WHY THE COMPACT DISC WAS NOT A REVOLUTION AND «CITYFISH» WILL CHANGE TEXTUAL SCHOLARSHIP, OR WHAT IS A COMPUTATIONAL EDITION?

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Abstract

The digital scholarly editions that textual scholars and digital humanists produced for over two decades have often been accompanied by claims about their revolutionary nature. Technological innovations are prone to induce such claims, as the case of the compact disc audio carrier exemplifies. However, on closer inspection we are hard pressed to identify the revolution that such innovations bring about. Arguments that textual scholars have put forward to claim fundamental differences between print and digital scholarly editions turn out to be weak. Some, therefore, claim that in fact no essential changes exist between print and digital text, nor between print or digital textual scholarship. However, none of the arguments takes into account the most striking difference between print and digital text, which is the performative potential of the latter. Digital text is endowed with a performative aspect through software code. However, current digital scholarly editions adhere almost exclusively to a representational philosophy in which the idea of text as a static materialized object is unaltered digitally remediated, that is: they are mostly static digital objects mimicking static print books. Perceived primarily as infrastructure underpinning digital scholarly editions, executable program code has until now largely been ignored by textual scholarship as a methodological means. Code, as will be explained, is the very embodiment of the ontological difference between print and digital text—it is text performing. This ontological shift and the emergence of a performative digital textual heritage do justify explorations of the methodological affordances that code creates for textual scholarship. As

an example of such an exploration the idea of the computational scholarly edition is introduced (as opposed to the "merely digital" scholarly edition) and a tentative implementation is presented. Finally it is argued that, rather than to extradite them, it is more productive to embrace digital and computational exploratory niches in textual scholarship.

Introduction

In response to recent critique on the contributions of digital scholarship to the field of textual criticism and philology, this contribution starts out with a consideration of the revolutionary claims that have been associated with digital scholarly editions. It argues that although technological innovations are often trumpeted as revolutionary, actual changes are modest at best. This is also true in digital scholarly editing as some have claimed. However, instead of concluding that digital scholarship has no import for textual scholarship as such—which has been suggested—this contribution argues that current digital scholarly editions have ignored the most differentiating aspect of the digital environment and of digital text, which is their performative nature. Digital scholarship will have little in the way of methodological innovation to offer the field of textual scholarship as long as digital scholarly editions remain mere mimetic icons of non digital texts. But embracing the performative aspects of digital text may yield more interesting methodological advances and affordances. A consideration of the performative aspects of digital texts clarifies how digital text is ontologically different from print or manuscript text. It is then argued why it is useful for a field like textual scholarship to have a niche activity in exploring the affordances of emerging digital technology. Finally an example of a work-in-progress proof-of-concept computational scholarly edition is presented.

Doubtful Revolutionaries

New technologies have a strong propensity to associate themselves with the words “revolution” and “revolutionary”. Some ten years after the

compact disc technology was engineered and two years after it was introduced to the consumer market, the 1984 December edition of the audiophile magazine *Audio* carried at least three adverts for compact discs players calling compact disc technology "revolutionary". Sony Corporation caps the list with three mentions of the revolutionary character of the technology in one ad (*Audio*, 1984:77). The "leader in digital audio" claims it "revolutionizes the compact disc revolution" in 72 points bold typeface.

Stories on how revolutionary things were exactly also tend to linger on. When the compact disc began its descent into oblivion, about to be all but replaced by USB sticks, portable media players like the iPod, media players on personal computers, and online streaming services like Spotify, the BBC ran a story on the occasion of the 25th anniversary of its introduction reminding the reader how revolutionary the technology was. Jacques Heemskerk, a senior engineer of the development team at Philips—the company that together with Sony engineered the compact disc technology—is quoted as saying that the members of his team "knew they were building a revolutionary product" ("Compact Disc Hits 25th Birthday" 2007) . "It was revolutionary in many fields - the optics were new, the disc was new. At the start of development there wasn't even a laser that would work well enough for our needs."

Technological revolutions are often self-proclaimed. Digital humanities as a field also generates strong overtones of a revolutionary ideology, as Julianne Nyhan and Andrew Flinn have shown (Nyhan and Flinn 2016). In textual scholarship we find proponents of digital technology who claim a revolution or wholly new models for the creation and interaction with scholarly editions (e.g. Siemens et al 2012). In a similar vein Robinson and Taylor (1998) described the revolutionary potential of the CD-ROM for textual scholarship, only to declare its obsolescence due to Internet publishing at the end of the very same article.

Nyhan and Flinn also showed that merely calling something revolutionary may not always be helpful. The intention in general is probably benign and innovators just want to signal "Hey, we're doing something new and exciting over here! It will benefit us all!" However, stressing the new and disruptive methodological affordances that new

technologies may create, can also inspire caution, distrust, and resistance—certainly in people who enact a form of scholarship, such as philology, that goes by carefully constructed norms and conventions that have developed over a long period of time.

Proclamations of a bright new future tend to inspire reasonable doubt in critical scholars, as we may gauge from Barbara Bordalejo, whose skepticism was incited by, inter alia, a more recent publication from Peter Robinson, titled "The Digital Revolution in Scholarly Editing" (2016). Robinson's article can almost be called anti-revolutionary. Although he is a well-known advocate of digital scholarly editions (Robinson 2004), this article actually undercuts a number of revolutionary claims that so far had good PR in the scholarship community. Robinson argues, for instance, that neither increased accessibility to text and facsimiles nor the creation of archive-like editions presenting multiple sources of the same text can be called truly fundamentally revolutionary. Bordalejo follows much of Robinson's argument, adjusts and expands it (Bordalejo 2018). Both Robinson and Bordalejo object to contentions by Elena Pierazzo (2011) and Patrick Sahle (2016) that digital scholarly editions did introduce fundamental changes to practice and product. Pierazzo claims, amongst other things, that digital scholarly editions change substantially the heuristics and hermeneutics of scholarly editing. But indeed on closer inspection it would be hard to determine that anything has changed as to the scholarly inference and decision process. Even if the production process may involve several digital elements and technologists, the scholars retain the responsibility for all scholarly matters concerning the edition—of which, for instance, the TEI-XML as a digital element is a mere registration with unclear new hermeneutic affordances, if any. Bordalejo expounds how, in fact, all aspects of editions that have been perceived to be a result of scholarly editions becoming digital either simply mirror the same aspects in the analogue situation or are, indeed, very much rooted in the non-digital context and history of scholarly editions. Stemmatological techniques, for instance, pre-date any digital engagement with texts. Referentiality is also not a property of texts that was suddenly realized *ex machina* by the invention of hypertext. And collation has a history well before the computer came along.

Accessibility and the idea of the edition as an archive—i.e. of all witnesses, instances, paratexts and metatexts—are not functions of the digital scholarly edition per se. Accessibility has always been the very point of scholarly editing, and the idea of the archive was floated well in the context of the debate on print scholarly editions, as Bordalejo explains. Indeed, as a "first law" in humanities computing goes, the digital environment amplifies what are essentially already existing functions in the analogue situation (O'Donnell 2015). And these mere amplifications are often mistaken as revolutionary new affordances.

Bordalejo's reasoning is not meticulous in all instances. The fluidity of digital scholarly editions as treated by Patrick Sahle, for instance, is taken as the ability of digital scholarly editions to evolve over time, to adapt to changes in perspective, and to be updated in the case of errors or new information. Bordalejo's counter argument is that no large scale digital editions exist that are fluid in this sense, because updating digital scholarly editions is in most cases technically and economically risky and infeasible. Apart from the fact that such editions do exist—regular updates, for instance, occur to the Van Gogh Letters (Jansen, Luijten, and Bakker 2009)—the argument is rather circumstantial even though it is quite possible to show that this kind of fluidity is far from a digital prerogative. Bordalejo even points earlier in the same article to the work of McGann that claims this kind of fluidity as an essential aspect of what he calls "the textual condition" (McGann 1991, cf. also McGann 2004).

Notwithstanding some minor quibbles, the central thrust of Bordalejo's argument is convincing: the essential method of scholarly editing has in no way been fundamentally changed by the blessings of digital technology. Of course in certain respects scale and speed have changed. Phylogenetic stemmatology is a feasible real time technique because computers are so incredibly fast, but the principles have not changed and predate digital computing. Crowdsourcing may have changed the scale of teams working on transcription, but essentially the quality control and expertise that ensure the academic quality of any scholarly edition still reside firmly with the scholar. Nothing has changed, really.

Bordalejo's argument is directive, authoritative, and normative. The final paragraph leaves no doubt as to what adequate scholarly editing is and whom befalls the authority to determine so.

> Editors must continue to edit according to the principles of textual criticism, and not according to the dictates of the digital fashionistas: there is no such thing as digital scholarly editing. There is only scholarly editing, which can be published in print or digital format, but that remains the same discipline linked to meticulous historical-critical work carried out by textual scholars or under their direct supervision.

The feistiness of that ultimate paragraph is reminiscent of Robinson's antagonistic contention that "digital humanists should get out of textual scholarship" (Robinson 2013). These are claims to authority obviously: the prerogative to determine what a scholarly edition of sufficient quality is and how it should be made lies solely with expert textual scholars.

But there are problems with this claim.

Digital versus Computational

When is change revolutionary? What makes a revolution a revolution? Did we change the way we listen to music because of the introduction of the compact disc? One could argue that music is listened to in many more places than in 1982. But this change was not due to the compact disc. It happened mainly because of the introduction of other types of analogue music reproduction technology that people younger than about thirty years of age may not remember: the ghetto blaster (boombox) and the Sony Walkman (cf. Von Jungenfeld 2015; du Gay, Hall, and Negus 1997). The ability to listen to recorded music has essentially not changed since the invention of the phonograph in 1877, but the possibility to regenerate the sound of recorded music through some technology has had major and complex cultural impact, of which an expanding notion of personal music and individual listening, the decontextualization of music from its originating environment, and increased use of music as a social engineering tool are but some examples (Katz 2004; Clarke 2007). Counter to revolutionary claims, however, the compact disc in all of this was a relatively minor agent of change. It was merely a popular carrier of

sound and music for a while. And it did not even live up to its promises. It would, for instance, do away with some limitations and vulnerabilities of the vinyl record. Records could easily be scratched, leading to an endless repeat of a few beats of the recorded music. The compact disc also came with a promise that its digital recording and playback technology would reproduce music exactly as the musicians had intended it to sound, without noise or deformations. And then it turned out that compact discs were not quite as robust as claimed. They too scratched easily, leading to partially or wholly unplayable discs, and often a weird electronic tudtudtudtudtud-like high speed repetition of a few hundredths of a second of the music. What was worse: they corroded. At least vinyl records could sit safely for years in their large cardboard sleeves on a shelf. But even five years of storage might produce rusted and hole-riddled compact discs that did not play. On top of that it turned out that there were audiophiles who were not at all impressed by the compact disc's purported technological superiority. Soon the proverbial warmth and full-bodied sound of records gained a stubborn community of fans, and a retro movement even made the vinyl record production business blossom anew.

So no, not exactly a revolution at all. But there was a change. The compact disc was the first truly widespread popular carrier of a digital signal. And so the predominant inscription signal of music changed, from analogue to digital. Since that time the vast majority of audio signals are recorded as and regenerated from digital inscription. A revolution? In the sense that we still listen to music, no. And not in the sense that it is still musicians and composers who create music. On the level of registration and recoding, however, the compact disc resulted in an almost complete replacement of analogue signal in a matter of two decades.

A very similar thing has happened with text. The inscribed signal has changed. Veritably all text we see and read these days, that was produced roughly from the year 2000 onwards, is somehow the result of digital signal processing. The book one reads was written using a word processor, it was typeset on a computer, and printed by a digital offset machine or, increasingly, a digital printing machine. The texts and slogans on purses, on posters: same thing. Subtitles, traffic signs,

announcement boards, all contemporary text is somehow the result of digital processing.

Nevertheless it is hard, indeed almost impossible, to tell as an unsuspecting reader: text has changed. Like music it is still simply read and used in the same or very similar ways readers have been used to, but they read a different text. It is interesting in this respect that Bordalejo would call on Tanselle to claim the exact opposite:

> In the foreword to Electronic Textual Editing, G. Thomas Tanselle states that printed and digital editions are not ontologically different: in essence, they both are the products of a series of procedures used by textual scholars which culminate in the production of one or more texts.

That is true only at the very surface of text's existence. What binds all arguments in current textual scholarship on digital text and digital scholarly editions together, from Tanselle and Bordalejo to Pierazzo and Sahle, is that they continue to consider only the surface of text, its humanly visible part in its convenient human-readable disguise of glyphs on some medium. It has surprised me before how strongly digital scholarly editions are rooted in a mimetic representational philosophy (Van Zundert 2016a & b). All digital scholarly editions try to convey some page-like representation of the text they want to represent. In this sense digital textual scholarship is addicted to screen essentialism (Kirschenbaum 2004), even skeuomorphism. Alan Galey contents that textual scholarship by "nature […] resists the fallacy of screen essentialism, the tendency to essentialize digital text" and that instead it sees "at once both the signifying surface and what lies beneath" (Galey 2010). I would disagree. Textual scholars in my experience lack every bit of knowledge to see what lies beneath the screen text in a digital-technical sense. To the average textual scholar a computer screen is just another sort of page, and one writes on it with TEI-XML.

According to a strong representational philosophy, the useful contribution of digital technology to scholarly editing is that scholars can now represent a physical book with a text as a digital book look-alike on a computer screen with the print text described through TEI-XML. Obviously this makes much sense as long as one adheres to, for instance, McGann's ideas that scholarly editing is about the establishment of

philological fact and the creation of an archive of texts that testify to such facts (McGann 2013).

As long as textual scholarship stays safely in the realm of reproducing screen essentialism-based digital simulacra, Tanselle is completely right and there is no ontological difference. However, the representational philosophy is a grossly narrow conception of scholarly editing—even if the most popular one—and it ignores nearly all the digital aspects of digital text. It also preserves for scholars the convenient misconception that nothing much has changed, and that digital text is just another form of text that they should treat just as they always treated text. It is a gross underestimation of what digital text is, and its popularity shows painfully how serious the lack of knowledge is about digital text in the textual scholarship domain.

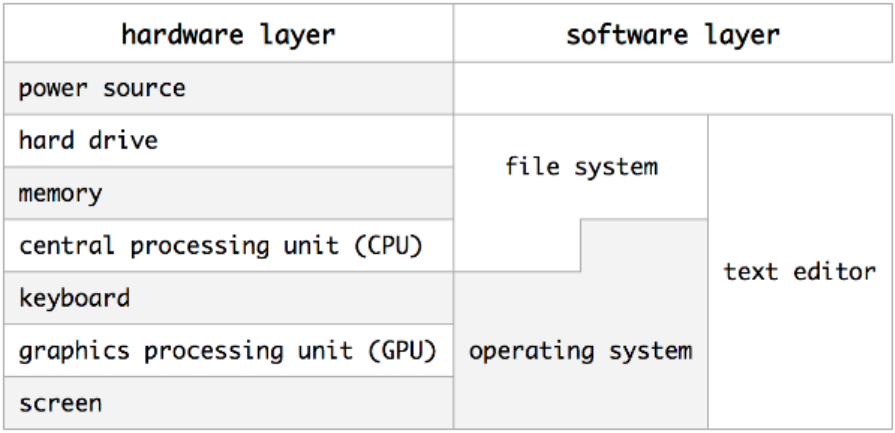
First of all: there is no such thing as plain text. Textual scholars using computers often seem to think that the characters they see are really materially there in the computer somehow. That if they see a text made of words and characters, that these characters really live in some file *as characters*. One may encounter a textual scholar already well versed, according to current measures, in digital approaches to text who knows that "plain text" is a best-practice choice to store text, as it will guarantee readability across platforms and independence of potential constraints from third party software. All that is true enough, but what it fails to appreciate is that any text textual scholars produce and use digitally is already dependent on a mesmerizingly complicated stack of digital hard and software that needs to interact quite precisely and flawlessly to make it even possible to see any characters on a screen.

When scholars see "text example" on a screen, they usually assume those characters are indeed somewhere in the computer. But what is in fact on a computer's hard drive is a series of differently magnetized microscopic spots, which are completely intangible to humans. The signal is far too weak and too small for humans to interact with. One cannot take a paperclip and feel where the strong and where the even stronger magnetized parts of the disk are to figure out what series of zeros and ones is represented. Because that is what these patches of magnetized disk represent: a digital signal. Of course there are other sorts of storage device—tape, SSD (solid state disk, or flash memory),

and so forth—but in all cases the recorded signal is inaccessible to the human senses. All these recording devices are small miracles of complex electronic technology, vastly more complex than any registration device that humans have ever used to inscribe any text.

But just the hard drive or another storage mechanism is obviously not enough to retrieve the text that is in a file. The full stack of technologies—*mutatis mutandis* some abstractions that I allow myself to keep things reasonably intelligible—that needs to be coordinated and work seamlessly together to be able to view even a plain text file as a human, looks like the 'stack' of technologies listed in figure 1.

FIGURE 1
A "minimalist" stack of technologies needed to read a digital text.



The layer cake of technologies in figure 1 is minimalist in the sense that these technologies are absolutely necessary to view any plain text file on a computer at all. Most digital scholarly editions of course exist not as plain text, but as digital texts marked up in TEI-XML. To view the edition as intended by the editor, a string of additional (software) technologies is usually needed: a web server, a web development frame work, XSLT, HTML, CSS, JavaScript, and a browser. Explanations of these technologies are held back to avoid wasting valuable article space.

But even the list will hopefully suffice to signal how much digital technology is actually required simply to depict a digital text in readable form.[1]

The salient point is that at no time in history was text as ubiquitously intangible to readers as it is today. Many technologies developed over time to register text: wax, parchment, ink, quill, pen, paper, libraries, the printing press, type writers, and so forth. But all forms of inscription have always been sensible or tangible to the human interpreter—even in particular circumstances where text was purposely hidden or obfuscated to exclude certain audiences, as when a cypher was used to limit readership, the signs of the encrypted message itself were visible to a reader.

The digital era is really the first age in which we use text on a daily basis that is just not visible to the eye or tangible to any of the other human senses in any way. Readers are completely dependent on intricate technology to view and experience digital text. An objection to this line of reasoning is often colloquially made, that with regard to text representation there is no difference between the digital environment and the modern electronic printing press. Both are tremendously complex technologies and a reader needs to know nothing about either to read the texts they produce. However, that is not a fair analogy. No author or editor uses an offset printing press to produce the notes, the initial draft, the final version, and the corrected proofread version of some scholarly work. But it is currently general practice to do so with a computer. So, indeed, it is the first time in known history that on a day-to-day basis scholars do comfortably register and read textual signs that cannot be directly perceived in any way by human beings.

Note that this is also not an iteration of the rather tired contention that digital text is all virtual and immaterial and therefore fundamentally of a different nature. Kirschenbaum's writings suffice to debunk these naive perceptions of digital materiality (Kirschenbaum 2008). But

[1] Note that this considers only a digital edition locally on a user's machine. Usually much more technology will be needed as most digital editions are retrieved over the Internet. With that come cables, DNS servers, TCP/IP, Routers, etc. etc.

materiality and tangibility are very different things. The intangibility of digital text for humans is not some newly unveiled fundamental property of text. It is a change of, well, tangibility. From tangible and perceptible to non-tangible and non-perceptible. Not a revolution. But still a change that forces us to pause and think critically about what this should mean for textual scholars, as it pertains to the very fabric of the matter they work with.

Of course it is also quite possible to just ignore this change and stay well within the representational paradigm, take that what is on the screen as the text, and claim that there are no problems, just scaled-up conveniences such as remote access and full text search. But how much sense does the choice make to equate the essence of a *digital* text with the surface that is depicted on a computer screen? How critically informed are textual scholars about the nature of digital text if they maintain that, essentially, digital text exists only to depict that which we find in printed material? The field's most notable standard is deeply rooted in this representational philosophy and geared fully to describing the surface and content of printed texts. The first sentence on the homepage of the TEI[2] states: "The Text Encoding Initiative (TEI) is a consortium which collectively develops and maintains a standard for the representation of texts in digital form." Thus its stated aim is the representation of non-digital texts in digital form, it is explicitly not the representation *of* digital texts as well. This statement is pars pro totem for the textual scholarship community in general—its preoccupation is with non-digital text.

However, what happens at the point in time when textual scholars want to create scholarly editions of electronic texts? How, for instance, does one edit Carpenter's *CityFish*? *CityFish* is literature that is published online and that reacts and changes based on a reader's interaction with it (Carpenter 2010). When certain images (imaginary maps of imaginary islands) are clicked, parts of the text change, which adds a generative aspect to the text. To be able to adequately think about how such an electronic text would have to be edited, one needs rather sophisticated technical knowledge of digital text. One may call the scholars in

[2] https://www.tei-c.org

possession of that knowledge "digital fashionistas" but their knowledge might actually be rather pertinent to textual scholarship in this case.

There is more, however, to the argument that textual scholars should develop a deeper grasp of digital text than just the contention that, at some point, textual scholars will also involve themselves with the scholarly editing of born-digital texts. Carpenter's *CityFish*, and also for instance her …*and by Islands I Mean Paragraphs* (Carpenter 2013) show an intrinsic aspect of digital text, which is that it has a processual dimension. Scholars tend to think of instances of text as static entities. Arguably most scholars currently agree with McGann that texts are fluid and that an edition is therefore a mere representation of the text at some point in time during its potentially long journey through the hands of authors, interpreters, readers, editors, re-workers, and so forth (Bordalejo 2018:13). However, most scholars also tend to think of a representation of a text at some point in time as a static depiction of linguistic signs on some medium (paper, screen, wax, etc.). But if there is something that can be called a fundamental difference between print and digital text then it is that digital text has an additional performative aspect. This performative nature may be passive or active. To understand this, one needs to appreciate the difference between data and code. Any digital signal that passively undergoes some transformation by a computational process—thus in which that signal itself performs no action—may be called data. In contrast code is digital signal that acts. It represents a process executed on data or some action taken as a result of being presented with some digital data or information.

The passive performative dimension is strong in so-called data files. Consider, for instance the tiny bit of XML in figure 2.

FIGURE 2
A short sample of arbitrary XML.

```
<sentence>We walk the corridors, searching the shelves and
rearranging them, looking for lines of meaning amid leagues of
cacophony and incoherence, reading<pagebreak/>the history of the
past and our future, collecting our thoughts and collecting the
thoughts of others, and every so often glimpsing mirrors, in which
we may recognize creatures of the information.</sentence>
```

This is basically what XML is—it sits as a magnetic digital signal on a hard drive, representing the linguistic and descriptive signs depicted above. When a user/reader opens a text editor to view this XML, the text editor works in unison with the operating system to have the file system retrieve the digital information from the hard drive. The file system translates the magnetic signal into the proverbial zeros and ones (actually represented by electric potential differences deep inside microscopic electronic circuits inside memory chips). The operating system, so instructed by the text editor, then feeds the digital information to the graphics processing unit that takes care of projecting on the screen pixel formations that the user/reader associates with characters. Again for intelligibility I abstract away all the additional hardware and ignore a fair bit of the subtleties involved with the software stack that is ultimately necessary to accomplish this. In this case the XML is passive data that undergoes a number of operations by hardware and software that turns its digital signature into human legible characters on a screen.

But digital text can also have an active performative dimension, in which case we call it code. Textual scholars with a basic understanding of XML may have encountered a variant of this performative aspect in XSLT (short for Extensible Stylesheet Language Transformations), which is the transformation or templating language that enables us to define operations on XML that transform it into some other representation—a visual HTML representation for instance. Figure 3 gives an example.

FIGURE 3
A short XSLT stylesheet.

```
<!DOCTYPE xsl:stylesheet [
  <!ENTITY mdash "&#8212;">
]>
<xsl:stylesheet version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">

  <xsl:output omit-xml-declaration="yes" indent="yes"/>
```

```
  <xsl:strip-space elements="*"/>

  <xsl:param name="pVisualizePageBreaks" select="'yes'"/>

  <xsl:template match="//sentence">
     <xsl:apply-templates/>
  </xsl:template>

  <xsl:template match="pagebreak">
   <xsl:if test="$pVisualizePageBreaks='yes'">
     &#8212;
   </xsl:if>
  </xsl:template>

</xsl:stylesheet>
```

The XSLT in figure 3 is code and can be both read as normal text and it can be executed by a computer so that its performance yields a certain result. The XSLT code defines a template to visualize the XML data from figure 2 and adjusts the visualization based on a certain value for the parameter called "pVisualizePageBreaks" that can be changed in the stylesheet if needed. This is not too hard to gauge from the code itself: the `<xsl:if>…</xsl:if>` part defines a condition that if the value of the parameter "pVisualizePageBreaks" is "yes", a symbol (in this case the HTML entity with number 8212, which is an m-dash or long dash) will be produced in the visual output to indicate a page break; otherwise the page break will be "silent".

Note that in the latter example we encounter text that is actively performative when invoked as code: based on certain information it deforms certain other information, the XML in this case.

We may still maintain that all this does nothing to invalidate Tanselle's contention that the ontological status of text did not change. We can still maintain that the hardware and software involved in the processes described above are mere conduits along which textual information is transported and that there is in fact little difference between magnetic signal and letters, that both are simply technologies with which text can be encoded. But I believe this view becomes problematic once we peek through the surface of the text on the screen and consider the particular interactions that text and code can entertain.

First of all there is again code itself, which is also simply text. A particular literacy is required to read text that is code, certainly (Vee 2013). But even a very basic understanding of this literacy will already get a reader a long way, much as with any natural language. What sets code apart from other text is its performative aspect, so much so that I would contend that it makes this kind of text ontologically different from other text.

Of course scholars could object that code is simply not a form of text that requires philological care or any other kind of scholarship. But recalling *CityFish*, and electronic literature in general that blurs the borders between code and text, at some point this will not be a tenable position for textual scholarship. And the philological care of such works obviously requires scholars to be knowledgeable of digital fashions and the workings of code.

Screen essentialists and those that hold that all there is to a text is indeed its surface, might still maintain that there is in fact a very neat boundary between code and text even in the case of electronic literature such as *CityFish*. *CityFish* works by changing parts of its text when a reader/user clicks on certain images. The JavaScript code that makes this possible looks a bit like that of figure 4.

FIGURE 4
Snippet of JavaScript code driving text action.

```
document.getElementById( 'image_island_1' ).addEventListener(
'click', function() {
  document.getElementById( 'paragraph_3' ).innerHTML( 'My island is
free to a remarkable degree from gales of wind.' )
});
```

The code of figure 4 defines that if a user clicks on the image of an island with the name "image_island_1" the text of a paragraph called "paragraph_3" will be overwritten by some other text. There is an argument to be made that the text part in this code ("My island is free to a remarkable degree from gales of wind.") is neatly separated from the text that is the code. That, again, the text is not part of the action the code defines, but that it is mere inert data that gets put in certain places on the screen and therefore, again, only that which is on the screen is the

text of concern to textual scholarship. The "philological facts" would in that case be all the possible text combinations that *CityFish* might be able to depict, and an archive of the work would just store all these individual combinations.

However, apart from the fact that the number of possible combinations makes this infeasible in the case of *CityFish*, this line of reasoning also denies that the code of *CityFish* contributes actively to the meaning formation of the text. Part of the intended meaning or message by the author—or, for those who adhere to a more post-modern conception of text, part of the meaning that can be read into the text—is dependent on the very interaction defined by the code. Using code to put an em-dash as a page break sign into a text may not interfere with the text's meaning all that much, but once the interaction pertains to words, syntactics, sentences, and text structure, an ever larger part of the text's meaning is ingrained in the interaction between text and code. Although more scholarly discussion is needed to tease out the exact boundaries of this idea, I think it is reasonable to claim that this does affect the ontological status of text.

The interaction between performative and static text, or code and text, is not the only reason why a claim may be made that digital text is ontologically different than print or manuscript text. If we peer into the looking glass beyond the mere surface of the text that is on the screen, we find that digital text lives in many different digital structures, and not just as the visual semiotics we see on the screen. A plain text file is the simplest way of storing a text digitally. And obviously there is markup. But beyond that there are texts that are expressed as databases, as graphs, and other data structures and code-like objects. Elsewhere Tara Andrews and I have argued that these data structures are at the very least part of the argument or theory about a text in a digital environment. But beyond that they are also in themselves true representations of a text and they are texts that can be read. It is not tenable to hold that only the visual screen-depicted version of these data structures is the digital scholarly representation of such texts. We claim that, just as Suzanne Briet expanded the notion of document, scholars need to expand the notion of digital text beyond what they think is in a digital file and what is on a screen (Van Zundert and Andrews 2017). Data structures that

represent texts are texts in themselves, but they are not mere inscriptions of the text—they are inscriptions that foreground and make explicit particular dimensions or aspects of the text.

Again one can do away with all of this, and claim that these digital objects are not the sorts of texts that scholars should tend to. However, that does not make these kinds of texts go away. Gatekeeping them out of the scholarly domain also, paradoxically, entails a confirmation of their being such a different form of text that scholars need not care. But if that is true, and since they are undeniably representations of text, then it follows they are ontologically different. And in the opposite case, if they are not ontologically different, then there is no reason not to consider these too as texts requiring scholarly attention.

All this does not mean that textual scholars should all become programmers too. But the claim is warranted that some branch of textual scholarship must take an interest in these strange digital beings that are also texts—simply because they are texts, but even more so texts that currently make up the major part of all information that humans exchange. Textual scholarship has always had its exploratory and experimental fringes. Paul Eggert gave a good overview of how the field has so far engaged with digital texts (Eggert 2010). Such an explorative periphery or leading edge is, I would argue, a sign of a healthy and viable scientific field that is aware of the needs and changes in the real world that pertain to its scholarly challenge, and wants to critically engage with these changes.

The Computational Edition

Most digital scholarly editions are disappointingly bland from a methodological perspective. They all stay safely within the realm of a representational philosophy. And that is a good thing. Change does not always justify revolution. However, it does serve scholarly purpose to explore further afield. Following Bordalejo's argument, little methodological change is to be expected from the current wave of print- and manuscript-mimetic digital scholarly editions. Given the examples that exist, this seems a fair reflection of the current situation. One cause for this may be found in how digital scholarly editions engage with code:

they do not. Code is of course used in digital scholarly editions. It is used to dress up the edition with point-and-click functionality: dropdowns for chapter structures or other text structures as navigational devices, leafing through the edition, clicking on index items, the ubiquitous full text search, and of course popup annotations. It seems that scholars are predominantly interested in code to turn paratext and metatext into helpful functionality, but nowhere does code involve itself with the actual text.

My claim is that in a quest for a more methodologically-aimed exploration, textual scholars need to investigate and experiment with a different kind of edition. Not a digital, but a computational edition. Digital editions so far are essentially passive digital texts that require an elaborate technological ecosystem that grabs them from a hard disk on some server, processes and transforms them, and transfers them via a network to the screen of a reader/user. These editions are data, usually XML. They are not code but rather encodings, or markup. In contrast a computational edition would not be a slavish encoding, but rather a computational edition would be code and therefore a program that could be executed by a computer. The execution of the program would result in some form of scholarly edition. To explain this somewhat further, consider the two examples in figures 5 and 6.

FIGURE 5
Plain text.

```
Willem die Madocke maecte
```

FIGURE 6
Computational text.

```
print( 'Willem die Madocke maecte' )
```

These examples take as the object of scholarly editing the first verse in *Van den vos Reynaerde* (transl. "Of the Fox Reynaert"), a mid 13th century Middle Dutch beast epic. An interesting text by itself, of which an English translation and edition is available (Bouwman and Besamusca 2009) but here it will just serve to explain the difference between digital

and computational. The first example lists the very words of the first verse. It does not contain anything more than that text, and if these words are stored as a digital file we may call it a digital text, or maybe even a digital edition, albeit it a tiny one.

The second example, however, is an executable computer program. The word "print" is a verb of the general purpose computer language Python (and a verb that appears in many computer languages it should be noted). It means that whatever follows between parentheses and quotes should be put to a screen or another medium for a user to view. The second example is therefore computational, it contains code rather than text. When executed the code performs an action, it renders the words of the verse on the reader/user's screen.

Obviously these examples are trivial, but the salient point is in the fact that the digital text is purely representational, while the code is performative. Put a little differently, it is the case that text captures information and knowledge, while code captures action and behavior. Digital editions are purely representational, they are only surface. Scholarly editors have until now mostly ignored the ontological possibilities of action and performance that text-as-code or text-as-process do afford. This is how I propose to define the difference between digital and computational scholarly editions: a digital scholarly edition is an edition that captures the scholarly result through encoding (text and/or markup); a computational edition is an edition that captures scholarly actions and decisions by inscribing these in code, re-enacting the scholarly practice when the code is executed. In essence this means that a digital edition is a static representation of the result of scholarly editorial work, and that a computational edition, every time it is executed, re-enacts the scholarly editorial work and thus creates an edition as a result.

The fact that code facilitates this possibility may not be immediately clear from the small example above. It would of course be possible to put parentheses and quotes around the text of an entire edition and to put "print" in front of it. However, that would not amount to a computational edition as proposed here. The idea behind the computational edition is that a scholar does not write the edition, but that he or she has the code creating the text of the edition. Consider, for

instance, the act of creating an annotation in an edition to explain a particular word or sentence that is difficult to understand. In our example this could be the word "Madocke". This is actually the title of a lost work of which nothing is known, but of which the content is subject to educated guesses (Bouwman and Besamusca 2009:14–15). In the conventional situation a scholar would collect information known about this topic from other texts. Then he or she would write a small narrative based on that information. Eventually that narrative would become a footnote to the text of the edition, marked up, presumably, according to the TEI specification as a `<note>`.

In the case of a computational edition no such writing would be done by the hand of the editor. Instead the editor would write code that could be executed as a program. This program would retrieve the required information from a specified source and would transform it into an annotation appropriate for the particular edition. It would then add the annotation to the text. Note the indirection—so called in information technology terms—that takes place here. It is not the editor undertaking the legwork of information gathering, and the writing and adding of the annotation. It is rather the editor instructing a program precisely where to obtain the information and what to do with it. Because the editor describes in code how and where the information was obtained and how it was treated, this captures meticulously the scholarly activity and not merely its result. In other words the computational edition captures all things editors tend to *do* but tend to not exhaustively *register* in a surface-only digital edition.

The computational approach to editing may at the moment seem far-fetched and problem riddled. What scholars are able to program such editions? What about the plethora of philological information that is not online in any decent authoritative form? How can an annotation be decently formulated if a scholar is not allowed to actually polish it through writing? All such criticism are valid currently, provisionally. However, that these objections exist must not mean that some small contingent of textual scholars should not experimentally explore the possible methodological affordances that code or other digital technologies offer textual scholarship—especially because digital technologies are developing fast and may tomorrow proffer linguistic

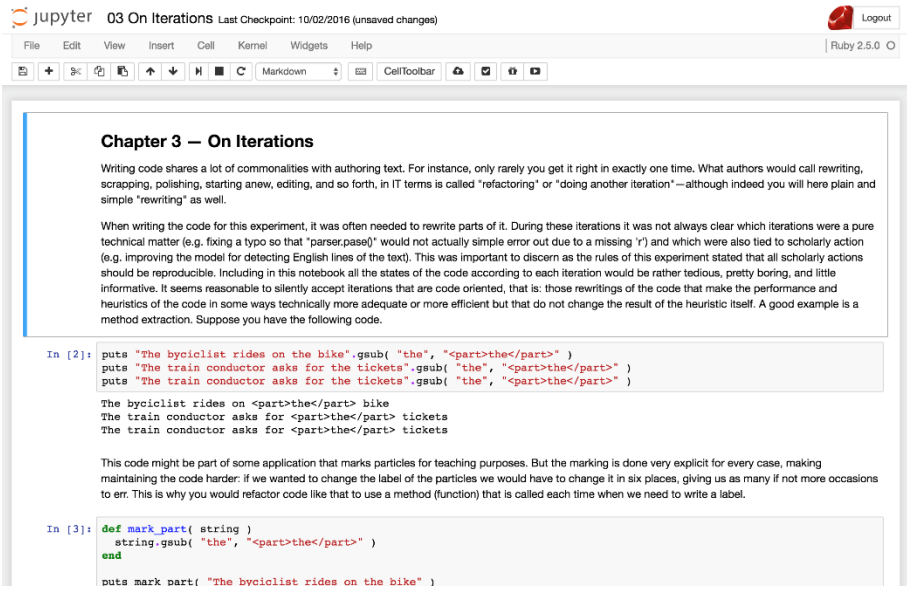
and epistemological aids that do not exist today. To remain relevant and capable textual scholarship should have its own digital labs, however small, to critically follow, explore, and implement these developments where useful and relevant.

A Proof of Concept Computational Edition

Being not just a scholar but also a scientific programmer, I regard some of my work as part of the exploratory niche in textual scholarship. Digital editions are wonderful products of scholarship and they contribute enormously to the accessibility and the relevancy of texts and textual scholarship, even if impact lacks disappointingly behind (cf. Porter 2013). However, it has always annoyed me how they stay in an all too convenient mimetic and representational mode, reverent to print culture. That is why I started exploring what it could mean for a scholarly edition to be computational rather than digital. The computational edition that is resulting from this is very much work in progress and is also in many respects just a baby step on a very long quest. But it is, I would argue, a genuine textual scholarship exploration of computational means.

The computational edition of *Van den vos Reynaerde* takes the form of a series of Jupyter Notebooks. Jupyter Notebook is a digital technology that allows to mingle human narrative and computer code. Having these two types of text alternating each other on the same page allows to explain exhaustively what the code is trying to accomplish (see also figure 7). The code of a Jupyter Notebook can be executed stepwise by a reader while he or she is both reading the code and the accompanying explanatory text. The computational edition of *Van den vos Reynaerde* in this way records, describes, and implements a form of computational edition, exploring what a computational edition may entail. Currently this edition uses the online facsimiles of one of the extant manuscripts of the Middle Dutch story—the so called 'Comburg manuscript'—which is in the care of the Würtembergische Landes Bibliothek under the description "Comburger Handschrift - mittelniederländische Sammelhandschrift - Cod.poet.et phil.fol.22".

FIGURE 7
A page from the Jupyter Notebook computational edition of *Van den vos Reynaerde*.



The point of this computational edition is not in fact to create a new authoritative edition of *Reynaert the Fox*. Rather in contrast this text was chosen because plenty of scholarly editions of it exist, and thus it will provide plenty of clues on what an authoritative scholarly edition of this text should contain. The challenge is to end up with a code base that, when executed, indeed provides a scholarly edition that is acceptable. Currently the code downloads the facsimiles available in the public domain, adds a transcription and starts to annotate the first word of the edition—the author's name—by associating it with sentences retrieved from scholarly works on this text. A very modest beginning indeed.[3]

[3] To execute the work in progress Jupyter Notebook computational edition of *Van den vos Reynaerde* one needs Python and Jupyter Notebook installed on a computer. Directions can be found at https://jupyter.readthedocs.io/en/latest/install.html. This

The computational edition of *Van den vos Reynaerde* shows its experimental character in the fact that it every so often concludes that some things cannot yet be done. For instance, although Transkribus[4] makes good headway in automatically transcribing medieval manuscript based on machine learning techniques, the amount of text of *Van den vos Reynaerde* does not suffice to apply this kind of technology. For now therefore, the edition has to do with a later transcription that can be automatically transcribed using computer tools. Again, the point is not to make this computational edition perfect from the start, but to explore the boundaries of what is and may be possible. As such, also scholarly actions that cannot yet be expressed computationally yield useful methodological information in this experiment.

A Rationale for the Computational Edition

A computational approach to scholarly editing may yield more substantial methodological innovations for the field of textual scholarship than digital editions might, because the computational approach draws in the code aspect of computing more fully and thus the performative nature of both computing and editorial work. One rationale for the computational edition is that it replaces the registration of the scholarly result (the edition) with the registration of the scholarly activity that results in the edition. The quality and validity of a scholarly edition is bound to the expertise, skill, and knowledge of the scholarly editor. This is why scholars in general make a sincere effort to explain

computational edition additionally uses Ruby as a programming language. Ruby can be installed from https://www.ruby-lang.org/en/downloads/. The iruby gem is required and can be gotten by typing `gem install iruby` at the terminal/command prompt. After these requirements have been installed one can download the notebooks from https://github.com/jorisvanzundert/reynaert-as-graph/tree/master/notebook, or one can use the `git clone` function to clone all of the code into a local directory. However, if executing the notebook is not a requirement, the content can be just read online at https://github.com/jorisvanzundert/reynaert-as-graph/tree/master/notebook.

[4] https://transkribus.eu/Transkribus/

and account for how they created a particular scholarly edition, for instance in an elaborate introduction to the edition. But this is an account at an arm's length of the actual scholarly activity. Instead of having, in a sense, a second-hand account of what went on during the creation of the scholarly edition, through code the audience can get a first-hand account as the code re-enacts the scholarly activity. If the trustworthiness and reliability of scholarly editing is in taking responsibility for its editorial actions and decisions, then there is no better reproducibility of these actions than through the meticulous registration of actions that coding can provide.

But reproducibility and accountability are not the sole motivators for this computational undertaking. Quite frankly, the reproducibility and accountability line of reasoning is a somewhat boring scientific argument that notwithstanding must be put forward. Far more fun however, is the exploration this project represents of how text—and thus editions—can be different from what we accepted until now as (digital) scholarly editions. For instance, the work on the computational edition of *Van den vos Reynaerde* raises the question if scholarly editions must represent the text only as text. In programming there are styles and genres too. One such style is called object orientation. In this paradigm objects of the real world are modeled as digital objects with the same or similar properties and behavior. A simple object oriented "dog" in the computer language Ruby may for instance be expressed as in figure 8.

FIGURE 8
A Ruby dog.

```
class Dog
  def bark
    puts "Wraff!"
  end
end

bello = Dog.new
bello.bark
```

The class defines an object Dog that has one behavioral function, which is to bark (in the sense that the onomatopoeia "Wraff!" will be put

to the screen). The key line "bello = Dog.new" creates an computational dog object that we can make bark by writing "bello.bark".

Van den vos Reynaerde is a narrative full of animals (including a pedantic little dog called Cortoys). Suppose we were to model all the animate and inanimate objects in the story together with their properties and behavior? A computational edition of this kind would eventually, when executed, enact the story rather than represent the text. Would that be an inadequate scholarly edition of the text? It would certainly be a different kind of edition. Maybe one that means a change to the methodological approaches of textual scholarship. And it would certainly be a scholarly edition well in line with McGann's view that we scholars are mere part of a long line of actors that propel texts through time.

I am a textual scholar, a literary researcher, and a scientific programmer. I do not take particular issue with the term "digital fashionista". But what is worrying is that such a denotation suggests that code and digital text are mere ephemeral fads that textual scholarship should ignore. That would be a very serious underestimation of the impact that the digital medium and computation have on the uses and affordances of text. There should be a place in textual scholarship proper to explore these impacts. For that we do have to cure however the myopia with regard to digital editions.

Conclusion

Digital humanists and textual scholars have been trying to figure out how digital scholarly editions differ in an essential or fundamental way from print scholarly editions for more than a few decades now. But all propositions until now turn out to be less than revolutionary. The only slightly satisfying answer maybe has been offered by Patrick Sahle, in saying that a digital edition finds its essence in showing traits that are intrinsically non reproducible in print. But carefully read that proposition only testifies to the impotence of its circularity.

This may lead textual scholars to conclude that there are indeed no fundamental differences between print scholarly editions and digital scholarly editions. And this again has led some to contend that digital humanists have nothing to bring to textual scholarship. Fair is fair, for all

its revolutionary language digital scholarship has not produced much revolutionary results. But the justifiable deprecation of grand revolutions may inadvertently be creating a blind spot for the far less visible but pivotal change that the digital medium caused to the ontological status of text.

Textual scholarship until now has adopted an exclusively mimetic descriptive approach for digital editing, prioritizing mark up and faithful remediation of physical artifacts. This endemic representational philosophy is favored through tradition, convention, and screen essentialism. It is obsessed with using the digital medium as a means to reproduce the solidified form of the book. The utility of all this above conventional print publication appears to be limited primarily to scale of access. It is the digital metaphor of mimesis that has caused textual scholarship to close its eyes for what sets print text apart from digital text: its performative nature.

Textual scholarship has thus denied the most pivotal aspect of text as part of the digital medium. This is the more remarkable because that what drives the medium's performative aspect is just another application of text: code. I cannot imagine that there would be any textual scholar that would want to forbid the making of books. I also cannot imagine that any textual scholar in possession of full academic faculties would willingly want to ignore the growing body of digital born texts and the texts that exists as code. As a field we have not even started to figure out how to deal with code-as-text and text-as-performance, nor have we reached far in examining the affordances that these forms of text create for digital scholarly editing. The claims about reproducibility and capturing scholarly decisions that I have made above offer a methodological rationale for this exploratory engagement and make it an epistemologically viable undertaking. The more immediate and important objective of creating digital editions as computational programs is, however, to indeed figure out how we, as textual scholars, can deal with text in its ontological changed form of digital text.

As textual scholars we have a choice here. We may choose to ignore the ontological change that text underwent, and we may regard scholarly editing as an academic task that is solely concerned with the representation of static instances of text. In that case digital scholarly

editing is at most a means to create wide access show cases of what wonderful things exist in the print world. But let us also in that case drop the ludicrous claims that digital editions must somehow be better books. If you want a better book, make a better book, not a digital edition. Indeed this is a scenario where digital humanists have little to offer to textual scholarship.

The other choice is that we accept code as a form of text, and computation as a valid form of textual scholarship, embracing the performative nature of digital text. Given that most text is already digital text this seems to me a sensible choice for textual scholarship. This choice does not imply a call for a methodological revolution where all textual scholars must become programmers overnight. With mark up the task of preparing textual scholarship's methodology for a digital era has not seen its end but at most the end of its beginning. This is not a revolutionary claim but a logical consequence from the demonstrated change in the ontological status of text. Adapting textual scholarship to this change requires an intimate knowledge of both text and code—but not from every scholar and not immediately. We are not in crisis, and there is no revolution going on. But there is incommensurability between print and digital text, which is likely to be a driver of methodological change (Kuhn 2012[1962]).

In all this warrants a genuine plea for a niche in textual scholarship for the computational savvy—call them digital humanists, fashionistas, or just what they are: scholars. Let these advanced methodologists seriously explore the affordances that text-as-code and code-as-text create for digital scholarly editing. And, more importantly, let them help textual scholarship prepare itself for an era in which digital born texts, electronic literature, and text-as-code become prime carriers of human cultural artifacts.

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