catalogue of illustrations has always remained an offline tool, apparently on CD-ROM, and the entries describing images, mentioned above, do not have any visual reproduction attached.

These two shortcomings were overcome by the Bodleian Broadside Ballads Project, developed by the VGG at Department of Engineering Science, University of Oxford and hosted by the Bodleian Library.[10]

In this context, a system of automatic recognition of printed images was designed and developed within the Bodleian Ballads Online re-

7 URL http://arkyves.org.

8 URL http://mandragore.bnf.fr/html/accueil.html.

9 All the following information on Icono15 is based on Firoben and Petit, *Icono 15*, 295-316.

10 The Bodleian Library Broadside Ballads Project was developed in collaboration with Giles Bergel of the English Faculty, relying on data previously gathered by Dr Alexandra Franklin (cf. http://www.bodley.ox.ac.uk/ballads/).

source to assist with the cataloguing and study of the figurative content of early British printed broadside ballads. The ImageMatch tool, which later evolved into the ImageBrowse tool, was used to search a set of 800 high-resolution images of ballads from the 17th century.[11] Images of the ballads' illustrations were uploaded in the Bodleian Broadside Ballads database, and their iconographic content was indexed and described using ICONCLASS and integrated with metadata about the collection.[12] An early prototype of the software tools that power the visual search feature of 15cILLUSTRATION database was used for developing the ImageMatch and ImageBrowse tools. In the section "Computer Software Tools Powering the 15cILLUSTRATION" of this paper, we describe the search tool that forms the basis of the visual search feature of 15cILLUSTRATION database as it is now.

The Icono15 database and the Broadside Ballads Project were the starting point for the development, within the 15cBOOKTRADE Project, of a new method to integrate an in-depth analysis of the illustrations printed in 15th-century editions within the major tools for bibliographical research.

3 15cILLUSTRATION Database

15cILLUSTRATION is an online database of 15th-century printed illustrations. It is based on a set of digital reproductions of 15th-century printed images stored on online servers hosted by the VGG that are regularly updated on the basis of contributions from scholars and researchers. It supports search queries based both on text metadata or on image regions, either taken from the images already in the database or from new images uploaded by the user.

In comparison with other categories of images, such as those found in single sheet ballads or prints, scholars aiming to catalogue and classify 15th-century printed book illustrations have to deal with an additional level of complexity, due to the technical constraints of the printing process of a book, which can run to hundreds of pages and contains several illustrations, often repeated. In order to find out how illustrations were used, it is necessary to map in detail their presence inside the editions where they appear.

The filename of every image contained in 15cILLUSTRATION is a unique identifier composed of the following three elements:

11 Quoted from Bergel et al., *Content-Based Image-Recognition*.

12 ICONCLASS is the most widely accepted multilingual classification system for figurative content in the Medieval and Early Modern periods. In ICONCLASS, subjects of visual representations are described through alphanumeric classification codes, called notations. Every notation is part of a hierarchical structure that functions according to a logic of increasing specificity. Cf. more on ICONCLASS at `www.iconclass.nl`.

- ISTC number, referring to the edition;
- MEI number, referring to the copy;
- folio reference.

Associating each image with a unique identifier allows us to quickly track the edition and copy from which the image was taken thereby allowing us to link the image with bibliographic information available in the ISTC database and ownership details present in the MEI database. The association (or link) of images with the ISTC database is crucial since, as will be explained in further detail below, it allows us to automatically retrieve the bibliographic information about each edition.

The link with MEI is also of great importance. Although it is easier for scholars to generally rely on the assumption that all the copies of a certain edition have the identical arrangement of illustrations, many examples and study cases prove that often this is not the case. As happens with types and the imprint of the text, the way in which woodcuts are used may present substantial differences between different copies of the same edition. These cases are particularly valuable for scholars, not only because they shed light on the printing material that the printer had at his disposal and on how this evolved over time, but also because they often allow us to distinguish between successive reprints and ultimately help to clarify the different stages of the printing process. Furthermore, such a link to MEI database guarantees that the ownership of the copy and its current location are always acknowledged and presented to the users of 15cILLUSTRATION.

In the digital reproductions of early-printed illustrations uploaded in the 15cILLUSTRATION, the impression of each block is tagged with metadata of two kinds:

- bibliographic metadata automatically sourced from ISTC, through the unique identifier of each image, to record the date and place of printing, the printer, the author and title of the edition where the image is contained;
- descriptive metadata assigned manually, which illustrate different features (figurative content, artistic style, measurements, etc.) of the specific block.

For the first time, the database enables scholars to track the cases of reuse, circulation and copying of single woodcuts through the search for visual samples alone, such as part of a border, an entire vignette or a small detail, as well as through textual keywords and metadata. These two ways of searching the database can also be combined together to further refine the query.

4 Different Stages of Development from 2014 to 2018

In this section, we describe the different development stages of the 15cILLUSTRATION project to provide an insight into the inception and progress of an interdisciplinary project between Humanities and Engineering Science.

The master's thesis by Clementina Piazza (University of Oxford, 2012), under the supervision of Prof. Cristina Dondi, demonstrated the potential benefits of applying innovative digital methodologies, such as visual recognition and image matching, to the research on the production and circulation of early-printed illustrations. Piazza's work focused in particular on the set of woodblocks used by the German printer Johannes Hamman for his incunable editions of the *Book of Hours*, issued in Venice.

The positive outcome of this preliminary assessment and the great potential of this research field gave the 15cBOOKTRADE Project, started in 2014, the confidence to assign a DPhil student (Matilde Malaspina) to expand it on a larger scale, this time in close collaboration with researchers from the VGG who had developed the visual search technologies used in the Bodleian Broadside Ballads Project, mentioned above.[13]

The initial work began in autumn of 2014 by gathering images from Italian, and particularly Venetian editions, with a preference for printed illustrations of Aesopic texts, namely various versions of the *Fabulae* and the *Vita Aesopi*. If one illustration consisted in two or more blocks combined together, they were isolated in different jpeg files, one for each block. Each file was then named separately. At the beginning, the metadata description associated with each illustration was manually stored in a revised version of the spreadsheet initially conceived by Piazza in her thesis work.[14] The metadata descriptions corresponded to the bibliographical features of the book (e.g. imprint and format), and the subject represented in the image. In this respect, a fundamental distinction between the objective description of the figurative subject and its iconographic interpretation had already been introduced through the use of both keywords and iconclass codes to describe it. This resulted in a set of digital images in JPEG format, each containing the photographic reproduction of one single printed block (or region), and in the associated metadata description stored in a row of the spreadsheet. This initial dataset of around 2000 images was sufficient to create an initial prototype of 15cILLUSTRATION that demonstrated the visual search functionality on 15th-century printed illustrations. This initial prototype was

13 Malaspina, *15th-Century Printed Italian Editions*.

14 Piazza, *Cataloguing Images in Incunabula*, 62-8.

presented at the official public launch of the 15cBOOKTRADE Project on 23 June 2016 at the Bodleian Library (University of Oxford). We also described this initial prototype in a research article published in the *Lettera Matematica* journal.[15]

This initial prototype lacked the text metadata search functionality because of the limitations imposed by metadata stored in a spreadsheet. The initial prototype helped reveal the limitations of our existing approach of splitting illustrations into multiple JPEG files and storing their metadata descriptions in a spreadsheet. Furthermore, this approach was extremely time consuming and inefficient. To allow online search and visualisation of text metadata, we needed to use a manual image annotation tool to manually define separate regions in an illustration corresponding to separate blocks. Manual image annotation tools also allowed describing these image regions with text metadata. Therefore, we selected an existing manual image annotation tool and began our manual annotation work.[16] We soon realised that we needed to develop our own image annotation tool because the chosen existing tool was difficult to install and use by non-technical users. To suit our needs, we developed a manual image annotation software tool called the VGG Image Annotator (VIA) that did not demand any technical knowledge from its users and was easy to use. The VIA software fulfilled all the manual annotation requirements of 15cILLUSTRATION scholars and has now matured as a general image annotation tool that has become an essential and invaluable research support tool in many academic disciplines. The VIA software tool is described in more detail in "Computer Software Tools Powering the 15cILLUSTRATION" section.

The manually annotated metadata created using the VIA tool allowed us to create the next prototype of 15cILLUSTRATION which included both visual search and text metadata search. This version of 15cILLUSTRATION was presented on 21 February 2017, as part of the Lunchtime Lecture Series of the Centre for Digital Scholarship of the Bodleian Library (University of Oxford). Then we also presented the VIA manual image annotation tool. The tools required to perform visual search and text metadata search were now ready. The remaining time of the project was used to collect more images and let scholars annotate them manually using the VIA tool. We added a text metadata search functionality to the visual search software. We also upgraded the visual search tool to show manually annotated metadata if the search result overlapped with a manually annotated region. Furthermore, the visual search tool was up-

15 Malaspina, Zhong, *Image-Matching Technology*, 287-92.

16 LEAR image annotation tool by A. Kläser, `https://lear.inrialpes.fr/people/klaeser/software_bbox_image_annotation`.

graded to also show bibliographic metadata automatically fetched from the ISTC database.

The final version of 15cILLUSTRATION online database contains 4725 illustrations along with manually annotated metadata associated with most of those illustrations. This version was released to the public in September 2018 and was presented during a conference in Venice.[17] This final version of 15cILLUSTRATION database is now publicly accessible at `http://zeus.robots.ox.ac.uk/15cillustration/`.

5 Illustrative Examples Showing the Use of 15cILLUSTRATION Database as Research Support Tool

According to ISTC, around 28,500 editions printed with movable types by the end of December 1500 survive today. Out of these, just under 4,000 were printed in Venice or are attributed to Venice-based printers on the basis of typographical features, the use of woodblocks, or historical and documentary sources.

The earliest illustrated Venetian editions that survive today were printed by the German Erhard Ratdolt at the end of the 1470s in partnership with two other Germans, Bernhard Maler ('Pictor', in Latin) and Peter Löslein. In particular, the first examples are two editions, in Latin and Italian respectively, of the *Calendarium* composed by the mathematician and astronomer Johannes Müller from Königsberg in Franconia ('Iohannes de Monte Regio', or 'Regiomontanus').[18]

In these cases the illustrations contained in the editions mainly consist of decorated title-page borders and initials, diagrams and astronomical representations. Although narrative vignettes start appearing from Ratdolt's first edition of the *Fasciculus temporum*, printed in November 1480, scholars have remarked how the role of Venetian artists in the design and making of woodcut illustrations became particularly important from the early 1490s onwards.[19]

17 Malaspina, Dutta. "The Use and Reuse of Printed Illustrations in 15th-Century Venetian Editions". *Printing R-Evolution and Society 1450-1500. Fifty Years that Changed Europe* (Venice, 21 Sept. 2018).

18 ISTC ir00103000 (the Italian edition) and ir00093000 (the Latin one).

19 The years 1486 and 1487 already saw the appearance of significant illustrated editions, such as the *Supplementum chronicarum* printed by Bernardinus Benalius in December 1486 (ISTC ij00210000), the *Aesopus moralisatus*, also printed by Benalius, in November 1487 (ISTC ia00150400) and S. Bonaventura's *Meditationes Vitae Christi* with full-page illustrations printed by Hieronymus de Sanctis in 1487 (ISTC ib00922000). A detailed account of the evolution of the practice of woodcut illustration in Italian 15th-century printed books is given by Armstrong, "Gli incunaboli illustrati", 171-228 later republished in Armstrong, *La xilografia nel libro italiano del Quattrocento*, 19-110.

As mentioned above, the research on illustrated editions of the Venetian production already had a valuable foundation in the work by Victor Masséna, Prince d'Essling. In his repertory *Les livres à figures vénitiens de la fin du XVe siecle et du commencement du XVIe*, Essling specifically focused on illustrated editions printed in Venice between the late 15th century and the late 16th century. The work counts 2585 editions in total, of which around 362 were certainly printed before the end of 1500, fifty-two without a precise date and the rest issued between 1501 and 1586. At the moment, around 400 editions are currently recorded in ISTC as having an Essling number. Unfortunately there is no way yet to systematically determine how many illustrated editions among all incunables currently exist.

The cases of reuse and circulation of woodblocks in early-printed editions are many, and concern different types of images: not only narrative vignettes but also diagrams, borders and decorated initials. In this context, the main challenge for scholars is certainly to be able to retrieve the cases where the same figurative representation is used to illustrate different narrative episodes and iconographic subjects.

And this task is precisely where the possibility offered by the 15cILLUSTRATION database becomes particularly innovative and useful, to combine a search via textual metadata with a search which is based purely on the visual instance of the image.

5.1 Case 1. Search Using Database Images as a Query

The structure of the database allows the user to browse through the *c*. 5,000 pilot images which are contained in it, as well as to group them by edition, on the basis of the ISTC number contained in the name of the file. For instance, searching for the ISTC number "ia00110000", the user finds all the illustrations contained in the corresponding edition, the *Vita Aesopi* printed in Venice by Manfredus de Bonellis on 27 March 1492. The database divides the illustrations according to the different gatherings in which they appear, contributing to clarifying the use and repetition of the blocks throughout the edition as shown in **[fig. 1]**.

From this result, it is possible to select any of the images and search for all its other uses and occurrences through the image matching software. Let us select, for instance, the illustration appearing on the last leaf e10*v* as shown in **[fig. 2]**. The woodblock portrays the last episode of the *Vita*, 'De interitu Esopi clarissimi fabulatoris', i.e. the scene where Aesop is thrown from a rock and murdered by the citizens of Delphi. The user can now select any portion of the image, such as the central vignette, highlighted in the picture, and search the database for other occurrences of the same impression. In this case, the search operation gives three results as shown in **[fig. 3]**.

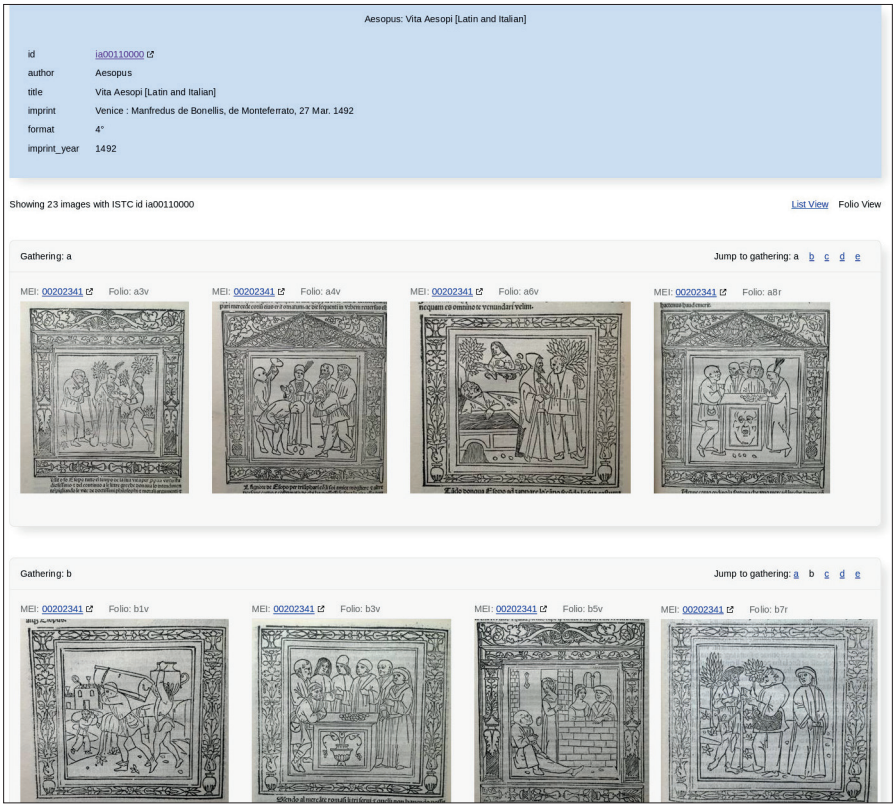


Figure 1 Some of the illustrations contained in the *Vita Aesopi* printed in Venice by Manfredus de Bonellis on 27th March 1492 (ISTC ia00110000), divided by gathering

Figure 2 Visual search query selected from gathering e10*v* of edition ia00110000

Search Result: 1 to 3 List View Tile View Tile View (images only)

1 Filename: ia00110000_00202341_e10v.JPG 6069.0

ISTC Metadata

id	ia00110000
author	Aesopus
title	Vita Aesopi [Latin and Italian]
imprint	Venice : Manfredus de Bonellis, de Monteferrato, 27 Mar. 1492
format	4°
imprint_year	1492

Details of Match Compare Matching Regions Use this image for further search

2 Filename: ir00338500_02006269_[*1r].jpg 102.0

ISTC Metadata

id	ir00338500
author	Rota, Lorenzo
title	La morte del duca Galeazzo
imprint	[Venice : Manfredus de Bonellis, de Monteferrato, about 1493]
format	4°
imprint_year	1493

Details of Match Compare Matching Regions Use this image for further search

3 Filename: ia00111000_00201956_e10v.jpg 62.0

ISTC Metadata

id	ia00111000
author	Aesopus
title	Vita Aesopi [Latin and Italian]
imprint	Venice : Manfredus de Bonellis, de Monteferrato, 8 Nov. 1493
format	4°
imprint_year	1493

Details of Match Compare Matching Regions Use this image for further search

Figure 3 Visual search results for query based on query region selected from gathering e10*v* of ISTC ia00110000

The first match is with the same edition from which the query image was taken.[20] The third match is from a later edition of the *Vita Aesopi*, also by de Bonellis and very similar in text and illustrations to the one where the query image was taken from.[21] The second match is more surprising, and refers to the appearance of the woodblock on the titlepage of an edition of the vernacular poem *Lamento per la morte del duca Galeazzo*.

The text is a ballad attributed to the Florentine Lorenzo dalla Rota, and composed to commemorate and mourn the assassination of Galeazzo Maria Sforza, Duke of Milan, in December 1476 (ISTC ir00338500).[22] Clicking on the ISTC number of the edition, the user discovers that the other illustration used on the verso of the second and last printed leaf of the ballad was also taken from an Aesopic text, and namely from de Bonellis' 1490s editions of the *Fabulae*, that he printed together with the vernacular Italian translation composed by the Veronese poet Accio Zucco di Sommacampagna at the end of the 14th century.

The specific image that concludes Rota's *Lamento* represents a rider galloping in the woods, while beating his mule on the back with a stick. A big fly is portrayed on the back of the mule. This woodblock was used as a narrative scene to illustrate the fable 'De musca et mulione' in all four editions of the Esopo zuccarino printed by Manfredus de Bonellis between 1491 and 1497.[23] The fable tells the dialogue between the mule and the fly, where the latter takes advantage of the reproaches of the rider against the slow mule.

5.2 Case 2. Search Using Metadata as a Query

The 15cILLUSTRATION also allows the user to search the database using metadata and keywords. In this case, the search is performed through a searching screen where two searching strings are available. In each string the user can type a bibliographic element concerning the imprint of the image (such as author, title, imprint) or a descriptive element concerning its figurative or iconographic content, its style, any text that might be included, its state of conservation and so on. In both strings, the user is requested to specify whether the search should be performed within the descriptive metadata, assigned through the tagging, or within the bibliographic metadata, automatically imported from ISTC.

20 Venice: Manfredus de Bonellis de Monteferrato, 27 Mar. 1492 (ISTC ia00110000).

21 Venice: Manfredus de Bonellis de Monteferrato, 8 Nov. 1493 (ISTC ia00111000).

22 On the ballad and its literary, historical and cultural significance cf. Salzberg and Rospocher, *Murder Ballads*, 164-85.

23 ISTC ia00151000, ia00152000, ia00153000 and ia00154000.

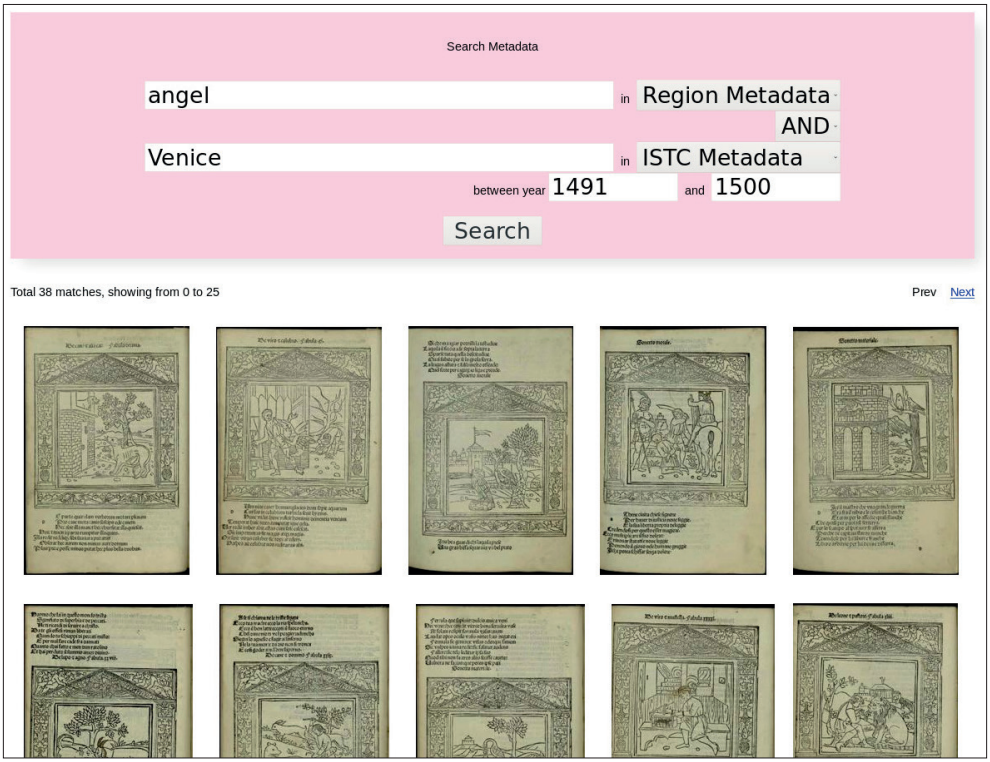


Figure 4 Metadata search result for query all images containing 'angel' (descriptive metadata) printed in 'Venice' (bibliographic metadata) 'between 1491 and 1500' (bibliographic metadata)

The two strings can be combined, so that it is possible to perform different sorts of combined searches, such as:

- all the images containing a 'dog' (descriptive metadata);
- all the images containing a 'dog' (descriptive metadata) and a 'woman' (descriptive metadata);
- all the images contained in editions printed in 'Venice' (bibliographic metadata);
- all the images contained in editions printed in 'Venice' (bibliographic metadata) in '1491' (bibliographic metadata);
- all the images containing a 'dog' (descriptive metadata) in editions printed in 'Venice' (bibliographic metadata).

A third string is dedicated specifically to searching editions printed in a certain year, or between two specific years. Among the many different possible searches that can be performed, the sample presented during the Printing Revolution conference concerned all the images containing 'angels' (descriptive metadata) printed in Ven-

Figure 5 Francesco Corna, *Istoria della Regina Oliva*. [About 1500]. Venice: Johannes Baptista Sessa. Leaf a1*r* (ISTC ic00909825)

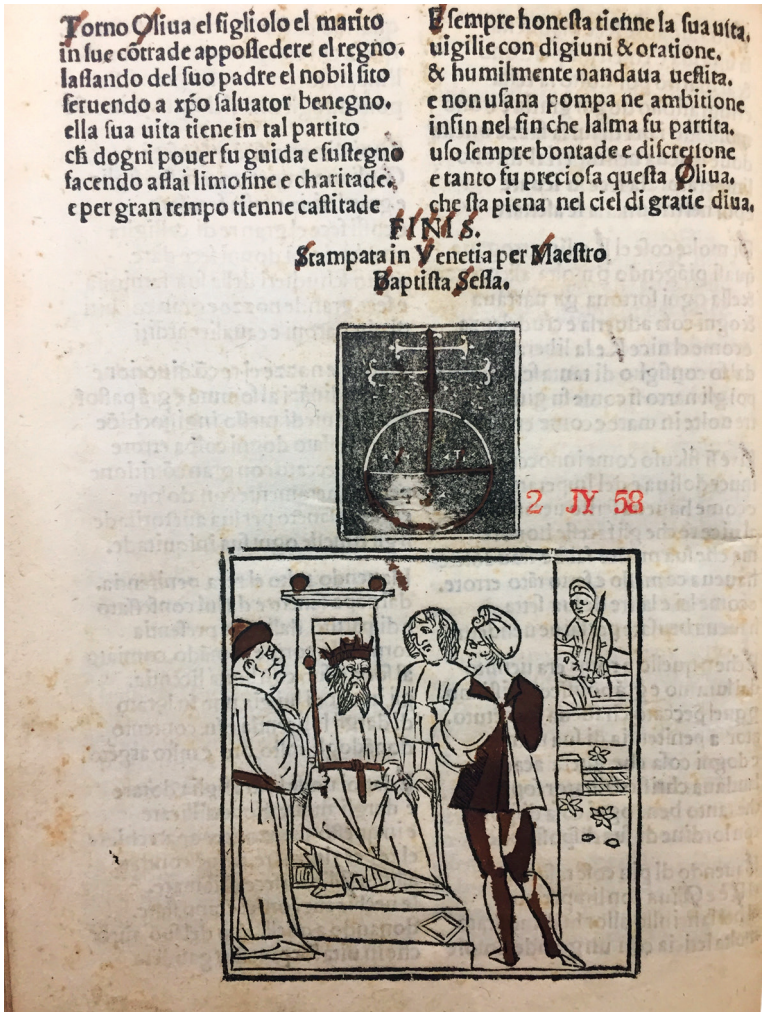


Figure 6 Francesco Corna, *Istoria della Regina Oliva*. [About 1500]. Venice: Johannes Baptista Sessa. Leaf b4v (ISTC ic00909825)

ice (bibliographic metadata) between the years 1491 and 1500 (bibliographic metadata). At the time of the conference, this query gave thirty-eight results, including a variety of images, among which the very common central vignette representing an angel which is found in many editions of popular texts printed in Northern Italy, and which was copied and reused many times, and images of decorated borders or laurel wreaths with winged putti appearing in them, as well as more iconographically complex representations as shown in **[fig. 4]**.

5.3 Case 3. 'Upload and Search'

In fifteenth-century Venetian production, along with the monumental frontispieces and beautiful editions of classical and liturgical texts containing long and fully developed programmes of images, there were many editions of popular texts in the vernacular, often in verse, which might contain only one or two illustrations only.

Among these is the *Historia della Regina Oliva*, a poem in eight-line stanzas, composed towards the end of 15th century by the Italian poet Francesco Corna da Soncino. The story tells about the adventures of the Roman emperor's daughter, trying to escape from her father who loves her.

Four incunable editions of this work survive from the 15th century, all produced in Venice; out of them, only one is illustrated, printed by Iohannes Baptista Sessa in 1500.

The edition contains two illustrations: on leaf [a1*r*] is a decorated border surrounding the frontispiece page **[fig. 5]**.

The second one, placed on the last leaf [b4*v*], below the colophon, portrays a group of men engaged in discussion **[fig. 6]**.

One of them is sitting on a throne, wearing a crown and holding a sceptre. The one standing on his right side looks deformed in his face, and touches his breast. On the right side of the image, a second scene is visible: a man is standing next to a coffin, holding a sword. A second man is sitting inside the coffin, with half of his bust emerging and visible in profile **[fig. 6]**. The details of the scene depicted do not correspond to any of those narrated in the book, so one might ask who these characters actually are and where this woodblock was taken from.

When the figurative representation and the iconographic content have so little in common with the text, it would be particularly difficult to retrieve the illustration used by relying solely on a verbal description, which often turns out to be too vague.

The 'Upload and search' feature of the 15cILLUSTRATION database allows a researcher to check if an unidentified illustration appears in the database and to track all the occurrences of that illustration in other 15th-century printed editions relying solely on the visual features of the query image itself.

Going through all the matches and their associated metadata (ISTC and manually annotated regions), can help in identifying the earliest appearance of the image, and therefore in revealing its original iconographic meaning.

In this case, the outcome of the query suggests that the image was first employed in Manfredus de Bonellis' edition of the *Vita Aesopi* published in Venice in 1492 and then again in 1493. In de Bonellis' editions the texts appears both in Latin and in its Italian translation, following Francesco del Tuppo's version established in print in 1485.[24] In particular, the woodblock in question was meant to illustrate the seventeenth episode of Aesop's life, 'Quo pacto Esopus magnifice sub licuro [*sic*] rege Babilonie deguerit ob sanam enigmatum interpretationem'. In this episode it is told how Aesop, after leaving the isle of Samos, reached the kingdom of Babylon, where he became one of the trusted men of the king Lycurgus and he also adopted a stepson, named Ennus. In order to hide his guilt at having slept with one of Aesop's servants, Ennus created false evidence to accuse Aesop of betrayal towards Lycurgus. Convinced by Ennus' staging, Lycurgus decided to condemn Aesopus to death and to order his man Hermippus to execute him. The Latin text then specifies that: «At Hermippus Esopi studiosus ipsum in sepulcro clanculum abscondidit, ibique diu vivum servavit». Hermippus secretly saved Aesop and hid him into a coffin, where he kept him alive for some time.

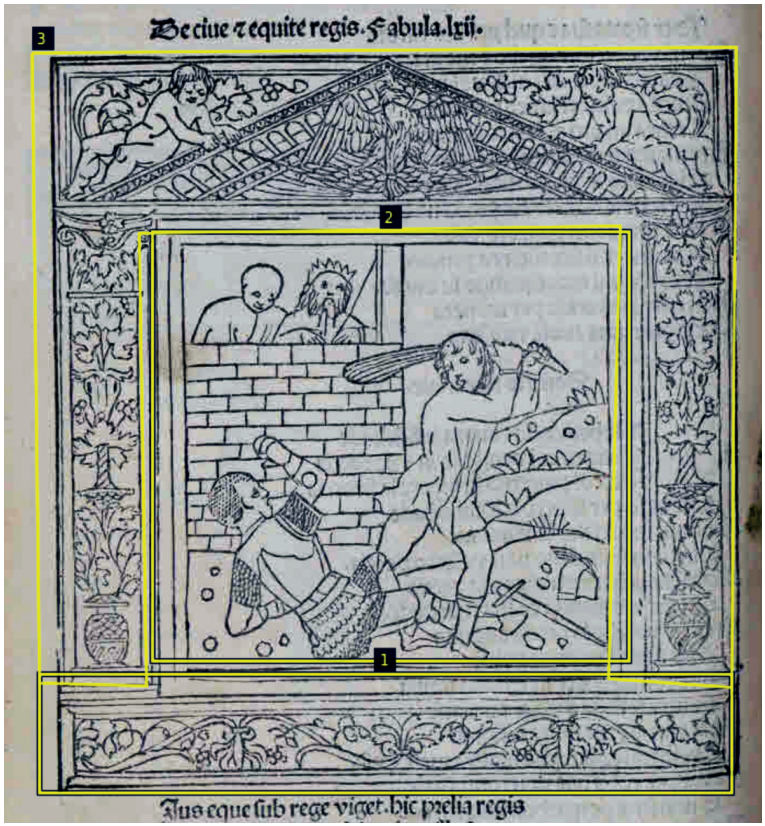
In light of this, the main scene of the illustration has to be recognised as the accusation of Aesop standing to the left of the king Lycurgus sitting on the throne. In front of Aesop stands the young boy Ennus, with long hair, on the right side of the image. The accusation takes place at the presence of another man, possibly Hermippus himself. The scene added on the right side of the woodblock **[fig. 6]**, on the other hand, is that where Aesopus is hidden in a coffin by his friend and ally Hermippus, after having been unjustly sentenced to death by Lycurgus himself.

6 Computer Software Tools Powering the 15cILLUSTRATION

The 15cILLUSTRATION online database allows scholars to search the database of 15th-century printed illustrations in the following two ways: (a) Metadata Search and (b) Visual Search.

Using metadata search, scholars can retrieve a set of all illustrations whose metadata conforms to user defined constraints on the

24 Francesco del Tuppo, *Vita Aesopi* and *Fabulae*. Naples: 13 Febr. 1485 (ISTC ia00155000); cf. also Rovere, *L'"Esopo" napoletano*.



folio	iconclass	internal_number_of_object	keywords
h7v	48AA983111 acanthus ~ ornament - AA - stylized48C161 column, pillar ~ architecture; 48AA9831 foliage, tendrils, branches ~ ornament - AA - stylized; 41D2652 lace;	b11	Foliage; Vase; ornament; Wings; Tendrils; Grapes; Columns;
h7v	85A(DE CIVE ET EQUITE REGIS) FABLESOFAESOP(WITH TITLE); 31D14 adult man; 31A2242 elbow; 45C12(CLUB) weapons for striking a blow: club; 41AA3361 human figure at (open) window, seen from outside - AA - feigned window; 47G532 tiles, bricks ~ building material; 44B113 king; 44B1212 throne; 44B191 crown (symbol of sovereignty); 46A12 nobility and patriciate; chivalry, knighthood; 41A31 facade (of house or building)	c62	Elbow; Rider; Club; Armour; King; Crown; Bricks; Wall;
h7v	48C162 arch, archivolt ~ architecture; 48AA983111 acanthus ~ ornament - AA - stylized; 48C161 column, pillar ~ architecture; 48AA9831 foliage, tendrils, branches ~ ornament - AA - stylized; 92D1916 cupids: 'amores', 'amoretti', 'putti'; 25F33(EAGLE) predatory birds: eagle; 41D2652 lace; 11GG191 angel(s) represented as child(ren) - GG - lower angel(s) without wings; 5(+1111) Abstract Ideas and Concepts (+ nude with wings); 25F3 birds	b10	Foliage; Vase; Ornament; Wings; Tendrils; Grapes; Columns; Laces; Putti; Eagle; Angels; Grapes; Columns; Archivolt; Nude; Bird;

Figure 7a-b Example of manually defined regions (a) and their description (b) created by research scholars using the VIA software loaded with a 15th-century printed illustration. Sample Image from Database (b) detected regions

metadata. The following is an example of a metadata search query: "Find all the illustrations containing 'angels' [*descriptive metadata*] printed in Venice [*bibliographic metadata*] between 1491 and 1500 [*bibliographic metadata*]". Bibliographic metadata and descriptive metadata are essential to support such metadata search queries. The required bibliographic metadata is sourced automatically from the Incunabula Short-Title Catalogue (ISTC) database.[25] The descriptive metadata is manually defined by scholars using a manual image annotation tool called VGG Image Annotator (VIA).[26]

The visual search capability of 15cILLUSTRATION allows scholars to visually search the 15th-century printed illustrations present in the 15cILLUSTRATION database using an image region as search query. Such a visual search feature is essential to address research questions related to the circulation of printed illustrations. This visual search is powered by VGG Image Search Engine[27] (VISE) which searches through thousands of images in the 15cILLUSTRATION database and instantaneously shows the images that visually match the search query image.

In the next two sections, we describe VIA and VISE software tools in more detail and how they are being used to power search functionalities offered by the 15cILLUSTRATION online database. VIA and VISE are open source software tools and therefore can be used for any purpose without paying any licensing fees. Therefore, these tools can be used as research support tools for other similar projects.

6.1 VGG Image Annotator (VIA)

Manual image annotation is the process of defining regions in an image and describing those regions using textual metadata. We have developed a manual image annotation software tool, called the VGG Image Annotator (VIA),[28] to allow scholars to manually annotate the 15th-century printed illustrations. There are a large number of manual image annotation tools but we invested in developing VIA because most of the existing tools require complex installation and setup procedures which often present a barrier to non-technical users. VIA does not require any additional software installation and runs solely in a web browser. Therefore, this application can run seamlessly in many platforms like Windows, MacOS and Linux and does not demand any technical knowledge from its users.

25 URL `https://data.cerl.org/istc/_search`.

26 URL `http://www.robots.ox.ac.uk/~vgg/software/via/`.

27 URL `http://www.robots.ox.ac.uk/~vgg/software/vise/`.

28 Dutta, Zisserman, "The VIA Annotation Software for Images, Audio and Video".

Figure 8a-b A sample image from the database of 15th-century printed illustrations. Query Image. (b) Detected regions in query image

Scholars who have expertise in the research and analysis of 15th-century printed illustrations, use the VIA software to manually define rectangle shaped regions on the images present in the 15cILLUSTRATION database and describe these regions using textual metadata.

The rectangular shaped regions often correspond to the full illustration, details in it, or the border decorating it. The manually defined textual metadata is grouped under nine attributes shown in Table 1. The VIA software creates an easy to use interface to define these attributes. **Fig. 7** shows a screenshot of the three manually defined regions and their corresponding descriptions for a 15th-century printed illustration. Producing these manual annotations is a time consuming process and therefore the VIA software allows the saving of ongoing annotation at the end of one session and resuming of the annotation process in another session. This manually annotated metadata associated with each image in the 15cILLUSTRATION database represents the descriptive metadata of the illustrations in the 15cILLUSTRATION database.

The Incunabula Short Title Catalogue (ISTC) database is the source of our bibliographic metadata that is automatically queried by the 15cILLUSTRATION online database to obtain Author, Title, Imprint details, Format and Imprint Year associated with each 15th-century printed illustration.

Based on the descriptive metadata and bibliographic metadata, the 15cILLUSTRATION online database is able to offer users the capability to perform metadata search queries like “Find all the printed illustrations containing the keyword “angel” and printed in Venice

Figure 9a-b A sample query image and its detections region

Figure 10 131 matching regions (correspondence depicted using green line) between query (left) and match (right) image

between 1491 and 1500". For this illustrative search query, 15cILLUSTRATION first searches the bibliographic metadata – Author and Imprint details – to select a subset of all the illustrations printed in Venice between 1491 and 1500 and then performs exact text keyword search[29] to obtain a final list of all the illustrations that were manually tagged by scholars with the keyword "angel".

7 VGG Image Search Engine (VISE)

The visual search capability of 15cILLUSTRATION database relies on the VGG Image Search Engine (VISE) to instantaneously search through a database of thousands of 15th-century printed illustrations using an image region as search query. This visual search functionality is essential to study the use and reuse 15th-century printed illustrations.

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 change due to hand-illumination or slight change in viewpoint. These are the variations that we observe when photographing an object (or an illustration) from different viewpoints or under different hand-illumination conditions. For the purpose of illustration, let us consider a 15th-century printed illustration shown in **fig. 8a** and assume that this illustration is part of a large database of images that needs to be visually searched by VISE. **Fig. 8b** depicts the extent and shape of detected regions denoted by coloured ellipses. The visual content in each elliptical region is denoted using a feature vector (i.e. a sequence of numbers). These feature vectors are capable of summarising the visual content of the region in such a way that two regions having similar visual content produce similar features. The region detection and feature vector computation is performed on all the images in the database. The same region detection and feature vector computation process is also applied to the user's uploaded search query image as shown in **fig. 9**. The task of searching for the query image in a large database of images now boils down to efficiently finding all the images in the database that match a large number of similar features with the query image. The feature vectors are transformed into a representation that allows robust and fast comparison of feature vectors while reducing the storage requirements. This operation results in a ranked list of matching images with the best match appearing at the top of the list and containing the largest number of

29 URL `https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.Series.str.contains.html`.

matching visual regions with the query image. To further improve the quality of search results, the ranked list is re-ranked based on geometric consistency between the query image and the initial search results. **Fig. 10** shows a sample of the top matching result where the green lines depict correspondences between the detected elliptical regions in the query image (left side) and the matching result (right side) from the database. Notice how the software is able to match corresponding regions even when a section of the illustration (i.e. the text "ESOPVS") is removed or occluded in the match image.

The VISE software builds on the software code developed by Relja Arandjelović during his post doctoral research at the Visual Geometry Group (VGG). The research underpinning different components of the VISE software is described in his DPhil thesis.[30] An early version of this software was also used to power the visual search functionality of the ImageMatch and ImageBrowser components of the Bodleian Broadside Ballads Project.

Table 1 Attributes of descriptive metadata associated with the 15th-century printed illustrations present in the 15cILLUSTRATION database. The descriptive metadata are defined manually by research scholars

Attributes of Descriptive Metadata	Description
Artistic_style	Synthetic description of the style of the woodcut, i.e. 'Italian | Venetian'; 'German'; etc.
Date_that_the_image_was_made	E.g.: '21/10/2018'
Folio	Where the image is found in the book, e.g. 'h7*r*' if the foliation is printed or '[h7*r*]' if the foliation is inferred
Iconclass	Iconographic elements found in the image, listed with their ICONCLASS codes
Internal_number_of_object	A progressive number which distinguishes within each edition all the centres ('c1', 'c2', 'c3', etc.), borders ('b1', 'b2', 'b3', etc.), diagrams ('d1', 'd2', 'd3', etc.), and initials ('i1', 'i2', 'i3', etc.). This combination allows to know not only the number of impressions contained in each edition, but also the number of woodblocks used, excluding repetitions

30 Arandjelović, *Advancing Large Scale Object Retrieval*.

Keywords	A synthetic description of the main figurative elements of each image, using keywords
Name	Name of the cut, consisting in the unique identifier of the picture (ISTC_MEI_foliation) plus the specific indication of the type of cut, e.g. 'ia00151000_02011231 a7*v* bottom border'
State_of_conservation	Synthetic information on whether the state of conservation of the block is good / worn / broken
Type_of_cut	Specifies whether the woodblock described is a central vignette, a border, a diagram or an initial
Owner_of_the_image_Library	The library owning the copy of the edition from which the image was taken
Owner_of_the_image_Scholar	Name of the scholar who contributed the image (if applicable)
Owner_of_the_description_Scholar	Name of the scholar who assigned the metadata

8 Conclusions and Future Work

In this paper we presented the 15cILLUSTRATION, which is an online database of 15th-century printed illustrations that supports both visual and textual metadata search. The 15cILLUSTRATION database has the potential to address many research questions related to the circulation of images, printers' practice and development of the iconographic tradition for editions printed in the 15th century. Throughout the article, we illustrated the different types of research questions which can be addressed using the 15cILLUSTRATION.

Furthermore, the 15cILLUSTRATION represents a positive and successful example of how collaborative efforts between researchers in the fields of humanities and engineering science can lead to the development of tools that have widespread applications in answering novel and challenging research questions in several academic disciplines. These fruitful forms of collaboration can also inspire further positive outcomes, and in fact the tools originally conceived and created as a part of 15cILLUSTRATION have now become valuable research supports for many other projects as well. For instance, the VIA image annotation software is now being used by academic re-

searchers in the Humanities, Art History,[31] Zoology, Geography, Anthropology, Engineering and other fields; and the VISE software is delivering visual search functionality to many other projects in Humanities such as the Iberian Book Project.[32]

At present, the 15cILLUSTRATION contains around 5,000 images. We are actively seeking to expand the coverage of the database by receiving contributions in the form of images and text metadata. Our aim is to improve this collection by inviting more institutions and scholars to contribute images to the database. In this respect, we have already agreed to collaborate with Marieke van Delft from the Koninklijke Bibliotheek in The Hague to incorporate in the 15cILLUSTRATION database a set of images printed in incunables from the Low Countries. Furthermore, we are also collaborating with Dr Laura Carnelos (University of Reading) and Dr Barbara Tramelli (Equipex Biblissima, CNRS/CESR) to include in the 15cILLUSTRATION database also images printed in the 16th century. It is a fact that woodblocks and iconographic themes travelled beyond geographical and chronological boundaries. In fact, many interesting examples of reuse and circulation of woodblocks originally issued for editions printed before January 1501 are actually found in much later editions and in some cases the existence of entire illustrated incunable editions, now lost, has been inferred from the appearance of their illustrations in the 16th century and later.[33] As is well known among scholars, the chronological line which was drawn to differentiate incunables from the rest of early-printed material, particularly before 1550, is purely conventional and mainly meant to facilitate surveys, research developments, and scholarly discussion.

One of the main challenges in this case is to find ways to uniquely associate each image with bibliographic metadata pertaining to the respective 16th-century printed edition and copy (similar to ISTC and MEI databases for the 15th century). Nonetheless, we are particularly keen on the inclusion in the 15cILLUSTRATION also of printed illustrations found in 16th-century editions. At present, the system allows the upload of the images only by VGG or 15cBOOKTRADE editors. In the near future, we would like to have a network of external editors which, through their own access credentials, can contribute images autonomously from their own devices.

31 Griffin, *Diagram and Dimension*.

32 URL `https://iberian.ucd.ie/`.

33 Among other cases, this hypothesis has been advanced for two illustrated editions of the *Vita Aesopi* recorded in bibliographical repertories. No copy of these editions remains today but some illustrations which are found in other 16th century editions portray subjects and scenes of the *Vita Aesopi*. Cf. also Davies, "A Tale of Two Aesops", 257-88, esp. 284 on their longevity.

We also aim to attract more contributions from scholars in order to improve the quantity and quality of the descriptive metadata associated with each illustration. For the time being, descriptive metadata can only be added to the images through the VIA tagging system before they are uploaded in the 15cILLUSTRATION. To make this process easier, we are currently exploring ways of upgrading the VIA image annotation tool to support collaborative annotation of images in the 15cILLUSTRATION database by granting access to scholars all over the world who are interested in contributing to 15cILLUSTRATION. Again, such an upgrade to VIA will not only be useful for this project but also has immense value for projects in other disciplines such as Zoology, Medicine, History of Art, Geography and Engineering.

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