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Malte Rehbein, Patrick Sahle, Torsten Schaßan

unter Mitarbeit von | in collaboration with

Bernhard Assmann, Franz Fischer, Christiane Fritze

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The Palaeographical Method Under the Light of a Digital Approach

Arianna Ciula

Abstract

This paper has the twofold aim of reflecting upon a humanities computing approach to palaeography, and of making such reflections—together with its related experimental results—fruitful at the implementation level. Firstly, the paper explores the methodological issues related to the use of a digital tool to support the palaeographical analysis of medieval handwriting. It claims that humanities computing methods can assist in making explicit those processes of the palaeographical research that encompass detailed analyses, in particular of the handwriting and, more generally, of other idiosyncratic features of written cultural artefacts. Thus, palaeographical tools are to be contextualised and used within a broader methodological framework where their role is to mediate the vision, the comparison, the representation, the analysis and the interpretation of these objects. Secondly, the paper attempts to evaluate the experimentations carried out with a specific software and, in so doing, to test a humanities computing approach to palaeography at a practical level, so as to direct future implementations. Some of these implementations have already been carried out by the current developers of the application in question with whom the author collaborates closely, while others are still in progress and in need of future iterative refinements.

Zusammenfassung

Der Beitrag verfolgt ein doppeltes Ziel: Einerseits will er den fachinformatischen Zugang zur Paläographie allgemein reflektieren und andererseits, zusammen mit der Vorstellung von Ergebnissen einschlägiger Experimente, diesen Zugang in konkreten Anwendungen fruchtbar machen. Als erstes untersucht der Beitrag deshalb den Nutzen digitaler Werkzeuge zur Unterstützung der paläographischen Analyse mittelalterlichen Schreibens. Er kommt zu dem Ergebnis, dass fachinformatische Methoden dabei helfen, genau jene Prozesse paläographischer Forschung explizit zu machen, die Detailanalysen einschließen. Dies umfasst insbesondere die Analyse der Handschrift oder, allgemeiner, die Analyse von einmaligen Merkmalen schriftlicher kultureller Artefakte. So können paläographische Werkzeuge kontextualisiert und in einem weiteren methodischen Framework genutzt werden, wo sie eine Vermittlerrolle zwischen dem Aussehen, dem Vergleich, der Wiedergabe, der Analyse und der Interpretation dieser Objek-

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te übernehmen. Zweitens versucht der Beitrag Experimente zu bewerten, die mit einer speziellen Software durchgeführt wurden. Dabei wird der fachinformatische Zugang zur Paläographie auf einer praktischen Ebene erprobt und auf zukünftige Implementierungen hingearbeitet. Einige der Implementierungen wurden bereits von den Entwicklern in enger Zusammenarbeit mit der Autorin des Beitrags realisiert, während sich andere noch in Arbeit befinden und weiterer kontinuierlicher Verfeinerungen bedürfen.

1 Written Cultural Heritage and Trans-Disciplinarity

Generally described as the study of ancient writing devoted to deciphering and interpreting historical manuscripts and writing systems, palaeography has its most evident application in the process of identifying date and provenance of a particular script. A task that may seem rather circumscribed if it wasn't for its object of analysis—an old manuscript, be it a fragment, a whole codex, a roll or just a line of script running on the spine of an old book—which introduces substantial factors of complexity to the case. If digital technologies are to assist palaeographers, reflections on the complexity of the cultural artefacts under study are therefore indispensable. The identification of possible critical processes within the palaeographical method is also crucial.

Palaeography is by no means the only protagonist on the stage of disciplines that study the written heritage through its cultural artefacts; as stated by Julian Brown the scene is much richer:

> Palaeography means, in the strict sense, the study of ancient handwriting, and its basic objects are these: first, to read ancient texts with accuracy; secondly, to date and localize their handwriting. […] The questions that palaeographers try to answer about a book are these. How, when, where, by whom and for whom was it first made? How has it been altered since? Who have owned it and used it? […] You will understand that a palaeographer has to do his work on script and books with one hand. The fingers of the other must all be reserved for putting into a wide and appetizing range of different pies, from philology to the history of art. (Bately, Brown, and Roberts 17)

In less metaphorical terms, palaeography cannot proceed without sharing methods, tools and outcomes with co-disciplines such as epigraphy, codicology, philology, textual criticism—to name but a few (see Figure 1 for an attempt at representing these disciplinary clusters).[1]

[1] It is interesting to note that, in the past, palaeography has struggled to be recognised as a discipline against the conviction that its role was rather the one of "handmaid", simple instrument of, in turn, history, philology, literature, art history, archaeology, epigraphy, and diplomatics. Quoting Julian Brown once

Thus, inter-disciplinarity or trans-disciplinarity is a framework that it is not possible to prescind from, when it deals with the design of a tool or a set of tools to support the analysis and interpretation of a written object.

Indeed, according to Boyle (xv) 'integral palaeography' is the study of the script as intimately related to the history of the object that bears it. Therefore, besides the script itself, a manuscript is studied through other clues to its making, its functions and uses, its philological sources and textual tradition, its provenance and biography. The clues are multiple: the development of the various crafts involved in the manufacture, the notes made by scribes or illuminators, the indications borne, for instance, by liturgical texts, such as kalendars and litanies, the history of provenance and textual tradition, the factors of decoration; all the above are valuable guides to be variously interpreted.[2]

Therefore, independently from its more or less limited scope, the more any digital tool or resource—being it a digital facsimile of a manuscript, an application to segment letter forms, a digital edition, or an electronic publication of other kind—can be integrated within an environment where complementary material is also accessible, the more it becomes exponentially useful to the palaeographer.

Moreover, if we agree with Ginzburg that the humanities in general deal with "minute investigations of even trifling matters, to discover the traces of events that could not be directly experienced by the observer" (1989, 103), a tool that supports palaeographic research and its conjectures should make explicit those processes of the palaeographical method which apply to detailed analyses of individual entities, so as to facilitate broader intellectual operations (or scholarly primitives, as described by Unsworth) involved in investigations of this sort: analyses, comparisons, and classifications.

2 Quantitative and Digital Palaeography

Despite being very much debated in the history of the discipline as non-orthodox methodologies,[3] statistical and mathematical approaches have been applied in palaeography in the past.[4] More recent sporadic attempts have been made to develop or adapt computational tools to support palaeographical analysis.[5] However, compared to the

more: "Palaeographers, like scribes, were useful; […] but not much was expected of them, and if they contributed to the progress of history and philology, it was only as the tools of better men." (Bately, Brown, and Roberts 17).

[2] Indeed, palaeographers treasure any visual representation of the manuscript sources under study and are eager to see more comprehensive image collections of such material made available and freely accessible in electronic form. For a recent discussion on the utility of digital resources for palaeographers see Dutschke.

[3] See in particular Poulle, D'Haenens, Ornato, Costamagna et al.

[4] See, for instance, Gilissen, Colloques Internationaux du CNRS, and Gumbert.

[5] See McGillivray, Moalla et al., Terras and Robertson, Terras, Stokes, and the following digital resources: CEEC, CDFP, EPPT, MANCASS C11.

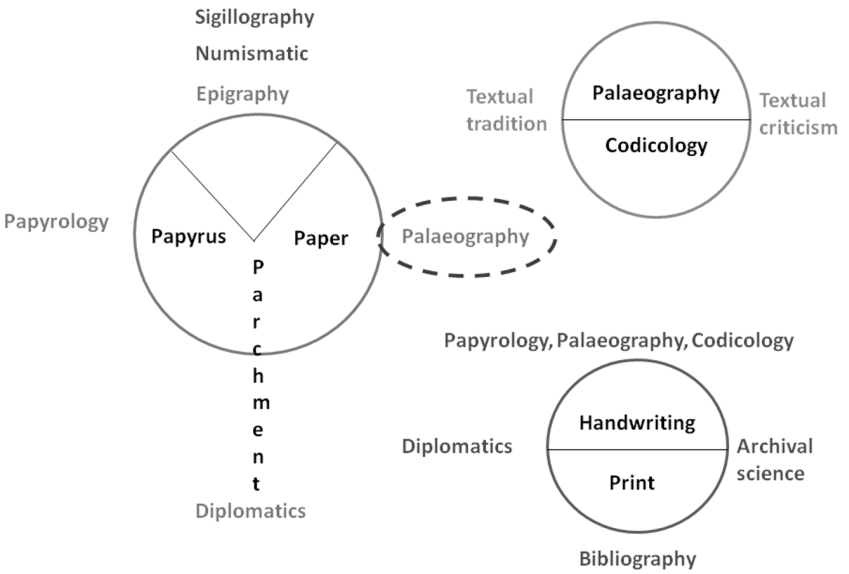

Figure 1. Disciplines that study the written cultural heritage (©Agati; note that the original chart was coloured, translated from Italian to English and slightly modified by the author).

state-of-the-art, the approach presented here is still characterised by a certain novelty and although in need of numerous improvements, has contributed to push forward the current developments of the computing application SPI (System for Palaeographic Inspection), the first design of which dates back to the 1990s.

The software in question (see Figure 2 for a drawing of its architecture and the interaction between its modules)—developed at the University of Pisa (Aiolli et al.) and currently being updated and improved at the University of Padova[6]—and its application to a specific corpus were described and discussed by the author in previous publications (Ciula 2003-2005).[7]

[6] The team of students in Computer Sciences at the University of Padova (Italy) includes Marco Dal Monte and is supervised by Professor Fabio Aiolli.

[7] The computing components of SPI were carefully tested and subjected to technical evaluation by its developers. However, the application had not beeen tested on a palaeographical corpus before the research project conducted by the author and summarised here and elsewhere (Ciula 2003-2005). The experimental use of SPI on a set of manuscripts was carried out as part of the author's PhD thesis (Ciula "Paleografia e

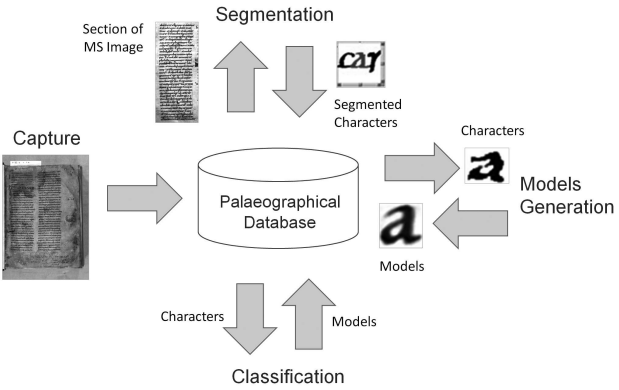

Figure 2. Architecture of Software for Palaeographic Inspections (SPI) developed at the University of Pisa (originally published in Ciula "Digital palaeography: using the digital representation of medieval script to support palaeographic analysis").

However, it is necessary at least to summarize briefly this research project which consisted in the following phases: (a) scanning of sample leaves of around forty codices held at the public library of Siena (*Biblioteca degli Intronati di Siena*); (b) image pre-processing for the insertion of the digital images in a relational database—which is the core component of the SPI software;[8] (c) segmentation of the relevant letters and ligatures (see Figure 3); (d) automatic generation of the letter models.

This approach of digital palaeography consists both of the process of preparing and collecting image data and, more innovatively, of the interpretation supported by the letter models (see Figure 4). The data collection was based on specific criteria to guarantee consistency across the chosen set of manuscripts. After the choice and definition of a palaeographical corpus took place, the following stages had to be thoroughly planned and documented: (1) definition of the digitisation criteria; (2) refinement and evaluation of the segmentation into letters and ligatures; (3) setting of the parameters for the letter model generation.

The recent but dense history of undertakings in manuscript digitisation and in image pre-processing for machine learning purposes,[9] especially the pattern recognition studies—some of which are at the base of the development of optical character recogni-

Informatica") on Manuscript and Book Studies (*Scienze del Libro*) at the University of Siena (Italy) completed in June 2005.

[8] The images were captured at a resolution of 300 dpi and archived in TIFF format before being converted to bitmap, cropped into sections corresponding to columns of handwriting when possible, and loaded into the application.

[9] For an introduction see Bunke and Wang.

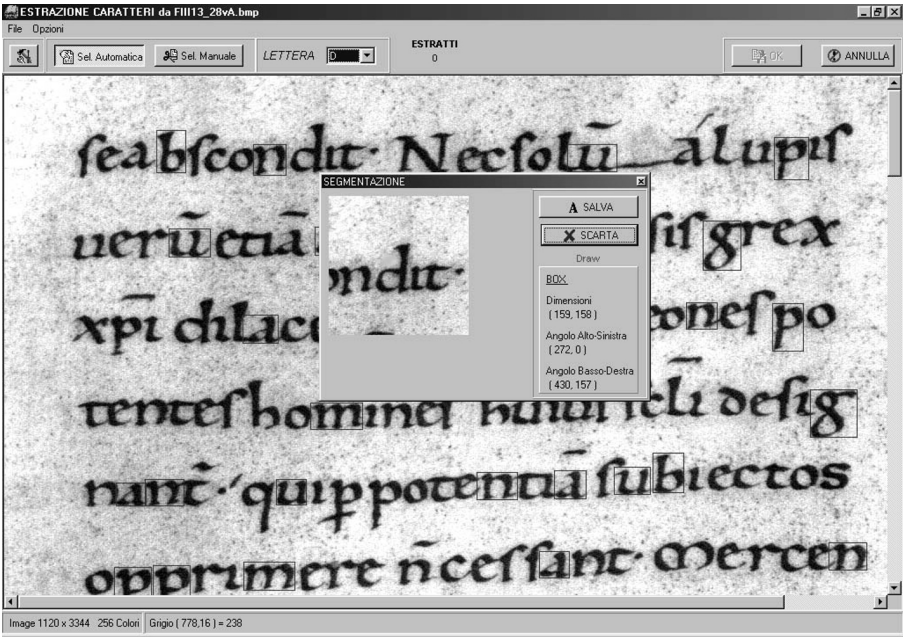

Figure 3. Example of segmented letter *d* within the SPI segmentation module.

tion systems known as OCR—served as background and supported the decisions while gathering palaeographical data.

On the other hand, the interpretative phase based on the analysis of the letter models and their automatic clustering has required insights into a much more established tradition of *doing* palaeography.[10] The comparison of types of letterforms—which is the main objective of analytical palaeography—has not effectively been supported so far by any tool. Therefore, the major challenge was represented by the attempt to integrate and support the palaeographical method within a digital humanities (as defined by McCarty 2003, 2005) research approach.

The experimental study has been carried out on a corpus of manuscripts written in different Caroline scripts, dating back from the tenth to the twelfth century and almost in every case certainly localisable in the area around the city of Siena in Tuscany or,

[10] On disquisitions around the palaeographical method see Costamagna, Pasquale, Ginzburg, Petrucci, and Supino Martini. See also Davis' paper on the supposed differences and commonalities between the palaeographical method and forensic document analysis.

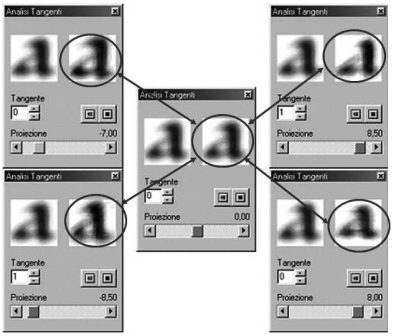

Figure 4. Example of model and dynamic graphical variations for the letter *a* as generated by SPI.

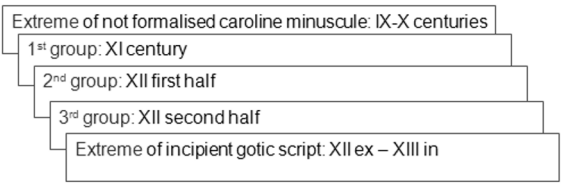

Figure 5. General palaeography of the corpus before the experimentation carried out with SPI.

more generally, in central Italy.[11] The direct results of the study—which consist mainly of a reclassification of the palaeographical corpus under examination as summarised in Figure 5 and 6—are thus based on the analysis of these specific occurrences of the Caroline minuscule and, eventually, on the regional evolution of the script. They provide a reorganisation of the corpus and of the script variants based on an integrated approach of computational and traditional palaeography.

2.1 Processes of Abstraction

However, the aim of this paper is to overtake the idiosyncratic interpretations related to this particular research project, so as to draw a wider picture. What are the methodological implications that arise from the unusual combination of analogical methods of letterforms description with the constraints and added values of a digital tool? It is worth noting that two main processes of abstraction had to be undertaken so as to make use of the abovementioned tool: firstly, the process of defining a taxonomy, a

[11] The initial categorisation is based on relevant catalogues and previous literature; in particular, see Avitabile et al., Garrison, Klange Addabbo, Cao et al.

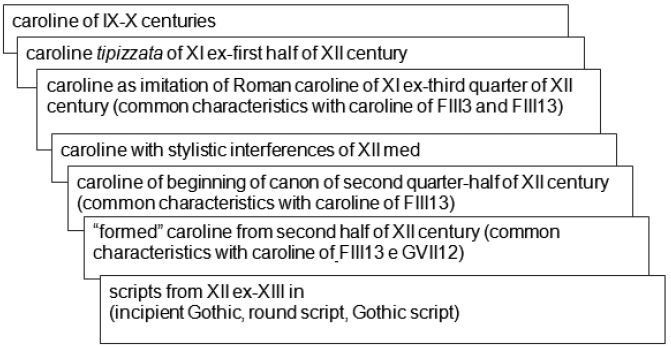

Figure 6. Re-organised palaeography of the corpus after the experimentation carried out with SPI (relevant manuscript signatures are used as references).

nomenclature to abstract from and *reduce* the 'polyphony' of individual manuscripts; secondly, the process of manipulating the digital images to abstract from and reduce the original morphology of specific letters.

The former process is certainly part of the traditional palaeographical method and was very much facilitated by the use of this tool, where every single graphical instance is decomposed into models that can be described one by one. However, beyond verbose narratives, a 'descriptive protocol' for such an annotation—comparable to the "analysis by chart method" used in forensic studies (Davis 258) —is not structured or configurable yet within the tool. On the contrary, the latter process consists mainly on a graphical approximation, and this is where the strength of the tool can be tested: SPI digests images and creates graphical digital letter models out of them, but, once more, not without technical limits as dealt with below.

2.2 Integral Palaeography

As stated above, the methodology behind this doctoral thesis was inspired by the concept of integral palaeography. Therefore, the corpus of manuscripts was analysed by concentrating both on the centrality of script—that is to say on the evolution of the Caroline minuscule in a localised region, on its relations with other styles, in particular on the influence of Roman book production—, as well as on the material culture aspects of the manuscripts, with the aim of integrating the digital models and the clues to their context and provenance as much as possible. In brief, this was achieved through the study of various characteristics of codicological and contextual nature in connection with the minute observation of the handwritten folia and of their mise en page. Indeed,

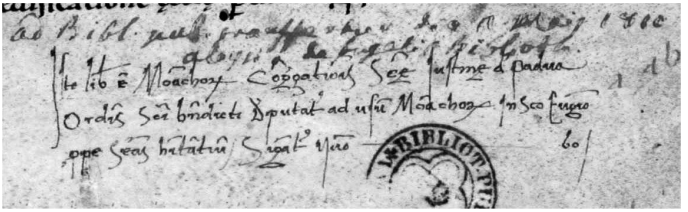

Figure 7. Codex FV21, Biblioteca Comunale degli Intronati (Siena, Italy), 1r. Three strata of information coexist here: the XV century note of possession (Monastery of S. Eugenio—Siena) in black ink, the XIX note of acquisition by the public library in red ink and the current stamp of the library.

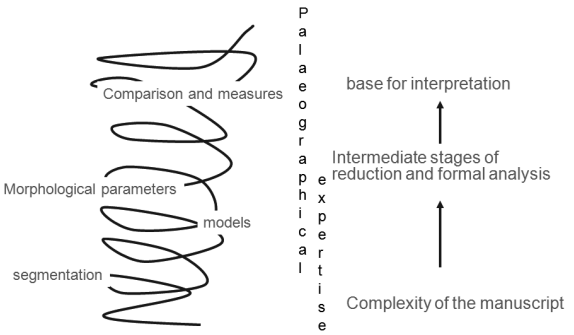

Figure 8. Representation of the intermediate stages of analysis leading towards the integration of the material history of the manuscripts and the digital models of its letter forms.

some of these observations have led towards the patrimonial contextualization of some of the codices (see Figure 7). It could be said that throughout the research process as supported by SPI, the complexity of the manuscript object was filtered through intermediate stages of reduction and formal analysis, so as to facilitate further deconstructions of the corpus eventually leading towards intepretative speculations (Figure 8). These intermediate stages of abstraction—namely, segmentation process, model generation, setting of morphological parameters, comparisons and measurements—are carried out while using the tool, but are not comprehensively and systematically supported by the tool itself.[12]

[12] As anticipated, the development of the tool in question was interrupted and has only recently been reconsidered and planned in collaboration with a team of computer scientists now based at the University of Padova (Italy).

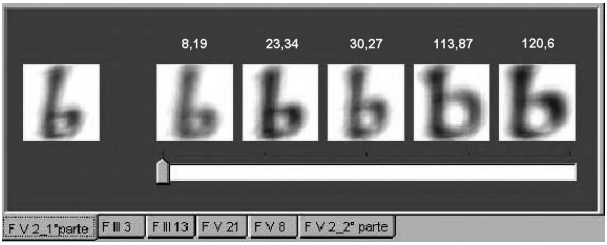

Figure 9. Example of the use of the diagram tool within SPI to compare various model of b in quantitative terms.

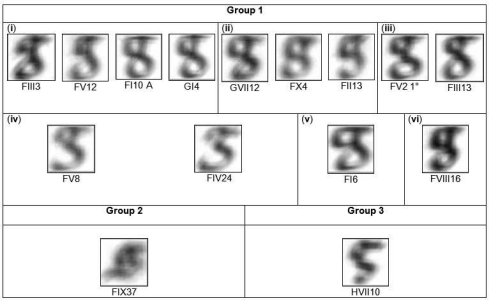

Figure 10. Categorisation of some digital models of the letter g.

2.3 Quantitative and Representational Value of the Models

The main powerful function of the SPI tool is its ability to compute graphical *features*. Indeed, the graphical models are digital in the sense that the morphological characteristic of the letter forms they encompass are expressed in quantitative terms. Thanks to the so called tangent-distance algorithm, the models can be compared numerically with the use of different tools internal to the system (the diagram in Figure 9 is one example of these).

Furthermore, the models bear a representative value. They incorporate the script or hand variants visually by making these variations perceivable to the eye. Therefore, the palaeographic analysis is forced to be anchored to the models as visible abstractions, *perceptible* prototypes (see Figure 10). The relativity of the research is then balanced by a somehow strengthened rigour in the method: the traditional formal-analytic approach is reinforced and modified by the use of a computing tool.

The question of the development of better tools is then: How much of the palaeographical expertise can the tool or its modules incorporate? If the use of the tool itself

contributes to define, refine and enrich the underlying method, to what extent can this process be fed back into the tool and make it more sophisticated? In other terms, with respect to methodological issues, the room for improvement of both a new method of digital palaeography and a more sophisticated tool to perform it, lies in the gap between what is or can be formalised in line with the traditional palaeographical method and how the use of the tool forces to formalise further.

3 Overcome Limits and Future Perspectives

Such formalisations not only need to be technically robust and viable, but—in relation to what is stated above about the nature of palaeography as a cooperative discipline—they also need to account for some possible integration with other computational approaches to the study of manuscripts.

For instance, it would be desirable to be able to envisage a palaeographical module—consisting of functionalities such as the ones encompassed by SPI—within a wider and much more debated framework: the development of tools, including web services, for the creation and annotation of digital editions (Bozzi; Burnard, O'Brien O'Keeffe and Unsworth; Ciula and Stella; Iacob et al.; McCarty 2002; McGillivray 2006; Robinson).

To this end, it is necessary to make some more technical considerations regarding the SPI application and its recent developments. Indeed, besides the need for a methodology to be fairly documented, so as to be useful to other case studies, there are two sets of issues and challenges to consider: the ones already reported and dealt with in collaboration with the current developers of SPI in its bright new vest as JSPI (Java System for Palaeographic Inspections), and the ones still to be tackled. The following comments attempt to merge these and report on some of the overcome limits or first solutions to be refined further in connection with the issues still to be tackled for future development.

1. Documentation and transparency
   The alpha version of JSPI is written in Java, supported by MySQL and by other standard technologies which are well established, open-source and as such reliable and sustainable for the future. In addition, the release itself is accompanied by a descriptive handbook (written in Italian and currently being translated into English with the possibility of making it available in other languages once the application has been publicly released) which is both user as well as developer oriented.

   With respect to transparency, the interface of JSPI tends to be more informative than SPI; for instance, the window which visualizes the performed segmentation of a character also provides the values of the relevant features, such as coordinates and circularity, being measured on the pattern under study (see Figure 11), while the

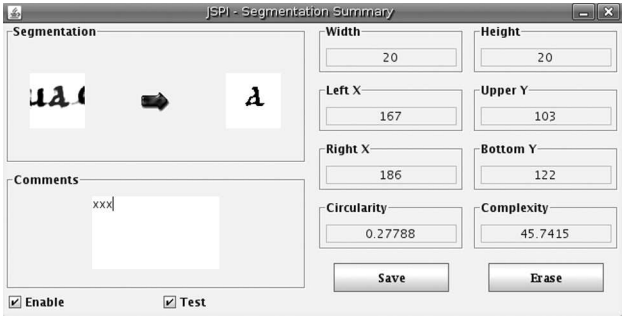

Figure 11. JSPI window which visualizes the features being measured on the pattern being segmented.

dendrogram view has a mouse-over facility to visualise information on the patterns being examined.

2. Use of standards, extensibility and interoperability
   In addition to what was mentioned under point (1) in relation to the use of standard programming languages and tools, it should be noted that the licenses of the whole set of technologies employed within JSPI allow free use.[13] This means that anybody could install the environment suitable for the software to work for free: a non-commercial and rather attractive solution for any palaeographer or humanities scholar.

   Furthermore, JSPI is platform independent and therefore overcomes the main limit of its predecessor SPI, which could operate only within a Windows 98 platform.

   In addition, a potential user-developer could modify the code of the JSPI software by downloading the Java Development Kit known as JDK and, by doing so, *extend* the functionalities of the application. Future developments will explore the possibility of incorporating the use of additional standards for the modelling of the data handled by the application (see point 3 below).

   The use of MySQL to manage JSPI in its current alpha release was the strategy adopted to move towards the implementation of a full web service in the future. Indeed, the choice of MySQL as DBMS (Database Management System) implies already the concrete potential of operating in a networked environment, where the relational database could live in a remote server. This means that JSPI users could access this centralised database within a network, and in doing so, share the same data, for instance, by visualising the same manuscript images, letter models, and diagrams.

[13] This applies to the IDE (Netbeans) as well as to MySQL and the libraries (Java, Jama, and MySQL JDBC connector).

3. Refinement of SPI functionalities
   a. Image pre-processing: better filters for image pre-processing are required to overcome difficult segmentation cases when the manuscript handwriting is damaged or particularly complex to isolate;
   b. Image processing: as its predecessor, JSPI accepts only bitmap of 24 RGB values at the resolution of 300 dpi, while more flexibility or automatic conversion procedures could be implemented;
   c. Segmentation: the grid from where to select letters and ligatures for segmentation is extensible within JSPI, so that a user can define and extend as appropriate the 'alphabet' or set of letterforms according to the style or hands under study; moreover, besides the possibility of performing the segmentation manually, which was an option also available within SPI, the choice between multiple segmentations is offered to the user.
   d. Textual description
      i. Descriptive encoding: some fields within the application could be refined to allow for complex expressions, for instance of date, and descriptions possibly to be exported by using a standard such as the Guidelines of the Text Encoding Initiative (TEI Consortium);
      ii. Connection between images and text: again, the possibility to export the association between descriptions of specific palaeographical properties and the coordinates within a manuscript image in a standard format such as the encoding proposed by the TEI facsimile module or SVG (Scalable Vector Graphics) would be a step towards dealing with this challenge;
      iii. Search functionalities: in relations to the two points above, the search within the relational database which constitutes the backbone of JSPI could be structured and visualised, so as to allow for more sophisticated queries to be performed, saved and exported.
4. Graphical interface
   JSPI interface is now in English (SPI was in Italian) and it incorporates more elegant graphical solutions compared to those offered by SPI. It is, however still in need of further tests and improvements to become more usable and accessible.

4 Conclusions

In conclusion, despite various limitations, the specific research carried out with SPI on the palaeographical corpus from Siena assisted both in reorganising the corpus of manuscripts under study, in leading the work of computer scientists in improving the development and design of the application, and in reflecting on broader methodological issues.

If there are any successes to report in relation to this undertaking, they are mainly due to the benefits of a collaborative endeavour between the author as stubborn digital humanist practitioner and the computer scientists as long-sighted developers who, beyond a dusty and mysterious discipline, glimpsed a field in which it was worth investing. On the other hand, if there are failures besides the ineptitude of the author, these are to be attributed to the difficulty of maintaining a project, which was never formally funded, across countries and disciplines. It is just one of the kind of interdisciplinary projects which are needed in the humanities, but for which sustainable funding models are still lacking.

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