The Relevance of Digital Humanities to the Analysis of late Medieval/Early Renaissance Music

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The spur for this paper was Nicholas Cook's oft-cited paper on computational musicology published in a collection of essays on recent developments in empirical musicology.[2] Cook prefaces his argument by observing that the shift from comparative musicology in the mid twentieth century to highly contextualised socio-cultural or structural analysis produced a setback in computational musicology, whose methods are most suited to interrogating large data sets.[3] Arguing that recent developments in computational musicology present opportunities for disciplinary renewal, Cook's conspectus for computational musicology is retrospective, focusing on long established but still useful music analysis tools like David Huron's *HUMDRUM* Toolkit.[4] Cook's computational musicology consists of data subjected to a set of tools, results obtained, articles published. For digital musicology, whose advent coincides with the invention of the World Wide Web, analysis is a multifaceted set of relations that relies upon linked data as encoded musical scores or metadata about those scores. Although desktop computational analysis tools are still crucial for processing and generating new data, the remarkable increase of data collection and sharing technologies promises to

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[2] Nicholas Cook, "Computational and Comparative Musicology," in *Empirical Musicology: Aims, Methods, Prospects*, ed. Eric Clarke and Nicholas Cook (Oxford: Oxford University Press, 2004), 103–126.

[3] On earlier critiques of digital humanities, especially those of historian Lawrence Stone, and the current state of the "interdiscipline", see Paul Turnbull, "Digital Humanities, or Digitally Based Humanities Research," in *Advancing Digital Humanities: Research, Methods, Theories*, ed. Paul Longley Arthur and Katherine Bode (Houndmills: Palgrave Macmillan, 2014), 258–273.

[4] "The Humdrum Toolkit: Software for Music Research," last accessed 29 Janaury 2018, https://musiccog.ohio-state.edu/Humdrum/. Also see Jonathan Wild, "A Review of the Humdrum Toolkit: UNIX Tools for Musical Research, created by David Huron,"*Music Theory Online* 2.7 (1996), http://www.societymusictheory.org/mto/issues/mto.96.2.7/mto.96.2.7.wild.html.

stimulate further research in the online environment.[5] There are challenges for ensuring the usefulness and longevity of this data, some of which will be identified below.

In this paper I share some of my thoughts on new methods of computational music data analysis. I will first consider current issues in the encoding early music into the raw data for symbolic music analysis, and some of challenges of early music analysis that set it a part from other repertoires. My focus is not on the technicalities of particular tools but rather how digital methods and tools for data analysis give rise to new research questions, provide the means for answering existing ones, or change the methods of musicology in general. Finally, I will discuss several recent projects developing computational music analysis tools, including those from my own research, and offer my thoughts on how these might be used to address new research questions, some of them of considerable benefit for shifting musicology's focus from traditional—and already abundantly critiqued—metanarratives to broader, more culturally dynamic micro- and macro-histories. I contend that digital musicology offers opportunities for bringing diverse disciplinary branches, such as music theory, analysis, historical musicology, source studies, music anthropology and music cognition, closer together. I will sound a note of caution, firstly concerning musicologists not succumbing to an assumption that digital musicology will provide all the answers and the fallibility of human designed systems. How the data arising from music analysis tools might be deployed to enhance existing online resources will not be discussed here.

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Encoding early music repertoires has been a feature of many projects in the past.[6] Notably, the data arising from these projects has not made it into the public forum: they used custom formats particular to the project. Indeed I have been involved in recovering Stinson's *Scribe* software data into a more descriptive

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[5] See, for example, the collection of essays in two special issues of *Early Music* 42, no. 4 (2014) and 43, no. 4 (2015); also multiple reviews of project websites in the *Journal of the American Musicological Society* 67, no. 1 (2014), 68, no. 2 (2015), 69, no. 3 (2016), 70, no. 2 (2017).

[6] See, for example, Walter B. Hewlett and Eleanor Selfridge-Field, "Computing in Musicology, 1966-91," *Computers and the Humanities* 25, no. 6 (1991): 381-392; John Ashley Burgoyne, Ichiro Fujinaga, and J. Stephen Downie, "Music Information Retrieval," in *A New Companion to Digital Humanities* (Chichester: John Wiley & Sons, 2016), 213–228; Eleanor Selfridge-Field, "The Evolving Uses of Encoded Music," Keynote delivered at the *Third International Conference on Music Encoding*, Florence, 18-21 May, 2015, forthcoming.

Extensible Markup Language (XML) format, although there are challenges arising from the very foundations of newer, though more publicly documented and supported, data encodings.[7]

One promising example of the use of XML for encoding music notation is the Music Encoding Initiative (MEI).[8] In the realm of early mensural or rhythmic notation, Laurent Pugin has directed the results of Optical Music Recognition (OMR) software into a layer of MEI devised for 16th-century prints of mensural notation.[9] Yet the present mensural layer of MEI needs much more work in order to capture the many notes and signs in manuscripts of mensural notation from the fourteenth and fifteenth centuries.[10] This needs to be done in a careful and concerted way by members of the MEI Mensural working group who possess expert knowledge of this notation, especially when certain notational features can be atomised to avoid the situation of where a new note name has to be invented for just one piece of music.

Yet there are problems that many active in the MEI community do not readily acknowledge. The first is the fundamental difference between the semantic and visual aspects of early music notation. MEI is notoriously ill adapted to the semantics of mensural music. In fact there is an argument that MEI should not be concerned with notational semantics. Rather it is the task of a separate system yet to be built that can interpret MEI Mensural data. That system does not currently exist. At the same time, MEI is frustratingly agnostic when it comes to paleographical elements in medieval music notation. Although team members of long-term projects like the *Beethovens Werkstatt* are expending considerable effort to encode complex pen-stroke vectors from the composer's autographs in the Common Western Music Notation or CWMN layer of MEI (referred to as Common Music Notation in MEI documentation), the process is time intensive and possibly unfeasible for early music

[7] John A. Stinson and Jason Stoessel, "Encoding medieval music notation for research," *Early Music* 42, no. 4 (2014): 613–617.
[8] Perry Roland, Andrew Hankinson, and Laurent Pugin, "Early music and the Music Encoding Initiative," *Early Music* 42, no. 4 (2014): 605–611.
[9] Lurent Pugin, *Aruspix: A software application for the optical recognition, the superimposition and the collation of early music prints* (2010 [cited 19 Feb 2012); available from http://www.aruspix.net/
[10] John Stinson and Jason Stoessel, "Revising MEI for research on late medieval manuscripts," in *2015 Music Encoding Conference*, ed. Roland Perry and Johannes Kepper (Florence: Music Encoding Initiative, 2017), forthcoming.

sources.[11] For MEI to be sensitive to some of the demands of paleographical analysis, particularly as OMR is combined with software to capture the individual features of musical writing, then a customised module for early music will need to be developed by MEI developers collaborating with music paleographers.

MEI is partly bound by epistemological constraints that have arisen from its original conception as way of encoding more recent CWMN. Over the last 300 years, CWMN has cut itself off from its foundations in mensural notation and more distant chant notation. As students of notation know, the foundation of CWMN lies in fourteenth-century, but many of the mensural concepts, like perfection, imperfection, alteration and the ability of a note to have several different values of relative duration according to context, have been put aside as a simpler, more widely understandable music notation was sought in the following centuries.[12] MEI's solution for mensural notation is a type of retrofit, wherein a layer of mensural notation tags augment the CWMN of MEI. Historically speaking this is a topsy-turvy solution, in which the ancestor of CWMN becomes its ugly clone. Gregorian chant notation, which has even less in common with CWMN, is appended as yet another separate module. These notations cannot be dismissed as localised phenomena or the products of scribal whim, but widespread testament to the early and long history of Western musical writing in which each system served as the foundation of the one that was to follow.

As a case in point for the artificiality of separating chant and mensural notation in MEI, take an interesting the fourteenth-century two-part composition *Gaudeamus omnes in Domine* found in the Ashburnham 999 manuscript in the Mediceo-Laurentian Library in Florence. Ex. 1 shows the end of the *Gaudeamus.* In this source, the plainchant on fol. 21r has been laid out in the same way as in several other books of chant. This includes the contemporaneous Douai, Bibliothèque Municipale, MS. 1171, which was copied in the same scriptorium as Ashburnham 999, and earlier neumed sources such as Gaddi 44, also in the Medicean-Laurentian

[11] *Beethovens Werkstatt: Genetische Textkritik und Digital Musik Edition* ([cited 31 January 2018); available from http://beethovens-werkstatt.de; Susanne Cox, Maja Hartwig, and Richard Sänger, "Beethovens Werkstatt: Genetische Textkritik und Digitale Musikedition. Eine Projektvorstellung," *Forum Musikbibliothek* 36, no. 2 (2015): 13–20.
[12] Willi Apel, *The Notation of Polyphonic Music 900–1600,* 5th ed. (Cambridge, MA: Medieval Academy of America, 1953).

Library.[13] Yet the same scribe in Ashburnham 999 also wrote on the facing fol. 20v a *discantus* in mensural notation, composed by Don Paolo da Firenze (c.1355–1436) to be sung polyphonically with the chant.[14] The letter .q. in both the chant and mensural voices signals a simultaneous change on the text *et collaudant* to the *quaternaria* time division of Trecento music. All notes of the chant are sung in breves—possibly indicative of the performance of chant in the early 15th century—and not according to the rules of mensural ligatures. Black minims (diamond shape notes with upward stems), semibreves (diamond shape notes), breves (rectangular notes) and longs (rectangular notes with downward stems) in the *discantus* are performed as binary notes in the *quaternaria* division in a similar way to their cognates in today's CWMN. This contrasts with the passage before the change to *quaternaria* in which some notes are ternary and others are binary, as determined by context.

Two observations reveal a central problem of encoding schema that separate medieval notation into two convenient "modules" that function as extensions of a later model of musical notation, namely CWMN. Square chant notation and mensural notation, as in the *Gaudeamus*, coexist in chant books from the fourteenth century onwards. Additionally, square chant notation, modal notation and mensural notation share much in common paleographically. Encoding chant, modal and mensural notation in a single medieval notation module offers significant advantages for comparative and paleographical research. The creators of MEI, by separating chant and mensuration notation, do not currently recognise these advantages.

Finally, there are those are those pesky examples of notation from the fourteenth to seventeenth century that in part epitomise what digital humanist Jerome McGann has called the "hem of a quantum garment", namely the non-residual leftovers that markup cannot capture.[15] Compositions written in the shapes of circles, mazes, harps, hearts, and more, reveal a surfeit of meaning that extends well beyond the

[13] Stinson and Stoessel, "Revising MEI for research on late medieval manuscripts," forthcoming.
[14] Ursula Günther, John Nadas, and John A. Stinson, "Magister Dominus Paulus Abbas de Florentia: new documentary evidence," *Musica Disciplina* 41 (1987): 203–246.
[15] Jerome McGann, "Marking Texts of Many Dimensions," in *A New Companion to Digital Humanities* (Chichester: John Wiley & Sons, 2016), 358–376, at 361; also see Willard McCarty, "Becoming Interdisciplinary," in *A New Companion to Digital Humanities* (Chichester: John Wiley & Sons, 2016), 67–83.

generalities of encoding into the culture that created this object (Ex. 2).[16] The same goes for compositions like canons that have more than one solution, something that composers delighted in for centuries, which has been marginalised by mainstream narratives of music history.

I confess that MusicXML remains one of the main sources of encoded music data for my projects and indeed many projects that are concerned with musical analysis. While plans for an early music layer of MusicXML are occasionally spoken of in hushed tones, at present MusicXML encodes only CWMN. MusicXML is touted as a portable data format, something that MEI cannot claim at present. Certainly, the music engraving software Sibelius has a plugin for MEI input and output, but MusicXML currently enjoys a greater level of support across the desktop software music engraving industry. Indeed, the lack of adequate open-access graphical editors for the Chant and Mensural Modules of MEI is a problem for which commercial solutions are unlikely to be forthcoming. MusicXML is exceptionally well documented, compared to some of the more arcane corners of MEI. Conversely, MusicXML does not yet encode metadata at the same level as that found in the rich MEI header. This has implications for linking scores, an area where MEI is currently ahead of the game. Finally, MEI is now under considerable pressure since the music engraving software developer MakeMusic handed MusicXML over to the W3 Consortium and the W3C Music Community Working Group was formed to explore its continued development as an open music encoding specification.[17] This group has targeted many of the features found in MEI.

When expending public research funds on building computational music analysis tools, as in the case of our Canonic Techniques project, decisions needed to be made about how best to achieve results.[18] We took into this project an existing framework that could read and write MusicXML files. The aims of our project meant that we

[16] Notable examples of pictorial scores from the musical repertoire of canons are discussed in Laurence Wuidar, *Canons enigmes et hieroglyphes musicaux dans l'Italie du 17e siecle* (Brussels: Peter Lang, 2008); Katelijne Schiltz, *Music and Riddle Culture in the Renaissance* (Cambridge and New York: Cambridge University Press, 2015).
[17] Michael Good, *MakeMusic Transfers MusicXML Development to W3C* (2015 [cited 24 August 2015); available from http://www.musicxml.com/makemusic-transfers-musicxml-development-to-w3c/; Michael Good, *Introducing the Music Notation Community Group* (2015 [cited 24 August 2015); available from https://www.w3.org/community/music-notation/2015/07/27/introducing-the-music-notation-community-group/.
[18] *Discovery Projects - Grant ID: DP150102135 [2015 - 2017]* ([2015]); description available from http://purl.org/au-research/grants/arc/DP150102135.

needed to prioritise building new analysis tools over adopting and integrating another music encoding standard, namely MEI. Simply put, faced with the choice between necessity and luxury, we prioritised necessity. While future integration of MEI into our analysis toolbox is likely to occur for CWMN, considerable risk in supporting MEI-encoded chant or mensural notation emerged since the definitions of these modules entered into a revision stage during the timeframe of our project. Finally, the development effort involved in implementing a mensural notation analysis framework is considerable. The complexities are manifold, including rendering mensural notation parts into scores *automatically*, safeguards for transcription errors, as well as handling several different dialects of mensural notation: Italian Trecento (and its sub-dialects), French ars nova, the often polymensurally ambiguous *ars subtilior*, the many forms of 15th-century French-based notation, and so on.[19] The challenge is not insurmountable, but will require more time and collaboration than afforded to, or possible with, our project.

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I have spent much time on issues of data since—as any good programmer knows—ensuring raw data in is the most suitable format makes all the difference when designing software for processing that data. Another challenge is having enough data. This was one of the limitations of David Huron's *HUMDRUM* toolkit. Its tabular data format in the early days required laborious hand encoding and months or years of a research assistant's time. Craig Sapp's *Verovio Humdrum Viewer*, which displays Humdrum encoding instantly to the screen as CWMN, is a remarkable contribution to the Humdrum community.[20] The advent of conversion tools that take a MusicXML score and output Humdrum data has also been a significant development.[21] While Humdrum has been useful in answering some research questions in early music, such as Denis Collins's work on Zarlino's canonic theory in early organ chorale settings, it is ill adapted to the conceptual framework of medieval and renaissance counterpoint.[22]

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[19] See Stinson and Stoessel, "Encoding medieval music notation for research," 616.
[20] Craig Stuart Sapp, *Verovio Humdrum Viewer Documentation* (2017 [cited 31 January 2018); available from http://doc.verovio.humdrum.org.
[21] See the *xml2hum* tool: Craig Stuart Sapp, *Humdrum Extras* (2005-2013 [cited 31 January 2018); available from http://extras.humdrum.org/man/xml2hum/.
[22] Denis Collins, "The Transmission of Zarlino's Canonic theory in seventeenth-century organ chorale settings," *Musicology Australia* 26, no. 1 (2003): 38–64.

Recently Michael Scott Cuthbert's Music21 toolkit has gained the attention of the research community.[23] Based in the Python Programming Language, this toolkit provides a suite of modules to query encoded scores on matters such as melodic identification, harmonic analysis and set theory analysis. Students of digital musicology would be well served to learn some Python and experiment with the Music21 toolkit.

Yet as a C and C++ programmer I find myself struggling to commit to a Python-based system for development. Not only do I find features of this programming language unsatisfactory and counterproductive to efficient programming, Python just cannot achieve the same level of high-speed low-level data querying and manipulation as languages like those of the C family.[24] Certainly the Python programming language is easier to learn and is in vogue in the scientific community as a programming language, yet I am left wondering whether digital musicologists are better served by a set of advanced integrated tools written in C++ that can be invoked through the command line or by a graphical front or a software library upon which new tools can be built. How many digital musicologists want to program computers? Probably not enough, but it is also a case of how many can spare the time in their academic lives to program.

I am fortunate enough to be a chief investigator and lead programmer in a project funded by the Australian Research Council that is examining the development of canonic techniques in the music of the fourteenth to early sixteenth centuries. Our project is also concerned with the place of canon in the musical culture of the period in question, but I shall not speak about this side of the project today. Canonic techniques consist of compositional devices of strict melodic imitation and melodic transformation (including retrograde, inversion and rhythmic permutations) that first appeared in the fourteenth century and reached their full extent by the beginning of the sixteenth century. Far from being abstract written

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[23] Michael Cuthbert, Christopher Ariza, and Lisa Friedland, "Feature Extraction and Machine Learning on Symbolic Music using the "Music21" Toolkit," in *Proceedings of the 12th International Society for Music Information Retrieval Conference, ISMIR 2011, Miami, Florida, USA, October 24-28, 2011*, ed. Anssi Klapuri and Colby Leider (Miami: University of Miami, 2011), 387–392; Dmitri Tymoczko, "Review of Michael Cuthbert, Music21: a Toolkit for Computer-aided Musicology (http://web.mit.edu/music21/)," *Music Theory Online* 19, no. 3 (2013), http://mtosmt.org/issues/mto.13.19.3/mto.13.19.3.tymoczko.php.

[24] *Cf.* Tymoczko, "Review of Michael Cuthbert, Music21: a Toolkit for Computer-aided Musicology (http://web.mit.edu/music21/)," §14.

exercises, canonic techniques were fundamental to extemporised polyphony from the fourteenth century until well into the modern era. Examples like the account of the examinations for a new choirmaster at Toledo in 1604 illustrate the high esteem and value bestowed upon a musician who could extemporise a canon on a existing voice or even voices.[25]

Since cats (or pictures of them) seem to be everywhere on the internet, I think the title of our analysis toolbox the Canonic Techniques Symbolic Music Analysis Toolbox, or CATSMAT for short, is apt (though I am not being serious in this respect) and memorable. We believe that our project's significance, especially but not exclusively its tools for musical analysis, extends well beyond the canonic repertoire.

In terms of some of the advanced analysis tools we are building, the following list is indicative:

- A complete set of file agnostic musical element classes that can be compared, manipulated and sorted as C++ objects. This means, for example, a note can tell you whether it is higher or lower than another note simply by using the greater than (>) or less than (<) operator in a comparison of each note object; it also means that notes can be treated essentially like characters and subject to search algorithms originally developed for electronic alphabets.
- Automated detection of melodic repetition, inversion and retrograde (key for automatically identifying canons in massive corpora of data);
- Tools for the analysis using a historical model of dyadic or two-part counterpoint, including contrapuntal repetition and relations between dyadic voice pairs, and repetition of contrapuntal modules;
- Melodic segmentation and similarity detection algorithms, especially for repeated dyadic counterpoint;
- General tools to count pitches, durations and contrapuntal elements for each and every canon.

We plan to release these tools to the wider community after we have completed our research on early canonic techniques and solved issues of deployment across several platforms. Their use will require some knowledge of C++ programming, or writing stubs to permit their use in other programming languages.

[25] Philippe Canguilhem, "Singing upon the book according to Vicente Lusitano," *Early Music History* 30 (2011): 55–103, at 155–158; also see Philippe Canguilhem, *L'Improvisation polyphonique à la Renaissance* (Paris: Classiques Garnier, 2015).

By now it should be apparent that some programming abilities should be among the skill sets for digital musicologists. Python, C/C++ and Java are computer languages presently best suit this task, though the landscape of programming languages can change quickly, as seen for example with the rapid demise of Pascal in the early 1990s in favour of C. C++ is generally less popular than it once was with the rise of Java and other flavours of object-oriented C like Objective C, C# and the new kid on the block, Swift. However, C (and by extension C++) and to some extent Python (if one doesn't care too much about data typing) provide a sound foundation for these and future computer programming languages. While not every digital musicologist will need advanced knowledge of a computer programming language, some knowledge will assist the task of assessing available frameworks or designing new analysis tools. Pragmatically speaking, it is difficult to be both a musicologist and a programmer: the demands of both professions are great and time consuming, and the pressures upon maintaining traditional outputs for musicologists is still great in terms of securing continuing or tenured employment.

Computational tools also need to branch into new methods or approaches, for example modelling modes of musical cognition, either as a way of confirming or denying the largely analogue work that was done in 1990s around music cognition. The ability to deal with a larger data set to test the theories of Jackendoff and Lehrdahl or Narmour, or probablistic models like David Temperley's are fertile fields whose bounties are still to be reaped.[26] At the same time, these approaches to music cognition are devoid of any attempt to reconstruct models for music much earlier than 1750. With the growth of interest in reconstructing historical listening practices using computational modelling, this area of research stands to potentially transform early music history.[27] It has many complexities and pitfalls, but computational methods lower the risk of expending many years of research on one model to just several months or even weeks.

[26] Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* (Cambridge, Mass.: MIT Press, 1983); Eugene Narmour, *The analysis and cognition of basic melodic structures: the implication-realization model* (Chicago: University of Chicago Press, 1990); David Temperley, *The Cognition of Basic Musical Structures* (Cambridge, MA: MIT Press, 2001); David Temperley, *Music and Probability* (Cambridge, Mass.: The MIT Press, 2007).
[27] Marcus T. Pearce and Tuomas Eerola, "Music perception in historical audiences: Towards predictive models of music perception in historical audiences," *Journal of Interdisciplinary Music Studies* 8, no. 1&2 (2014–2016): 91–120.

To conclude, I want to step back a moment to address a potential concern that the field is at a juncture where musicologists could lose touch with traditional methods, which are founded upon a well-established set of academic and cultural skills. Digital musicology methods are not a replacement for traditional methods: they are an enhancement, a type of musicological bionic arm (or arms, if you will) still dependent upon the underlying knowledge at the heart of the field. At the same time, digital musicology is beginning to provide tools for the further testing and challenging of some of the assumptions about music laid down during musicology's foundation in the early twentieth century. A further and related concern is what McCarty has summarised as the "the almost total grip of hermeneutical inhibitions on digital humanities".[28] The task of collecting, processing and connecting data semantically only goes a part of the way in serving the historian's needs. Answering questions about what patterns (or clusters or exceptional "blips") in the data might mean and how might these results be understood within their historical frame remains the central challenge of digital historical musicology.

To return full circle to Cook's article on computational musicology, the key difference between non-digital musicology and digital musicology is that the interpretative framework of the latter assumes at once a greater clarity than ever before by virtue of large data sets. Yet, within this expansive field of vision, new opportunities arise for identifying sets of collective behaviours of communities of composers or the distinct originality of individual composers; or, to approach this from the perspective of reception, established conventions and expectations pitted against departures from the norm. At this point, the historian returns to the individuated work in question, to ask traditional questions about its status, text and use in a musical culture. Is it an exceptional creation or just an inept example of musical composition? Only the judgement of a historian will tell. A key difference between past hermeneutic approaches in music history and the horizon of opportunities emerging in digital musicology is that the historian can be now more confident that their conspectus is a repertoire-wide one (or technique-wide one as in the case of canons), as opposed to one that emanates from a particular focus upon a favourite composer or repertoire of music.

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[28] Willard McCarty, "Getting there from here. Remembering the future of digital humanities: Roberto Busa Award lecture 2013," *Literary and Linguistic Computing* 29, no. 3 (2014): 3. McCarty's deft turn of phrase explicit encapsulates Stephen Ramsay, *Reading Machines: Toward and Algorithmic Criticism* (Urbana: University of Illinois Press, 2011), Chapter 1.

Abstract

In a seminal publication on computational and comparative musicology, Nicholas Cook argued more than a decade ago that recent developments in computational musicology presented a significant opportunity for disciplinary renewal. Musicology, he said, was on the brink of new phase wherein "objective representations of music" could be rapidly and accurately compared and analysed using computers. Cook's largely retrospective conspectus of what I and others now call digital musicology—following the vogue of digital humanities—might seem prophetical, yet in other ways it cannot be faulted for missing its mark when it came to developments in the following decade. While Cook laid the blame for its delayed advent on the cultural turn in musicology, digital musicology today—which is more a way of enhancing musicological research than a particular approach in its own right—is on the brink of another revolution of sorts that promises to bring diverse disciplinary branches closer together. In addition to the extension of types of computer-assisted analysis already familiar to Cook, new generic models of data capable of linking music, image (including digitisations of music notation), sound and documentation are poised to leverage musicology into the age of the semantic World Wide Web. At the same time, advanced forms of computer modelling are being developed that simulate historical modes of listening and improvisation, thereby beginning to address research questions relevant to current debates in music cognition, music psychology and cultural studies, and musical creativity in the Middle Ages, Renaissance and beyond.

Short biography

Dr Jason Stoessel (PhD 2002) is a Senior Lecturer in Music at the University of New England, Australia. He has published widely on late medieval music and music theory, medieval culture and digital musicology. He was an Associate Investigator with the Australian Research Council's Centre of Excellence for the History of Emotions (2014–2017). He has received (with Denis Collins) consecutive three-year Discovery Grants from the Australian Research Council for the years 2015–2017 and 2018–2021. He regularly blogs about his research at jjstoessel.blog.

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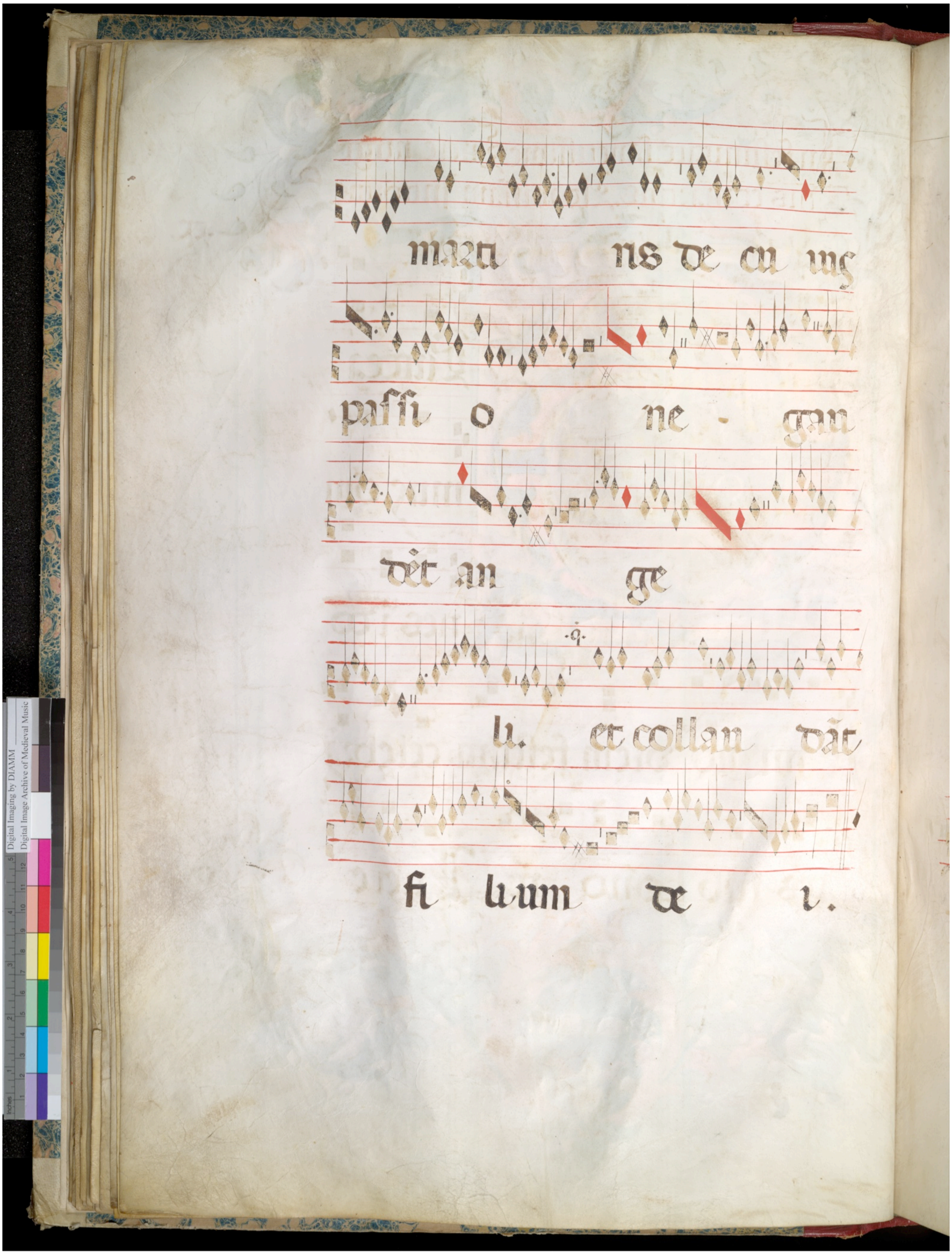

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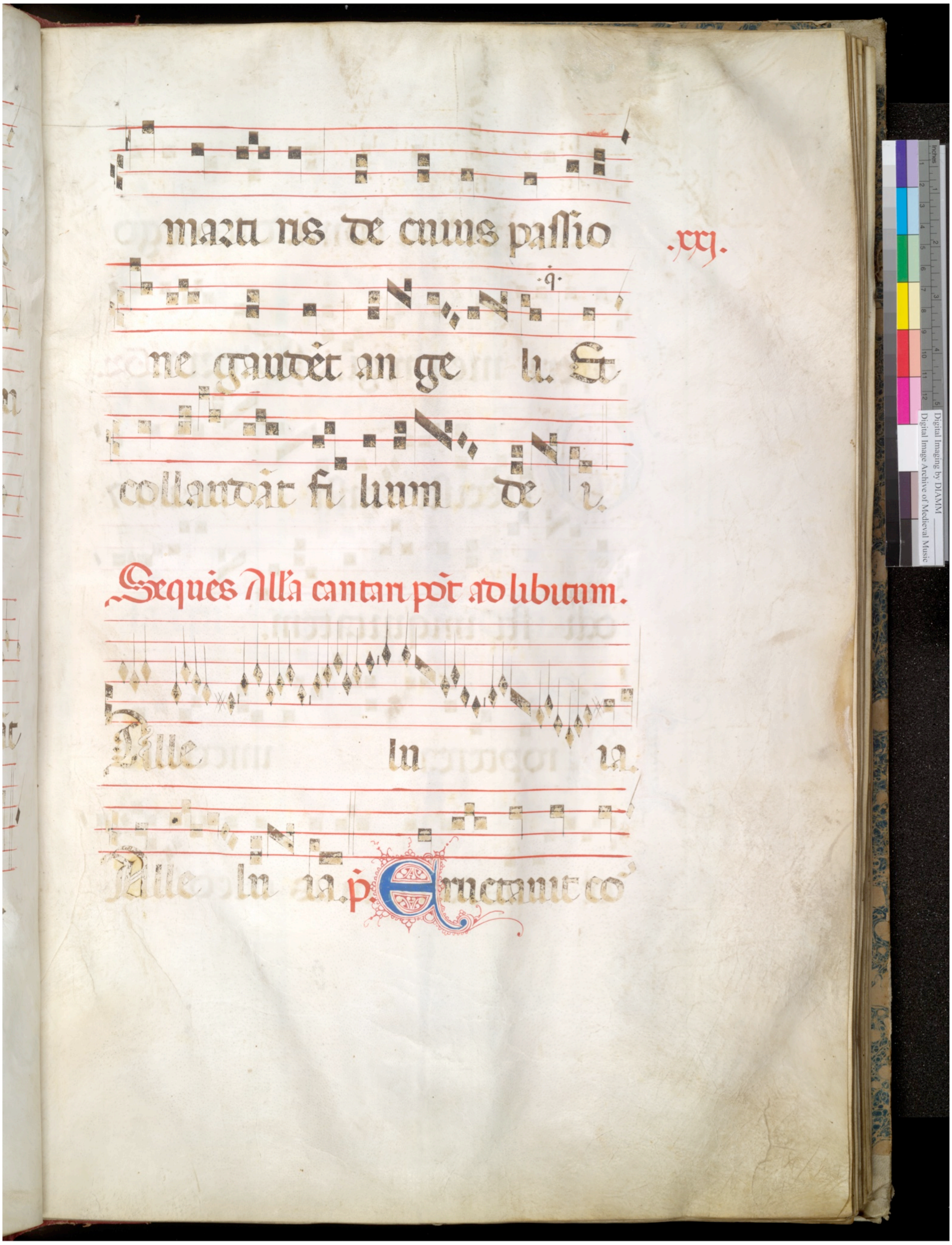

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