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Investigating Renaissance polyphony with digital tools

Development and application of the new software ReDiX for harmonic analysis

von

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Abstract

In recent years, a lot of effort has been spent in developing music analysis software capable of interpreting and analysing a vast quantity of data and extrapolating relevant features. This has been accompanied by a constantly growing amount of music available in machine-readable formats.

In this thesis, I will introduce my newly programmed software, ReDiX – Renaissance Digital eXplorer, which is designed for harmonic analysis of Renaissance polyphonic music. The development of this tool and its practical application to some current musicological research has enhanced the understanding of the music at hand, providing at times statistical confirmation of hypotheses, at time surprising answers, and opening up numerous fronts of discussion.

Contents

Preface

When starting to perform in-depth analysis of Renaissance music, I soon encountered questions that necessitated the investigation of large *corpora*. After examining and learning how to utilise the existing digital tools, I came to recognize that they all had specific limitations, particularly in terms of the ease with which harmonic analysis could be performed and the visualisation of the results. Consequently, I resolved to develop my own tool, ReDiX.

In doing so, I was able not only to answer my research questions more effectively, but, by developing the software and having to "translate" music-theoretical aspects into a computer readable format, I gained a much deeper knowledge of the music itself. This thesis will present the tool itself, as well as the reasoning and challenges behind its development and the practical application to some case studies.

I am grateful to Johannes Menke, who first recognized the potential of combining my programming expertise with my musical knowledge, and encouraged me to pursue this avenue. His feedback and suggestions were of great help in guiding my work. I am grateful to Florian Vogt for accepting to supervise this thesis. I thank him for his patience in following my often chaotic workflow, for his expertise on the topic, for the many invaluable and precise insights, and for dedicating time to me both within and outside of the planned weekly schedule. I am grateful to Fabian Moss, Hansjörg Ewert, Martin Kirnbauer and all the other colleagues present at the Kontrapunkt-Werkstatt in Würzburg (October 2023), where I first presented a seminar about the topic, for the profitable observations and the enriching final discussion. I am grateful to my *Schola* colleagues Iris, Elias, Tilman, Valentin S. and, in particular, to Sebina and Valentin R. for establishing a friendly and supportive environment. They were always ready to help, to motivate and to share their knowledge. I am very grateful to my wife and my son for bringing me back from the remote Scandinavian lands and the even more remote mathematical abstractions, and offering me the chance of getting involved once again with music.

Chapter 1

Introduction

1.1 Digital music analysis

The analysis of big chunks of data with computers is nowadays a common part of pure and applied research in many scientific disciplines. Although this phenomenon has yet to be fully embraced in musicology, the speed and precision of digital tools have attracted considerable interest in the field of musical analysis as well.[1] A digitally-aided analysis can be understood as consisting of three mutually interacting aspects.

Repertoire This denotes the available repertoire, on which the research will focus.

Research question This includes not only the specific problem to be investigated, but also the different questions which need to be answered, the direction of the research, and all the musicological considerations that guide our analysis.

Encoding This denotes the specific way in which the music is converted into machine-readable formats.

I will spend the next paragraphs defining more precisely these three elements, since they constitute the methodological foundation of the work I will present.

Repertoire Since quite some time, an enormous amount of scores is available on the web, particularly thanks to the International Music Score Library Project[2] and the Choral Public Domain Library[3], most of which are in PDF format. Though of great value for many purposes, this gigantic virtual library of PDF files is almost useless when

[1] See for example Huron 2002; Cuthbert and Ariza 2010 for surveys on two of the most used software nowadays; the CRIM project, *cf.* Freedman et al. 2020, is an interesting example of musicological research based on digital tools.

[2] `https://imslp.org` (active May 2024).

[3] `https://www.cpdl.org` (active May 2024).

wanting to perform digital analysis, since each page of PDF file, which is essentially a picture, cannot be understood as containing musical elements (staves, measures, notes, pauses, etc.) from any software, let alone having a precise representation of the relations between those elements.[4] Unfortunately, this difficulty makes the large majority of the available scores useless for the purpose of digital analysis on a large set of pieces. A computer-readable format is a file format that captures the nature and hierarchy of the musical elements in such a way, that a software is able to recognise them and modify them in a musically meaningful way. Examples of transformations include: transposing, removing a stave from a score, computing intervals between notes, and so forth. In digital musicology, the relative high number of formats that represent music in a computer-readable manner does not necessarily help the cause. For each format, there exists a software (or a software family) that is capable of processing that format; however, the conversion from one type to another is, as of yet, unsatisfactory. Digital formats for music include: MEI, MusicXML, MIDI, MuseData, LilyPond, humdrum. The lack of a commonly recognized standard causes different encoding projects to utilise different formats, which in turn poses restrictions to the size of any coherently encoded repertoire.

Research question The musicological problem and the question formulation which guide a digitally-aided research must take into account the peculiarity and limitations of digital tools. In particular, in order to obtain a meaningful answer, the questions asked to any software must be composed of unambiguously defined concepts which a machine is able to grasp. Since every digital information is in the end of numeric nature, this means that the digital analysis can only handle precisely defined mathematical objects. This does not imply that the question must necessarily contain numbers: here is a typical example. The question "how many cadences are there in Bach's *Brandenburg concerts*?" is in principle not a well-defined question, because the concept of a cadence is does not (yet) have an univocal definition. But the question can be mathematically well posed, by first describing and defining a cadence. For example, regarding perfect cadences, these could be defined as a pattern of the form V→I or V^7→I, which can in turn be translated into an exact numerical representation. This however, necessitates of another definition: what is a V (resp. I) degree? If the piece does not modulate, this is

[4]Through the many ongoing projects of optical music recognition (OMR), the situation might change relatively soon in the future. Although the current stand looks promising for the basic musical elements, and consequently for pieces which employ a relatively simple notation, the obstacles to an automatic full faithful representation of the whole musical complexity seem yet to pose challenging problems. On this subject, see Rebelo et al. 2012; Calvo-Zaragoza, Jr, and Pacha 2020. A different approach tries to retrieve musical information from audio tracks (Music Information Retrieval), see for instance the projects of the University of Würzburg (`https://www.informatik.uni-wuerzburg.de/ch/research/projects/` (May 2024)) and the survey Casey et al. 2008.

easily defined, but how to numerically define/detect a modulation, and assign the new scale-degrees the notes? As can be observed from this brief example, the necessity of mathematically defining every object one needs to digitally count/find/analyze, sheds new light on the way we think about seemingly well-defined music-theoretical concepts. I think that confronting this challenge and having to adapt and expand our knowledge merely to pose a question is a profoundly positive, often underestimated consequence of working with digital tools.

Encoding Since music is a highly complex structure, a digital encoding of it may follow different paths. Let us take, for example, a four-part choral piece. One could encode it hierarchically (this is the concept behind the MEI format), that is, as a deeply nested sequence of containers. See Example 1: a `measure` contains four `staff`s, each `staff` contains a `layer`, each `layer` contains a `note` (or a `rest`), an so on.

```
<measure xml:id="measure-L1" n="1">
  <staff xml:id="staff-L11F4" n="1">
    <layer xml:id="layer-L1F4N1" n="1">
      <note xml:id="note-L21F4" dur="breve" oct="4" pname="e" accid.ges="n"/>
    </layer>
  </staff>
  <staff xml:id="staff-L11F3" n="2">
    <layer xml:id="layer-L1F3N1" n="1">
      <note xml:id="note-L21F3" dur="breve" oct="4" pname="e" accid.ges="n"/>
    </layer>
  </staff>
  <staff xml:id="staff-L11F2" n="3">
    <layer xml:id="layer-L1F2N1" n="1">
      <mRest xml:id="mrest-L21F2" />
    </layer>
  </staff>
  <staff xml:id="staff-L11F1" n="4">
    <layer xml:id="layer-L1F1N1" n="1">
      <note xml:id="note-L21F1" dur="breve" oct="3" pname="e" accid.ges="n"/>
    </layer>
  </staff>
</measure>
```

Example 1. Josquin des Prez, *Mille regretz*, bar 1 encoded in MEI format.

This type of encoding is typically very well suited for graphical rendering of scores: indeed, the majority of notation software (MuseScore, Sibelius, Finale, etc.) use an analogously structured file format to save music. On the other hand, such a structure makes it more difficult to extrapolate vertical components (chords), since notes which sound at the same time belong to different containers, with possibly different nesting depths. Also melodies (horizontal components) are split inside different containers (`Bars`), and would be available as single objects only after a careful reconstruction. A linear structure organized along the time-flow, as employed for example in the humdrum

format,[5] might suit better the purpose of analysing vertical and horizontal components, but make other aspects less transparent. For advanced projects, one might want to customize the encoding further, by leaving out certain aspects, or highlight others. This can be done by starting from an existing database in a given format and by adjusting it through algorithmic procedures.[6]

These three key elements of a musicological digital analysis, namely the *repertoire*, the *research question* and the *encoding*, form a strongly interdependent network. The influence of the repertoire on the problem, and vice versa, is quite self-evident: the problem to be investigated refers to the available repertoire, and the music at hand limits the direction of the search. It would be obviously impossible to perform a digital analysis on pieces that have not been digitised! The encoding may depend on the selected repertoire: Gregorian chant, mensural vocal music, baroque and romantic instrumental music all contain different musical components and require changes in the encoding language. The problem of interest also also exerts a significant influence on the encoding one selects. As mentioned above, different formats emphasise different features, and the choice might fall on one or the other according to the questions that need to be addressed.

1.2 Motivation and goals: a practical review of existing tools

The aspects presented above and their interaction will be discussed in this section for the specific case of my project ReDiX – Renaissance Digital eXplorer. My personal interest in Renaissance polyphonic music and my flair for digital tools and programming led me quite quickly in wanting to investigate some questions and problems on a large scale with the aid of a computer. This hope was supported by the existence of a substantial amount of music of this style in digital format. The main projects in this regard (Josquin Research Project, 1520s Project) and the collection of Palestrina's Masses will be discussed in detail in section 2.1.

Among the various aspects of this musical style that could be studied, I was particularly interested in the harmony. I aimed to be able to quickly identify specific voice-dispositions across the entire repertoire, in order to be able to locate and compare similar passages. This could be particularly useful when studying the employment

[5] This encoding language will be discussed more in detail in section 2.4.

[6] For repertoires of moderate size, also the manual annotation of various features is possible. A very interesting project which relies on this is the *Lassus Tricinium Project* by Wolfgang Drescher, see subsection 2.1.4.

of dissonances. I also wanted to draw statistics on the use of specific chords in different composers: that the harmony in Josquin is not Palestrina's is evident, although both rely only on root- and sixth-chords as basic consonant material. Is it possible to numerically trace down these stylistic differences?

Two key features that guided me in the development of ReDiX were a user-friendly interface that does not require any prior knowledge of any programming language, and the ability to easily locate and view the musical passages that match the user's request. The former allows a large number of musicologists and musicians who are not programmers to access the tool and employ it in their research. The latter, which in my opinion should be an important feature for any music-related software, is at the same time important and not easy to implement, since the raw digital music formats are quite non-graphic in their representation: I already showed above how the MEI format looks like, and an example for the humdrum format will be shown in section 2.4. In order to achieve this graphical clarity, I developed ReDiX as a simple webpage, where the user can input a search query and obtain a list of musical excerpts matching the request. The code and the webpage are available open source on github.[7]

To have a GUI (Graphical User Interface) where the user must not write any line of code might seem superfluous to many programmers; however, I believe that it is of the utmost importance not to discourage many people to incorporate digital tools in music analysis. I was discouraged myself by the existing tools, and I will explain why with an example. Let us pose a relatively simple question, which arose from my personal experience in a real-life teaching situation: what is the proportion of root-chords in the music of Josquin? As mentioned above, questions must be mathematically well defined. What do I mean, then, by "proportion" and "chord"? I will leave these definitions deliberately flexible, and I will specify them case by case in the examples.

The humdrum toolkit

The humdrum toolkit is a light and powerful set of *bash*[8] commands, which rely on a specific digital format (`krn`). The following description can be found on humdrum's homepage.

> Humdrum was originally created by David Huron in the 1980s, and it has been used steadily for decades. The Humdrum "universe" might be thought

[7]The webpage must be run locally. Instructions for the download and the setup are avilable at `https://github.com/ugobindini/redix` (May 2024).

[8]The Bash (Bourne Again SHell) is a textual environment (nowadays common to all operating systems) where basic computer programs can be launched by typing commands. For an introduction, see `https://en.wikipedia.org/wiki/Bash_(Unix_shell)` (May 2024); the full manual is available at `https://www.gnu.org/software/bash/manual/` (May 2024).

> of as consisting of two main segments: the notational style (particularly the `**kern` representation) and the software for analyzing the notated material. This software exists in the original format (the Humdrum Toolkit), as well as the updated and extended versions (such as Craig Sapp's Humdrum Extras, and VHV/humlib).[9]

The repertoire currently encoded in `krn` format is mostly available at `https://kern.humdrum.org`, where over 100,000 pieces are available for download, mostly from the Baroque, Classic and Romantic era. Three other big datasets for Renaissance polyphony, on which I based ReDiX, are referenced to and described in section 2.1.

The fundamental function of humdrum commands is to automatically annotate musical pieces with supplementary information, including melodic and harmonic intervals, markings related to specific features, and figured bass. Additionally, these commands can be used to extrapolate elements of the music, such as single voices or bars, or to schematize the musical content, including counterpoint structure. These annotations, added to the original file or exported to a new file, can then be processed by plain bash commands which perform text manipulation (searching for patterns, sorting, extracting lines containing given elements, etc.). This mechanism allows for lightweight files and high computational speed.[10] However, the readability of the syntax is somewhat limited, and even for relatively simple tasks, it is necessary to be very familiar not only with the toolkit itself, but also with the other bash commands and with *regular expressions*.[11] These were for me quite challenging obstacles, and although I was able to obtain some answers to my simplest questions, the amount of work and trial-and-error time needed was demoralising.

As a demonstration, let me show how to answer the question posed above. After installing the toolkit[12], launching a terminal, consulting the list of available tools[13] and studying the manual of the command `sonority`, which identifies "vertical chordal sonority across multiple **kern spines"[14], I arrived at the following construction

```
sonority -f t:i h://jrp/Jos | grep :0 | sort | uniq -c
```

which classifies the root-chords in Josquin's music and prints the following output.

[9] `https://www.humdrum.org` (May 2024).

[10] The commands described below take fractions of a second to output the results.

[11] Regular expressions are a standard textual syntax for representing patterns: see `https://en.wikipedia.org/wiki/Regular_expression` (May 2024) for a detailed description and an introduction to this programming language.

[12] Currently not possible on Windows-based Operative Systems.

[13] `https://www.humdrum.org/tool/index.html`.

[14] `https://extras.humdrum.org/man/sonority/` (May 2024).

```
5 aug:0
790 dim:0
476 dom7:0
349 dom7x5:0
1 french6:0
144 halfdim7:0
19506 incmaj:0
23718 incmajx3:0
24864 incmin:0
1 italian6:0
33504 maj:0
938 majmaj7:0
33632 min:0
3 minmaj7:0
1209 minmin7:0
2792 minmin7x5:0
```

Notice that the above arrangement of keywords follows the bash syntax and makes use of the regular expression `:0`. In particular, the *pipe* character (`|`) chains two commands by letting the output of the preceding one be the input of the following one. In the above construction, the first command (`sonority`) is the only one specific to the humdrum toolkit, while the others (`grep`, `sort`, `uniq`) are common bash commands for text manipulation.

The result indicates that in the music of Josquin there are 33504 major root-chords, 33632 minor root-chords, 19506 incomplete major chords and 24864 incomplete minor chords (missing the 5^{th}), and 23718 root-chords missing the 3^{rd}. By launching two variants of the above command, namely

```
sonority -f t:i h://jrp/Jos | grep :[0-3] | sort | wc -l
sonority -f t:i h://jrp/Jos | grep ^X | sort | uniq -c
```

one gets the total number of classified (resp. unclassified[15]) chords in Josquin's music, that is 195813 (resp. 42058).[16], and it is thus possible to obtain the proportions of 28,2% complete and 28,6% incomplete root-chords on the total chords in Josquin's music. Notice once again the regular expressions I needed to construct, "`:[0-3]`" and "`^X`", which are already getting quite involved.

[15]Not reducible to stacked thirds.

[16]Careful analysis of the output of similar commands shows that 3 of these are actually mensural proportions, which have a very similar syntax.

Given how the humdrum format encodes music, we can finally specifically define in this case the meaning of "chord" and (consequently) "proportion": this is explained in detail in subsection 2.3.2.

The advantages of working with the humdrum toolkit are primarily the speed and the relative simplicity and lightness of the `krn` encoding format, together with a large (and growing) online-available repertoire, which can be quickly included in the analysis. The disadvantages are a very complex and obscure syntax, which combines regular expressions, humdrum commands and bash instructions, and the significant graphical limitation of working exclusively with text files. I was indeed never able to automatically display in score format the passages I selected; instead, the passages had to be separately browsed, opened and scrolled through in PDF files.

The Music21 package

Music21[17] is a powerful library which extends the widely used `python` programming language; knowledge of this language is a necessary prerequisite to its employment.

The `music21` package offers a set of powerful commands for music manipulation, encompassing the most crucial aspects (harmonic, melodic, rhythmic). However, in order to investigate refined questions, the user's involvement in quite a bit of `python` programming is unavoidable. The syntax is more transparent than that of humdrum, but the speed not comparable: even for relatively simple tasks, the waiting time is quite long (see below). It is in principle possible to obtain a graphical display of selected score snippets, but this requires a significant effort.

A moderately large *corpus*[18] is available, but unfortunately, when dealing with Renaissance polyphonic music, apart from the impressive collection of Palestrina's masses, the core *corpus* of this library contains only a dozen of other works.

The first step for the proposed study-case is therefore to download all Josquin's pieces in some digital format, and load them into a `python` variable (named in this example `josquinPieces`). This is obtained with the following line of `python` code.[19]

```
josquinPieces = [converter.parse(f"jos/{fname}") for fname in
    os.listdir('jos') if not fname.startswith('.')]
```

Tested on a MacBook Pro with M1 chip, this takes about one minute, so already a non-negligible amount of time. With some more coding, one can transform this

[17] `https://web.mit.edu/music21/`.

[18] For the full list of available pieces, see `https://web.mit.edu/music21/doc/about/referenceCorpus.html`.

[19] This example assumes that the desired pieces are downloaded and saved in the local folder named "jos".

collection of scores into a local *corpus*, which remains available across sessions. This would result in a reduction in loading time, although the necessary programming skills to obtain this are of a higher grade.

The statistics on the types of chords can then by stored in a `dictionary`[20] named "counter" by the following code-snippet.

```
counter = {'chord': 0}
for piece in josquinPieces:
  reduct = piece.chordify()
  for c in reduct.recurse().getElementsByClass(chord.Chord):
    c.closedPosition(forceOctave=4, inPlace=True)
    c.annotateIntervals(inPlace=True)
    counter['chord'] += 1
    ciphering = "".join([l.text for l in c.lyrics])
    counter[ciphering] = counter.get(ciphering, 0) + 1
```

After about 4.5 minutes of running time, the program is able to print the desired results: of 257175 total chords, 68095 are complete root-chords (26.5%) and 68552 are incomplete root-chords (26.7%).[21]

The advantages of working with Music21 are a highly flexible and well-written library, with a wide range of functions for analysing different musical aspects, and the employment of a widely used programming language. With some effort, also getting visual access to specific music-snippets is within reach. The main disadvantages are that users must first learn the `python` programming language, the non-graphical interface and the slow speed in loading the repertoire and processing the data.

A preview: ReDiX

The main user interface of ReDiX, a search form, is shown in Figure 1.1.

[20] A dictionary is a `python` object which associates keys with data. In this case, for every different chord-ciphering, the number of such chords is stored.

[21] These proportions are lower than those obtained with the humdrum toolkit, since the latter does not include "empty" sonorities with only unisons and octave doublings in the count of total chords.

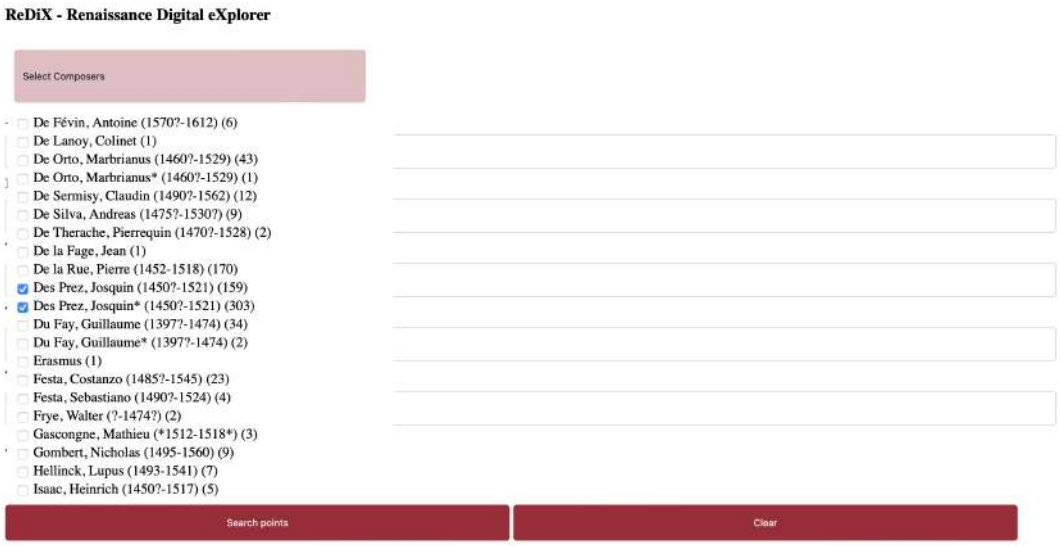


Figure 1.2: Selecting all (secure and not-secure) Josquin's pieces.

Figure 1.1: The homepage of ReDiX.

After selecting the desired composer(s) from the drop-down menu,[22] as shown in Figure 1.2, in this case one does not need to specify further restrictions, since we are interested in collecting statistics on the whole corpus of Josquin's music. Launching the search yields the table shown in Figure 1.3 (since it is a very long table, I only display here the first entries; all "points" (chords) not shown here are increasingly rarer dissonant combinations.[23]

One can see the number and proportion of chords with each specific figured-bass

[22]Josquin's pieces are divided in secure and not-secure (marked with a *). See the more detailed discussion in subsection 2.1.1.

[23]For a precise definition of what a "point" is, see section 2.4.

Collected 251118 points on beats 0 1 2 3 from the following composer(s): Des Prez, Josquin; Des Prez, Josquin*.

Root chords: 150381 (59.88 %) sixth chords: 40236 (16.02 %) dissonances: 60501 (24.09 %)

Figure	# points	Ratio
[3,5]	67269	26.79 %
[3]	43226	17.21 %
[5]	23564	9.38 %
[3,6]	22683	9.03 %
[6]	17553	6.99 %
[]	16322	6.5 %
[4,5]	5857	2.33 %
[4]	5027	2.0 %
[3,7]	4329	1.72 %
[2]	4318	1.72 %
[7]	4079	1.62 %
[2,5]	3320	1.32 %
[3,4]	3254	1.3 %
[3,5,7]	2782	1.11 %
[2,3,5]	2573	1.02 %
[4,6]	2555	1.02 %
[3,4,5]	2217	0.88 %

Figure 1.3: All of Josquin's vertical sonorities in one table (here cut short due to lack of space).

ciphering.[24] By clicking on the figured bass ciphering, all the corresponding musical snippets can be displayed in score format. A more detailed user's guide for a finer tuning of the search parameters is provided in section 2.6.

1.3 Overview of the following chapters

When I decided to program a new software for harmonic analysis in Renaissance music, I underestimated the extent of the music-theoretical challenges that would need to be addressed. These include the selection of the repertoire, the definition of intervals and chords, and the description of rhythm. In chapter 2, I will present the development

[24]To understand why the total numbers are slightly different than those obtained with other softwares, see again the discussion about attribution to Josquin and the pieces I decided to discard from the JRP database in subsection 2.1.1.

of ReDiX from a technical and musicological viewpoint, documenting the challenges I faced, and the decisions I took. In particular, I will present the repertoire included in the software, the types of problems and questions that the software was designed to address, and the encoding used in the software. A short but comprehensive user guide for the website will conclude the chapter.

Once the software was ready, although further improvements will surely be implemented in the future, I was able to address some of the research questions I wanted to investigate. In chapter 3, I will demonstrate how the use of ReDiX might shed a new light on some case studies. This does not intend to exhaust the potential of the software, but rather to demonstrate which sort of musicological questions might enjoy a widened perspective if one can rely on digital tools. One problem will regard the comparison between styles of different composers from different periods, with a particular focus on the use of sixth-chords. I will then approach two problems of doubtful attribution. In analysing these examples, I will especially try to highlight the interaction between the results of the digital analysis and the current state of musicological research.

Finally, in the concluding chapter 3.2.2 I will discuss how the development and utilisation of digital tools enhanced my understanding of the underlying repertoire and broadened my perspective on harmonic aspects of Renaissance polyphony. Furthermore, I will present possible future directions for the development of ReDiX and for the advancement of digitally-aided analysis in general. In Appendix , the 2870 pieces that constitute ReDiX's current repertoire are presented in a (long) table.

Chapter 2

Developing ReDiX

2.1 Collecting and selecting ReDiX's repertoire

As stated in the introduction, my choice of working with Renaissance polyphonic style was influenced by the availability of a substantial quantity of music encoded in a computer-readable format. However, it should be noted that certain prominent composers, such as Lassus and de Victoria, will not be included in the discussion due to the lack of available digital transcriptions. The strong digital trend which is currently leading the scientific world will cause more and more music to be encoded in digital format. This will, in turn, allow tools like ReDiX the reliance on a bigger and bigger repertoire in the future.

I will first present the three main sources, the union of which constitutes the currently available repertoire in ReDiX; I will then present a couple of databases which, though available, were not included in ReDiX's repertoire for the purpose of the analysis presented in chapter 3. It is important to remark that the availability of these repertoires offers at any point the possibility of quickly including them as well for future research projects. It is also important to note that this kind of collaboration and inclusion of databases from one project to the other is only possible when projects adhere to an open-source policy. This should become standard practice in scholarly work when hoping for a quick and efficient development of digital tools in musicology.

2.1.1 The Josquin Research Project

A real fortune is the large database that has been created by the "Josquin Research Project" (JRP).[1] The project was founded by Jesse Rodin in 2010 in collaboration with

[1] `https://josquin.stanford.edu` (May 2024).

Craig Sapp at CCARH[2].

> The JRP was provided funding to confront a well-known scholarly problem: of roughly 340 works attributed to Josquin des Prez, only a fraction are securely attributed. As an initial goal, we sought to digitize all these works to enable comparative analysis.[3]

The project then extended to include a large database of many composers, whose period of activity overlaps with Josquin's (*1450–55, †1521). These include:[4]

Alexander Agricola, *1446 †1506
Gilles Binchois, *ca. 1400 †1460
Antoine Brumel, *ca. 1460 †after 1512
Antoine Busnoys, *ca. 1435 †before 1492
Loyset Compère, *ca. 1440/45 †1518
Ludwig Daser, *ca. 1526 †1589
Antoine De Févin, *ca. 1470 †1511/12
Pierre De La Rue, *ca. 1452 †1518
Marbrianus De Orto, *ca. 1460 †1529
Guillaume Du Fay, *ca. 1397 †1474
Walter Frye, fl. ca. 1445–1475
Henricus Isaac, *ca. 1450 †1517
Jean Japart, *ca. 1450 † after 1500
Johannes Martini, *ca. 1430/40 †1497
Jean Mouton, * before 1459 †1522
Jacob Obrecht, *ca. 1457/58 †1505
Johannes Okeghem, * ca. 1420/25 †1497
Matthaeus Pipelare, *ca. 1450 †1510/16
Johannes Regis, *ca. 1425 †1496
Johannes Tinctoris, *ca. 1435 †1511
Gaspar van Weerbeke, *ca. 1445 †after 1517

In addition, about 80 anonymous pieces are encoded. The music is available in many different formats: PDF, MIDI, humdrum, MuseData, NoteArray, JSON Piano Roll, MusixXML, MEI, MP3. For my project, I selected the humdrum format, as the representation of music as a time-sequence of vertical sonorities fits with the goals I had for ReDiX, and it simplifies the integration of the pieces in my tool. This will be explained in detail in section 2.4.

Given the main goal for which this database was produced, one can understand that it includes some fragmentary material, and that meticulous care was put into the attribution of the works. However, for ReDiX, the inclusion of fragments (one surviving voice of a polyphonic piece, or pieces where one or more voices are missing) is not appropriate. Since the objective is to investigate the harmony of Renaissance music, it is necessary to have musical material that is complete with respect to the number of voices. Moreover, the detailed discussion of the attribution for each single

[2]Packard Humanities Institute's Center for Computer Assisted Research in the Humanities: `http://www.ccarh.org` (May 2024).

[3]`https://josquin.stanford.edu/about` (May 2024).

[4]Here and in the following sections, the composers' dates are taken from *Die Musik in Geschichte und Gegenwart*, `https://www.mgg-online.com` (May 2024).

piece is not the foremost intention of my project. In JRP, Jesse Rodin conducted a meticulous investigation, particularly with regard to the compositions of Josquin Des Prez. These are categorised into four main groups, designated by numbers 1 to 4: secure (1), provisionally attributable (2), problematic (3), the rest/almost surely by another author (4).[5] In order to keep track of this, but not to overcomplicate the queries to the database in my project, I decided to divide the pieces in: secure pieces (corresponds to levels 1 and 2 in JRP) and not secure pieces (levels 3 and 4). In the latter case, the composer name is annotated with a * in ReDiX.

Should a particular phenomenon be encountered during an analysis using ReDiX, there is always the option of deepening the investigation by examining the attribution issues for that piece at a later stage. In this way, one is also able to analyze at once all the pieces which are attributable to Josquin, producing a frame which can be confronted (for example) with an unsecure piece. More on this in section 3.2.

Since I was planning to work with databases originating from different sources, I decided first of all to adopt a standard form for the composers name. I chose `Surname, Name`, where the surname also includes particles (De, De la, etc.). Secondly, I sought to standardise the titles of the pieces, including in the title (after a slash) eventual movements specifications or alternative titles. For example, the Kyrie of a Missa "L'homme armé" is titled `Missa L'homme armé / Kyrie`. These operations were performed automatically on the entire repertoire, with the assistance of suitable programming scripts.

A successive step was to look carefully through the entries, correct some mistakes or typos in titles or composer names, and exclude from the repertoire pieces (*i.e.*, files) according to the reasoning explained above. I summarize and justify these operations in the following paragraphs.

The anonymous song "J'ay pris amours a ma devise" was encoded in three versions: one with high *contratenor* (judged as probably the original), one with low *contratenor*, one with low *contratenor* where all the strophes of the *rondeau* form are written out. I decided to keep only the first two mentioned, since the latter merely repeats multiple times the musical material of the second.

The title of Busnoys' motet "Anima mea liquefacta est / Stirps Jesse" was misspelled as "Stirips Jesse": corrected.

Two pieces (De La Rue's "Missa Pro Fidelibus Defunctis / Communio I" and Josquin's "Missa D'ung aultre amer / Credo") were encoded twice, but one copy was corrupted. This was discarded (and the other copy kept). The corruption of the file is also evident on the JRP website: when trying to open these pieces, the follow-

[5] On this topic, *cf.* also Rodin 2015, where the author proposes a list of "Fifty-one works of extremely secure attribution" to Josquin Des Prez. These correspond with the pieces labeled as secure (1) in JRP.

ing error is prompted: `ID `Rue1024g.a'` (resp. `` `Jos0703c.b' ``) `contains invalid characters.`

From the big pot of non securely Josquin-attributed works in JRP, I decided to exclude the following fragments.

- "Gloria de Beata Virgine". The discantus is in S. Gall 463, and a 3-voice fragment of 11 breves is in a treatise by Glarean.
- Zacconi 1592 fragment. Two excerpts of one voice, totalling 11 *longae*, which are said to come from a motet "Celi enarrant gloriam Dei". The complete version of the homonymous motet is kept as spurious Josquin work.
- Bologna 142 fragment "Fors seulement". One voice said to come from a 6-voice setting of the song. The voice is nearly identical to Ockeghem's *tenor*.
- "Iniquos odio habui". A *tenor* in relative long note values, no more information is known.
- "Inter natos mulierum". An intabulature in BerlS 40026: the fact that this is not a vocal piece, and is heavily diminuted, would alter the search results when analyzing vocal polyphony.
- "Mirabilia testimonia tua". A complete *superius* part, no more information is known.
- "Omnes gentes". Two one-voice fragments, a *superius* (6 perfect *longae*), an *altus* (4 perfect *longae*).
- "Adieu mes amours". Of this 6-voice version, texted as "Ave Maria", only 3 voices survived. This does not allow for a meaningful analysis of the harmony.
- "Exultent et letentur" (Zacconi 1592). One voice (*altus* or *tenor* range) totalling 5 perfect *longae*.
- "Castigans castigavit me dominus". One voice (*Bassus*), totalling 11 perfect *longae*.
- "Seculum nostrum". One voice (*altus*) totalling 6 perfect *longae*.
- "In deficiendo". One voice (*altus*) totalling 6 perfect *longae*
- "Scriptum est enim". One voice (*superius*) totalling 5 perfect *longae*

In the pieces of Ockeghem, there was a common occurence of songs which were doubly encoded, with one corrupted copy and one regular copy. The corrupted versions raise on the JRP website the error `Bad MD5 tag`, of which I ignore the nature. I therefore kept only the non-corrupted version of each of the following: "Fors seulement l'attente", "Fors seullement contre", "L'autre d'antan", "La despourveue", "Ma bouche rit", "Ma maistresse", "Se vostre cuer", "Ung aultre l'a", "Permanent vierge / Pulchra es / Sancta Dei genitrix".

I excluded Tinctoris' fragment "Comme femme", as it is one voice (*superius*), with diminutions as in an instrumental version.

After all these adjustments, the database on which I based this thesis contains pieces from the following composers (in brackets, the number of pieces).[6]

Agricola, Alexander (10)
Brumel, Antoine (6)
Busnoys, Antoine (66)
Busnoys, Antoine* (2)
Compére, Loyset (27)
De Févin, Antoine (6)
De la Rue, Pierre (170)
De Orto, Marbrianus (43)
De Orto, Marbrianus* (1)
Des Prez, Josquin (159)
Des Prez, Josquin* (303)
Du Fay, Guillaume (34)
Du Fay, Guillaume* (2)
Frye, Walter (2)
Isaac, Heinrich (5)
Japart, Jean (22)
Martini, Johannes (118)
Martini, Johannes* (3)
Mouton, Jean (21)
Obrecht, Jacob (15)
Ockeghem, Johannes (100)
Ockeghem, Johannes* (2)
Pipelare, Matthaeus (5)
Regis, Johannes (4)
Tinctoris, Johannes (18)

The complete list of the pieces can be found in Appendix .

2.1.2 The 1520s Project

The 1520s Project[7], which shares with the JRP the technical director Craig Sapp, takes on the challenge of "making the repertoire of the early sixteenth century available for performance, study, and analysis".[8] Quoting again from the website:

> Founded in 2019 by Benjamin Ory, the project offers high-quality digital editions of the music in four data types: as PDFs, as Sibelius files, as

[6]Here, and in the following sections, each mass movement counts as a separate piece.
[7]`https://1520s-project.org`.
[8]`https://1520s-project.org/about/` (May 2024).

MusicXML files, and as Humdrum files.[9]

Given the different intention of the project, which compared to JRP focuses more on making a large amount of music available, and less on collecting all possible fragments related to one composer, the emerging database required much less adaptation to be employed for my aim. I only had to adjust the composers' names and the titles according to the standard already mentioned, and correct a small typo: one piece of Costanzo Festa was attributed to "Costnazo Festa".

The database contains one fragment by Ludwig Senfl (in D-HRD Fü MS 9820), a 4-voice passage totalling 18 imperfect breves.[10] Since there are no missing voices, the harmonic analysis can be carried out on it with meaningful results, so this piece was included in the ReDiX database.

The following table illustrates the content of this database (in brackets, the number of pieces).

Arcadelt, Jacques *1507 †1568 (1)
Barra, Hotinet fl. 1510–1523 (1)
Bauldeweyn, Noel (7)
Bisgueria (1)
Champion, Nicolas * ca. 1475 †1533 (1)
Conseil, Jean *ca. 1498/1501 †1535 (4)
Daser, Ludwig *ca. 1526 †1589 (5)
De Lanoy, Colinet (1)
De Sermisy, Claudin *ca. 1490 †1562 (12)
De Silva, Andreas *ca. 1475/80 †after 1522 (9)
De Therache, Pierrequin *ca. 1470 †1528 (2)
De la Fage, Jean fl. ca. 1515–1535 (1)
Erasmus (1)
Festa, Costanzo *ca. 1480/90 †1545 (23)
Festa, Sebastiano †1524 (4)
Gascongne, Mathieu fl. 1512–1518 (3)
Gombert, Nicolas *ca. 1495 †ca. 1560 (9)
Hellinck, Lupus *1493/94 †before 1541 (7)
Jachet of Mantua *1483 †1559 (16)
Jacotin (8)
Le Santier, Jean (1)
Lhéritier, Jean *ca. 1480/85 †after 1552 (16)
Lupi, Johannes *ca. 1506 †1539 (3)
Maistre Jhan *ca. 1490 †after 1541 (9)
Moulu, Pierre *1484 †after 1540 (8)
Renaldo (2)
Richafort, Jean *ca. 1480 †ca. 1550 (28)
Senfl, Ludwig *ca. 1490 †1543 (30)
Verdelot, Philippe *ca. 1480/85 †1527/30 (41)
Vinders, Jheronimus fl. 1510–1550 (3)
Willaert, Adrian *ca. 1490 †1562 (60)

The complete list of the pieces is provided in Appendix .

The 1520s project is still ongoing: this picture captures the state of the database on March 3rd 2024, and the analysis of the next chapter is based on these pieces. Future

[9] *Ibid.*

[10] The 1520s project collaborates with the New Senfl Edition: this is probably the reason why this fragment was included in a database otherwise containing only complete pieces.

versions of my software, and future research on this topic, will be able to rely on a bigger pool of digitized pieces.

2.1.3 Palestrina's Masses

The third big contribution to ReDiX consists of the corpus of Palestrina's Masses. These files (in humdrum format) were encoded by Bret Aarden starting from MIDI files. These in turn were produced by John Mille, starting from the 35-volume *opera omnia* edited by Raffaele Casimiri.[11] The `krn` files I used are available as part of the larger corpus associated with the aforementioned software *music21*, and can be found on git-hub.[12]

In comparison with the other two examples, I suspect that this collection of data is somewhat less reliable from the editorial viewpoint. When testing the basic functionalities of ReDiX, one of the things I tried was asking for every possible vertical sonority in Palestrina's pieces, and the last entry in the search result, a chord occurring only *once* on the beat in the whole corpus of Palestrina's masses, has the following ciphering `[2,5,7]`. This passage is shown in Figure 2.1, a snapshot from the ReDiX webpage: I strongly suspect that the *Gamma-ut* in the lowest voice should be a semibreve instead of a breve in bar 32.

Although one cannot judge such a colossal transcription work from one mistake, I have not found so far analogous cases in the JRP of the 1520s Project files.

2.1.4 Some available yet not included *corpora*

For the purpose of this thesis, I based my research on the repertoire described so far. Since ReDiX is partly an ongoing project, other pieces will be included in the future, thus allowing for a wider range of research questions to be investigated. Some online available notable collections were left out for now, based on different reasons.

Lassus Tricinium Project

The Lassus Tricinium Project[13], directed by Wolfgang Drescher (HSM Freiburg), makes use of humdrum toolkit to provide an interactive webpage for analyizing Lassus' 50 *Geistliche Psalmen* for 3 voices. The project's concept is well conceived, and the

[11] *Le opere complete di Giovanni Pierluigi da Palestrina*, ed. by Raffaele Casimiri, Lavinio Virgili, Knud Jeppesen and Lino Bianchi, Rome: Fratelli Scalera, 1939–1999.

[12] `https://github.com/cuthbertLab/music21/tree/master/music21/corpus/palestrina`.

[13] `https://lassus.mh-freiburg.de` (May 2024).

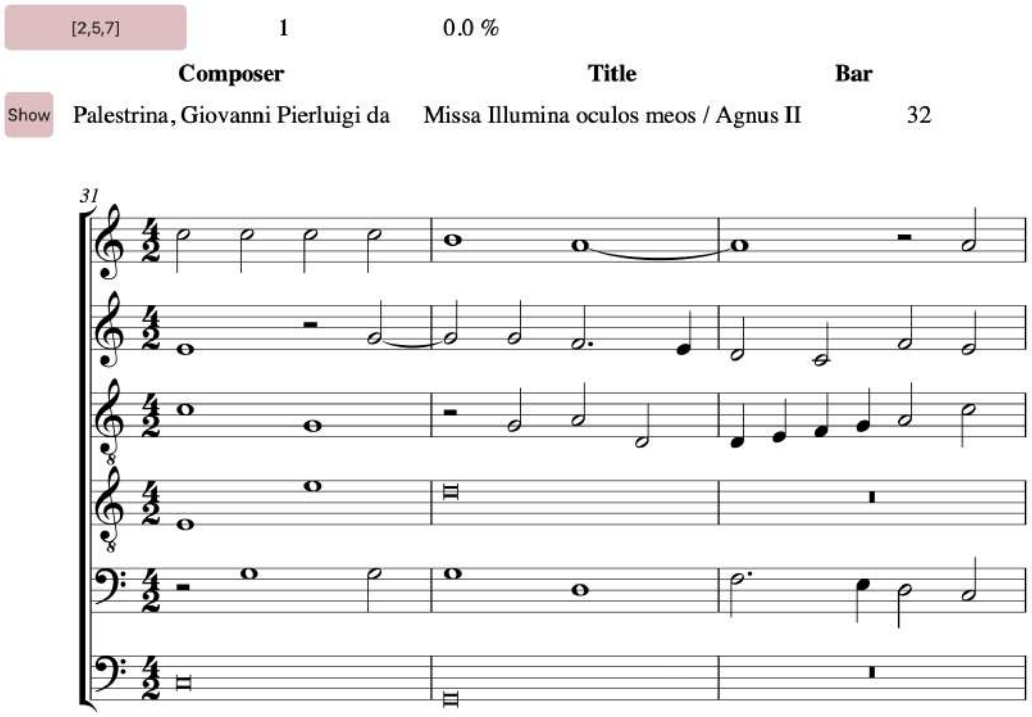


Figure 2.1: A suspicious sonority in Palestrina's *Missa "Illumina oculos meos"*, bars 31–33.

interface works extremely well. The 50 pieces are available in humdrum format on github.[14]

I decided not to base my analysis on this repertoire for the simple reason that the 3-voice setting of these pieces could return a biased picture of Lassus' harmonic.

Tasso in Music project

The Tasso in Music[15] project aims at a complete digital edition of the Renaissance and Early baroque musical settings of Torquato Tasso's (1544–1595) poems. Most of these settings are not yet available in modern printed editions.

> The Tasso in Music Project aims to fill this lacuna [unavailability in modern editions] by creating a complete digital edition of the extant late sixteenth- and early seventeenth-century settings of Tasso's poetry.[16]

The repertoire, edited in humdrum format thanks to the supervision of the technical director Craig Sapp, consists of 778 secular pieces.

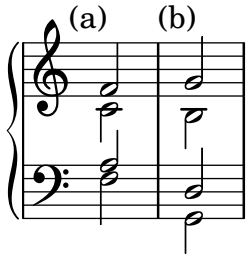
[14] `https://github.com/WolfgangDrescher/lassus-geistliche-psalmen/tree/master` (May 2024).
[15] `https://www.tassomusic.org` (May 2024).
[16] `https://www.tassomusic.org/about/` (May 2024).

Although this is a large and valuable database, I did not use it for the research problems presented in this thesis. One one side, the concept behind the project causes the database to gather pieces from many different composers. Given a specific composer therein, the small sample of pieces cannot be representative of his/her style. Including a madrigals repertoire would also mean facing some technical challenges, given that the note values are typically one rhythmic level smaller than in motets and masses.[17] This necessitates a reconsideration of the rhythmic position of dissonances and consonances, *cf.* the discussion in section 2.5.

2.2 Towards harmonic analysis: understanding chords

Once the aforementioned repertoire had been incorporated into ReDiX, I needed to encode the music in a format which allows a quick search for patterns, but at the same time enables the user to get specific information about the location of what they are interested in (composer, piece, bar). In order to perform a harmonic analysis on a large scale, I selected an encoding scheme which would reduce the musical material to some numeric patterns, which can then be easily grouped and counted. This process may appear straightforward, but it is in fact quite complex, with numerous decisions to be made along the way. Each of these decisions has an impact on the subsequent analysis and requires careful explanation. In this section, I will present the process of encoding a polyphonic musical piece into a suitable numeric representation.

Since, as explained above, harmony is my primary focus, it is reasonable to start by encoding a chord. Let us consider the chords in Example 2.



Example 2. Root-chords in different positions.

A possible representation of this chords would be (a) `[f,a,c',f']`, (b) `[G,d,b,g']`.[18] This is a nice human-readable format, but it does not directly encode the harmonic

[17] In sacred music, the usual text-bearer is the *minima*; in secular music, especially after the 1550s, declamation on *semininiminae* becomes the norm.

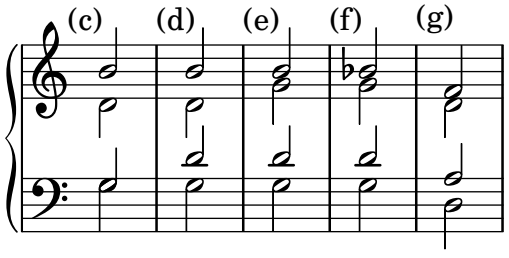
[18] Here and in the following, I will enclose in square brackets a code which represents a chord, *i.e.*, a vertical superposition of one or more note(s).

structure, *i.e.*, the interval relations between the notes. In order to highlight this, one has several possibilities. I will discuss some of these.

Progressive build-up from below Let us denote an interval by a natural number denoting the size, preceded by a letter denoting the type (`p` = perfect, `M` = major, `m` = minor, etc.). We could describe a chord by indicating the lowest note, followed by a sequence of intervals, where each one is the interval between two successive notes (when progressively going from the lowest to the highest). The chords in Example 2 would therefore be encoded as something resembling (a) `[f: M3,m3,p4]`, and (b) `[G: p5,M6,m6]`.

Single reference note It is also possible to choose a note of the chord and encode all the others as intervals from this note. Reasonable choices for the reference note might be the lowest, the highest, or the note sung by a predefined voice (*e.g.*, the *bassus*/*tenor*/*cantus* note). Taking for example the lowest note as a reference, the chords in Example 2 would therefore be encoded as (a) `[f: M3,p5,p8]`, and (b) `[G: p5,M10,p15]`. If the reference note is not the lowest one, a direction (up/down, or positive/negative) of each interval would also need to be specified.

These two encoding schemes (which are only examples of a very large number of possibilities), are, in principle, equivalent. That is to say, by knowing the rules that define each encoding, one can convert a label from one scheme to the other without ambiguity. Therefore, on an abstract level, there may not be a preference for any given ruleset that defines an encoding scheme, as long as this ruleset uniquely associates each "chord" to a code. This unique association chord $\leftrightarrow$ label requires a well-defined notion of equivalence between two chords, that is: one needs to establish when two chords are considered the same, and therefore can share the encoding. This is indeed a crucial point for every kind of statistical analysis. If two chords are defined as the same and encoded with the same label, they will be considered the same under any viewpoint. Let us consider the chords in Example 3.

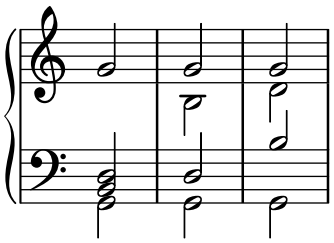


Example 3.

Which of these chords should be considered the same? There is of course no absolute answer to the question, as it depends on the *context* and on the *goal* of the analysis.

For my work, I decided that (c) and (d) are equivalent, or, more generally, that I will not keep track of voice-doubling. This choice depends primarily on my goal, as a voice doubling does not alter the vertical sonority; however, the context plays a role as well, since, in Renaissance polyphony, doublings are much more frequent than in later vocal polyphony (compare, for instance, with four-part Bach chorals). If one were to keep track of all possible combinations, the number of possible chord labels would be quite high. For example, every three-note chord in a five-voice setting (with the possibility of resting out one or two voices) would have ten possible labels. This distinction might be useful if one is specifically interested in voice-leading or voice-doubling phenomena in this repertoire, but this was not my primary focus.

On the other hand, (d) and (e) should be different. Both of them are complete G major chords, but the specific voice disposition is a relevant factor in the sound analysis. Compare for example the chords in Example 4.



Example 4. Different G-major chords.

Even though they are all complete G major chords, with the same upper and lower note, they sound completely different. I figured, that the preference for the one or the other in different contexts or different composers could a relevant feature for the analysis. More on this in subsection 3.2.1.

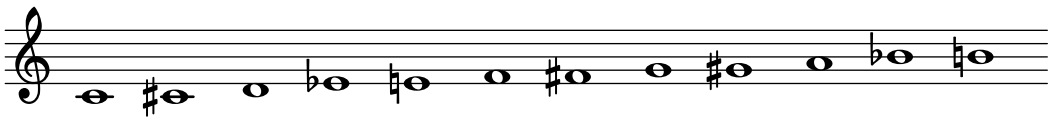
More subtle is the distinction between the chords (f) and (g) in Example 3, as they might be considered different or equivalent depending on the goal of the analysis. If one asks questions like "how many root chords there are in Josquin's music compared to sixth-chords?", the fundamental of the chord is unimportant. On the other hand, clearly, for other questions it may be relevant: one could ask for example: "if the lowest note of the chord is *e*, is a root-chord more likely than a sixth-chord?". In view of this, I decided that I needed to keep track of the absolute height of the chord (not only of the relative intervals that build it).

One of the choices I made, which may appear somewhat unconventional at first glance, is to consider (e) and (f) of Example 3 as equivalent chords. This is solely a consequence of the *context*, as I will explain in the following section.

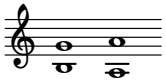
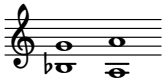
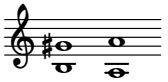
2.2.1 Diatonic vs chromatic: the *musica ficta* problem

The style I addressed spans from about 1450 to 1594, and in this period *musica ficta* was common practice. Given the size of ReDiX's repertoire, it is of course impossible to go through all the pieces and set my own "editor's accidentals".[19] On the other hand, since the pieces are coming from three different databases, I cannot expect the editor's accidentals to be assigned uniformly: some editors might have a "heavier" hand and tend to add more chromatic alterations than others. Moreover, the accidentals in the scores may have been explicitly notated in the sources from which the edition was compiled. However, even in this instance, if a piece appears in multiple sources, they might not be coherent in the indications. In short, it is often challenging to determine whether a note should be altered, and to which degree of certainty.

It is worth noting that, in the case of Palestrina's masses, the situation is more unambiguous: for most of them we can rely on primary sources (prints) which present more reliable accidental indications. If one were to perform some statistical analysis only on Palestrina's *opus*, it might be possible to work with a complete chromatic description of the music material, *i.e.*, with the full chromatic scale.



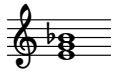
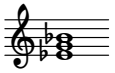
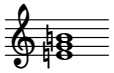
We see here once again how context (in this case: the repertoire) and goal (which questions we are trying to answer) determine an encoding choice.

Let me point out that the temptation to assign alterations based on an automatic procedure, *e.g.*, a computer program running through all the notes of the database and deciding for each of them if it should be altered, seems unrealistic. It would of course be possible to search for all cadential *clausulae* $6 \to 8$, $3 \to 1$ for every pair of voices, but not in all cases a *ficta* is appropriate: it might depend on the harmonic context of the cadence (what do the other voices sing) and the melodic context of each voice. Moreover, specifically in the case of  , both *ficta* options  and  are in principle possible, and the decision should be based on the modal context.

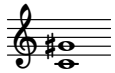
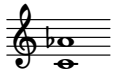
Finally, some alterations might be based just on melodic grounds, in passages where there is no cadential progression. These include: notes which might be altered to avoid augmented or diminished intervals in the melodic shape, the famous case of a *b* as an

[19] In the JRP and the 1520s Project, editorial accidentals are provided in the graphical rendition of the scores on the websites, but are not available in the digital encoding in humdrum format.

extension note upon the natural hexachord (*fa supra la*), which should be sung *b-fa*, and the analogous case of an *e* upon the soft hexachord.

Harmonic grounds might also cause some alterations. The allowance/disallowance of the diminished root-chord can influence some *ficta* decisions: is the disposition  to be tolerated, or should one always correct it as  or  ? How would an algorithm determine when to tolerate the diminished triad and when not to, and, in the second case, decide if the first or the second solution is preferable?[20]

Musica ficta corresponded to a variegated spectrum of performance practices, so there was already back then no univocal solution. It was a performers' task as much as text underlay and diminutions, all of which can depend upon the character of the piece, the execution speed, the (accompanying) instruments and other factors. Given the subtlety and complexity of the phenomenon, I cannot currently imagine an algorithm providing a reliable solution. Moreover, as already said, in case of a big repertoire, a manual annotation is also to be discarded as either possibly incoherent, yielding statistics which depend on the taste of different editors, or unfeasible by a single editor.

As I was setting up my project, this observations lead to the decision of working completely diatonically. The description of any interval is therefore just a natural number: `1` for the unison, `2` for a second (there is no distinction between major and minor) and so on. Notice that this is only possible since Renaissance polyphony does not make use of enharmonic intervals: different notations of the same interval, like  and  , represent different intervals: the first one a 5^{th}, the second one a 6^{th}. This is no longer the case in the Baroque era and beyond, where different ways of writing the same interval become increasingly interchangeable, particularly within passages that modulate enharmonically.

Having established a diatonic encoding for the intervals, let us go back to chords.

2.2.2 *Fundamentum relationis*

As discussed above, a chord (or vertical superposition of intervals) can be encoded in many different equivalent ways. I decided to take as a reference note the lowest sounding note, and to describe a chord as a list of intervals in increasing order. Going back to Example 2, the labels look something like (a) `f: [3,5,8]` and (b) `G: [5,10,15]`.

The choice of taking the lowest note as a reference might be questionable as anachronistic. After all, according to Tinctoris' lexicon, "Tenor est cujusque cantus compositi

[20] On the specific problems regarding the connection between *musica ficta* and harmony, see Urquhart 2021, in particular chapter 4, and references therein.

fundamentum relationis".[21] There are obvious practical reasons to take the bass as a reference: one is that we, modern people, are used to treat the bass as reference for chords since the introduction of the *basso continuo* practice. It is just much faster to describe and understand the chord (a) in Example 2 as "*f* with 3rd, 5th and 8ve" than "a 6th on *a* between *tenor* and *cantus*, with a lower 3rd of the *contratenor bassus* and an upper 3rd of the *contratenor altus*". Moreover, if the *tenor* were taken as reference, what would the reference note be if the *tenor* has a pause?

Luckily, the concept of lowest note as reference for the harmony is both practical and historical. Simon De Quercu (or Simon van der Eyken), a theoretician from around 1500 born probably in Brussels and active in Italy and Austria, presents the table displayed in Figure 2.2 at the very end of his *Opusculum musices*.[22]

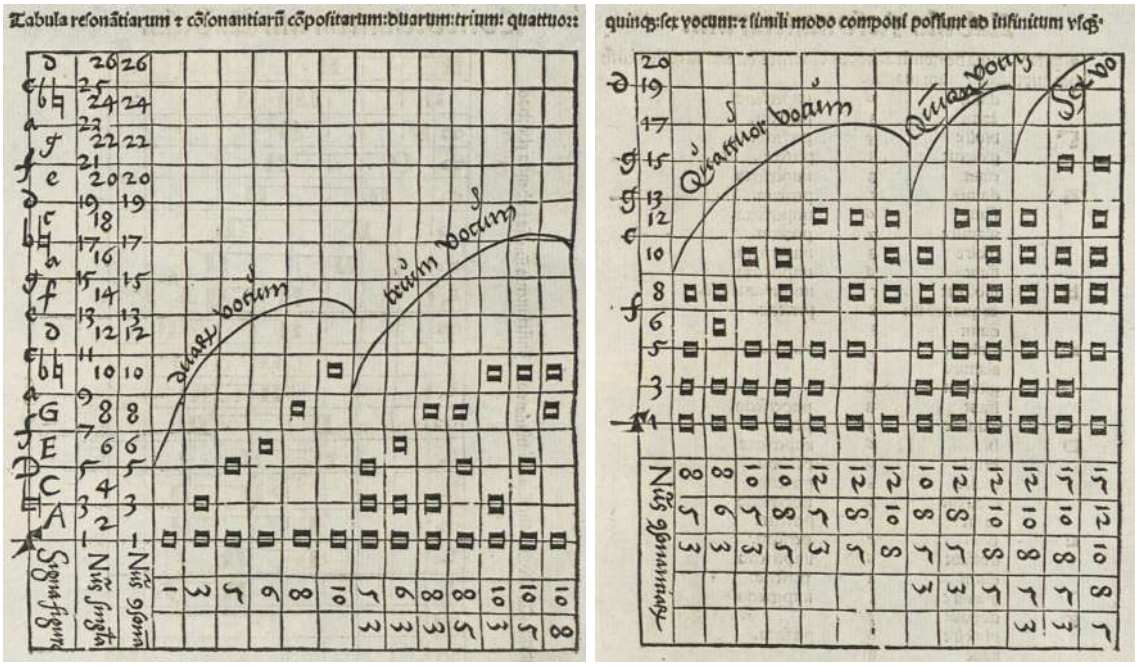


Figure 2.2: Simon de Quercu, *Opusculum musices [...]*, 2nd edition (1513).

The caption reads: "Tabula resonantiarum et consonantiarum compositarum, duarum, trium, quattuor, quinque, sex vocum, et simili modo componi possunt ad infinitum usque".[23] We can see on the left three columns. The first ("Signa figure"[24]) shows the notes in the *Gamut*, raising in pitch from bottom to top. The second ("Numerus singlariter"[25]) show progressive natural numbers (starting from 1), which denote the

[21] "The *tenor* is the fundament of the relation of every polyphonic song." In Tinctoris 1495, under the lemma "Tenor".

[22] *Cf.* Quercu 1513, four pages before the end (the print has unnumbered pages).

[23] "Table of the composite resonances and consonances of two, three, four, five and six voices, and in a similar way can be composed further indefinitely".

[24] "Symbols of the note".

[25] "Number one by one".

interval between the corresponding note and the *Gamma-ut*. The third ("Numerus consonantiarum"[26]) shows only the numbers (intervals) of the second column which are consonant with the *Gamma-ut*. The table then shows how chords with two to six voices can be build on the bass (which is assumed constantly as the *Gamma-ut*), with a *continuo*-like ciphering underneath. If one takes this table and expands it "ad infinitum" (as suggested by the author), a set of all possible labels describing consonant chords can be obtained. The analogy with the encoding I described is striking.

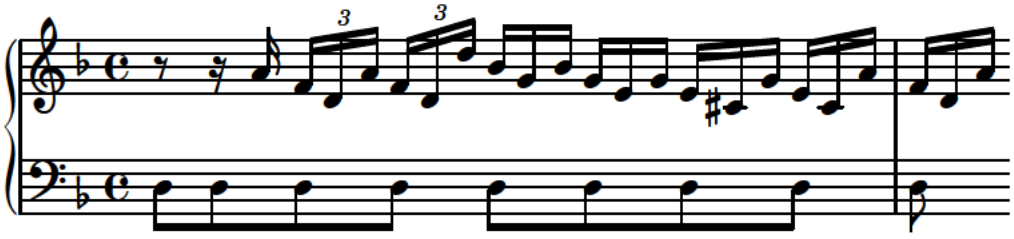
As a side note, of the 26 chords provided in this table, 3 are sixth chords (11,5%). This figure is not far from the proportion of sixth chords we can observe in the repertoire (more on this in section 3.1).

2.3 From static to dynamic encoding: the time component

Once I decided how to handle the "vertical component" of a musical piece, *i.e.*, the encoding of a chord, I was left with the "horizontal component", *i.e.*, the time evolution. Given that the memory of any digital medium is of finite size, the continuous time variable must be discretised. There are two principal approaches to this process of encoding a musical piece into a sequence of static elements: *fixed sampling rate* and *variable sampling rate*.

2.3.1 Fixed sampling rate

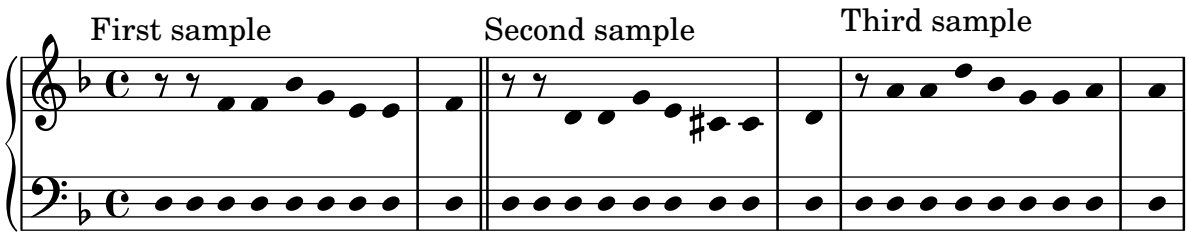
When working with a fixed sampling rate, an imaginary metronome is set to some constant time unit (note value). At each "click", the instantaneous sonority is sampled and encoded, and a list of labels representing static elements (in my case: chords) is stored as representation of the piece. This technique can lead to some very interesting analytic experiments. Just as a quick demonstration, consider the prelude from J. S. Bach's *Well Tempered Clavier* (BWV 851) whose incipit is shown in Example 6.



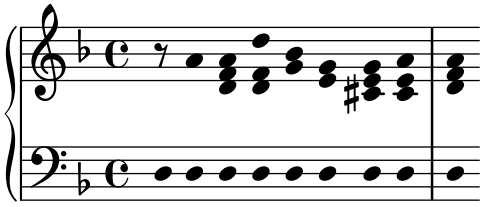
Example 6. J. S. Bach, Prelude BWV 851 (incipit)

[26]"Number of the consonances".

Let us set the sampling period[27] equal to an eighth-note, and take three different samples: in the first one, the metronome starts on the beat; in the second one, it starts 1/3 of an eighth note after the beat; in the third one, it starts 2/3 of an eight-note after the beat. Not only can we explode in this way the hidden polyphony of the right hand,



but we also can overlap the three samples to reconstruct the complete harmonic structure.



In different contexts, this method might be useful to extract information about the interaction structure/ornament by sampling a piece on-beat and off-beat and comparing the results. If one takes a very slow "metronome", *i.e.*, a very long sampling period, like one or two bar(s), even information on the form (phrase structure) may emerge.

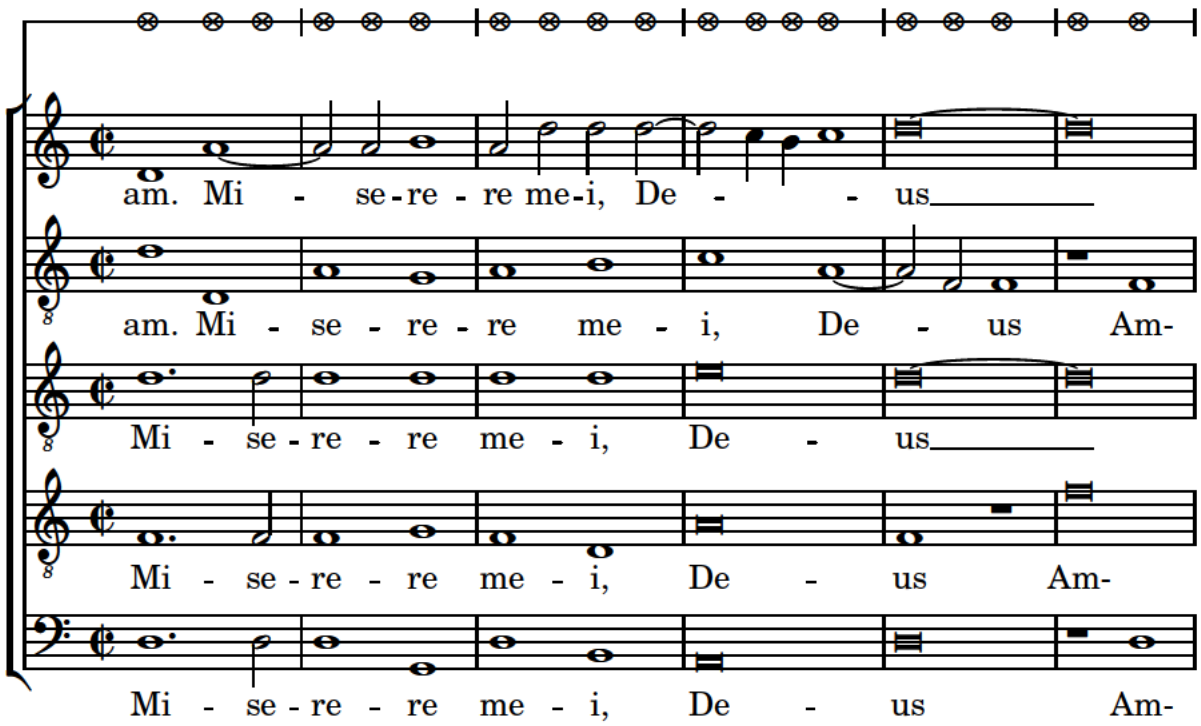
2.3.2 Variable sampling rate

I chose instead to work with a variable sampling rate, that is: the sampling period depends on the local musical context, and might vary between any two consecutive samples. In the humdrum format, a sample is taken if and only if one of the following (not mutually exclusive) cases occurs:

- at least one voice sings a new note;
- at least one voice sings after a rest;
- at least one voice stops singing at a rest;
- at least one note is repeated (because of text underlay).

[27] The sampling period is defined as the inverse of the sampling rate, and it is normally measured in seconds. For example, if the sampling rate is 100 Hertz, the period is 1/100 = 0.01 seconds. Since I did not specify a speed of execution of the piece, I will work with note values instead.

If this occurs, I will say that the music has a *point* in that position. This definition yields ReDiX's points, the basic objects with which I will be working in the next chapter. In Example 9, I marked in a "timeline" on top of the score the positions of points; in correspondence of each symbol ⊗, a sample is taken.



Example 9. Josquin des Prez, *Miserere mei, Deus*, bars 40–45

The reasons why I decided to use a variable sampling rate are partially technical, partially dictated by what I wanted to highlight (and be able to search for).

When working with a fixed sampling rate on a single piece, one can set the rate according to the rhythmic characteristics of the piece. In order to capture a complete description of the piece, the period should be less than or equal to the minimum note value in the piece. When working on a large repertoire, such as that of ReDiX, this approach is not optimal since, on the one hand, a unique sampling rate is required in order to facilitate comparisons between points from different pieces; on the other hand, the minimum note value of the entire repertoire (in this case, eighth-note) is for some pieces way too short. For example, if a piece has only minims as a minimum note value, each chord would be sampled (and counted) four times. Given that the objective was to create a comprehensive representation of harmonic phenomena, namely to sample every possible vertical combination present in the repertoire, a lengthy list of points would have been generated for each piece, resulting in a considerable amount of redundant repetition. This approach is not only inefficient from a memory storage perspective but also has a detrimental impact on the ability to navigate from points to the location

in the score. Suppose I am looking for a particular vertical combination: if the search results has for each occurrence multiple items, it is much more impractical to scroll through. It is possible to program the software to compress these repeated points *a posteriori*, and present just (say) the first one to the user. However this would amount to having one entry for each *point*, so why not just sample with a variable rate to start with?

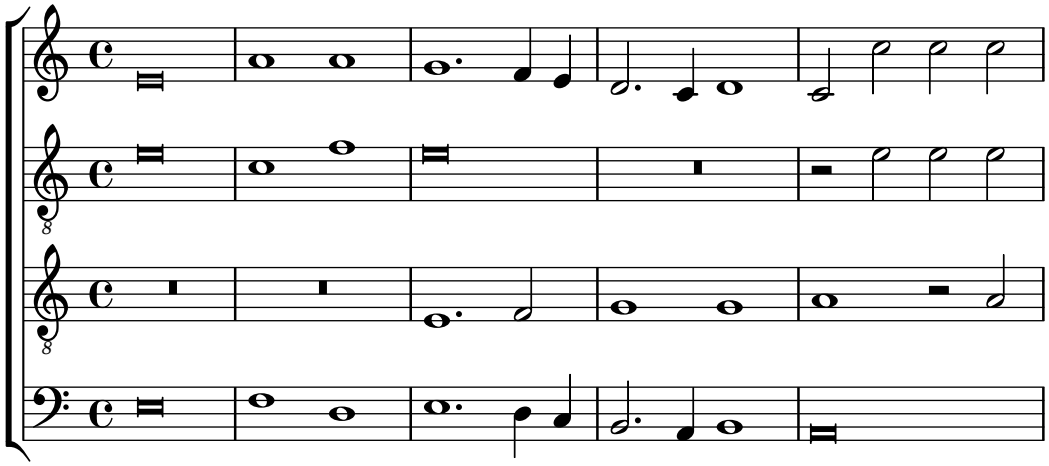
An important remark should be made. When performing statistical analysis on points which are collected using a variable sampling rate, one should keep in mind the meaning of ratios and percentage. If for example I say: "In Josquin's music, 70% of the points are root chords", this *does not* mean that "In Josquin's music, we hear root chords 70% of the time". As each point has a distinct temporal duration, it is not possible to directly translate the number of points into time units. This meaning of the number of points and their proportions will be implicitly assumed in chapter 3.

2.4 Conversion of `humdrum` files into ReDiX's points

In this section, I will delve more deeply into the technical aspects of programming my tool. The implementation of the encoding scheme described in the previous sections begins with the 2870 `krn` files which constitute the database. These are plain text file: here is what the beginning of Josquin's "Mille regretz" looks like in the `**kern` representation, and below a score of it.

```
!!!COA: des Prez, Josquin
!!!COM: Lemaire, Jean
!!!OTL@@FRA: Mille regretz
!!!AGN: Chanson
!!!SCT: NJE 28.25
!!!SCA: New Josquin Edition 28.25
!!!voices: 4
kern       **kern    **kern    **kern
*staff4    *staff3   *staff2   *staff1
*Ivox      *Ivox     *Ivox     *Ivox
*I"Bassus  *I"Tenor  *I"Altus  *I"Superius
*I'B *I'T  *I'A      *I'S
*clefF4    *clefGv2  *clefGv2  *clefG2
```

```
*k[]        *k[]        *k[]        *k[]
*M2/1       *M2/1       *M2/1       *M2/1
*met(C|)    *met(C|)    *met(C|)    *met(C|)
=1-         =1-         =1-         =1-
0E          0r          0e          0e
=2          =2          =2          =2
1F          0r          1c          1a
1D          .           1f          1a
=3          =3          =3          =3
1.E         1.E         0e          1.g
4D          2F/         .           4f/
4C/         .           .           4e/
=4          =4          =4          =4
2.BB/       1G          0r          2.d/
4AA/        .           .           4c/
1BB         1G          .           1d
=5          =5          =5          =5
0AA         1A          2r          2c/
.           .           2e          2cc
.           2r          2e          2cc
.           2A/         2e          2cc
```



Example 10. Josquin des Prez, *Mille regretz*, bars 1–5.

In the humdrum file, the first lines collect *reference records*, that is, metadata about the piece. In this case, the composer, attributed composer, composer dates, title, genre, edition references and number of voices are given.[28] The remainder of the file is a table

[28] A full documentation of the allowed reference codes can be found at `https://www.humdrum.org/reference-records/` (May 2024).

with four columns: each column corresponds to one voice.[29] Lines beginning with an asterisk character `*` are *interpretation records*. They specify for each voice information such as instrument type, instrument name (full and abbreviated), clef, key signature and tempo indication. After the sign indicating the beginning of the first measure (`=1-`), the music begins. Each line corresponds to a vertical combination of elements, and successive lines occur successively in time. In the single voices, we can recognize elements like notes, rests, dots (= the previous note/pause is still ongoing).

For each file in the repertoire, I created a python *class*, that is: an (abstract) object, named `Piece`. This object contains the main metadata (Composer, Title of the piece) and a unique alphanumeric identifier which corresponds to the piece (this is just a cautionary measure in case the same composer wrote two or more pieces with the same title). Each `Piece` is linked to a list of `Points`, each of which corresponds to a line of the `krn` file. Notice that in the `**kern` representation, each line corresponds exactly to a point as defined in subsection 2.3.2. This simplified a lot the encoding procedure, and was also one of the reasons to choose the humdrum format as a starting point.[30]

Each `Point` contains the following information:

`piece` The link to the piece to which the `Point` belongs.

`base_note` The lowest note. In order to facilitate counting and transposing inside the software, this is encoded as a natural number. `0` corresponds to the C just outside the normal piano range (on the low side), and the numbers increase going up one note (recall that everything is encoded diatonically). The *Gamut* ranges therefore from 18 (*Gamma-ut*) to 37 (*e la*).

`full_chord` The label corresponding to the complete chord, as described in section 2.2.

`reduced_chord` In this field, I take the intervals in `full_chord` and reduce them inside an octave. For example, a 10^{th} is listed as a 3^{rd}, a 16^{th} as a 2^{nd} and so on. The octave and its multiples are ignored.

`absq`, `bar`, `beat` The rhythmic position of this point in the piece, consisting of the distance from the beginning of the piece measured in quarter notes, the bar number and the position inside the bar.

If the chord consists only of one note (resp. only of octave and its multiples), the field `full_chord` (resp. `reduced_chord`) reduces to an empty list, represented as `[]`.

[29] In more complex pieces, additional columns for text, dynamics and other streams of data may be included.

[30] Compare and contrast with the hierarchical structure of the MEI format Example 1, which would make the conversion of a piece into a list of points more tedious.

base_note	full_chord	reduced_chord
e	[8]	[]
f	[5,10]	[3,5]
d	[10,12]	[3,5]
e	[8,10]	[3]
d	[3,9,10]	[2,3]
c	[4,10]	[3,4]
B	[6,10]	[3,6]
A	[7,10]	[3,7]
B	[6,10]	[3,6]
A	[8,10]	[3]
A	[8,12,17]	[3,5]
A	[12,17]	[3,5]
A	[8,12,17]	[3,5]

Table 2.2: The first points of Josquin's *Mille regretz*, as encoded in ReDiX.

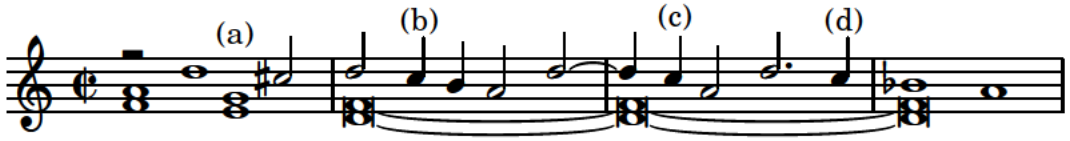
Saving the field `reduced_chord`, is technically redundant, since it can be obtained algorithmically by `full_chord`. However, the software runs much faster if this operation is performed only once when populating the database. One should not forget, that we are dealing with more than 1 million points: each operation that needs to be performed on all of them can quickly become very time-consuming. In Table 2.2, I display the fields `base_note`, `full_chord` and `reduced_chord` for the points sampled from Example 10.[31]

Notice that it is possible to reconstruct the whole example (up to voice doublings) from the first two columns, knowing the rhythmic information. The third one produces a figured-bass ciphering of the piece.

2.5 Rhythm: a difficult, partially unsolved challenge

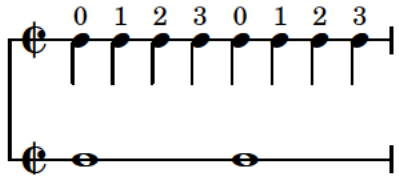
As mentioned above, for each point also rhythmical information is stored. When I developed the software, I felt this was important when investigating questions about dissonances, since the rhythmic position of a dissonance is of crucial importance in its description. Consider for instance the 3-voice counterpoint snippet shown in Example 11.

[31]For better readability, the lowest notes are reported as modern note names, and not as numbers.



Example 11. A `[3,7]` chord in 4 different rhythmic positions.

These ways of treating dissonances are all common in Renaissance counterpoint. In case (a), the dissonant chord formed by a minor 3rd and a minor 7th is on the beat (on the *semibrevis* level), what in the following I will denote by position 0. Therefore, the common treatment is to prepare and resolve the dissonance. In (b), the same vertical combination of intervals is positioned on the third *semiminima* of the *semibrevis* (position 2). The dissonance is in this case part of a common figure in *contrapunctus diminutus* (what later will be called *transitus irregularis*). Analogously, the same interval combination might appear on position 1 (c) as or position 3 (d): in the first case a *cambiata* figure, in the second a passing note.[32] I decided therefore to allow ReDiX's users to filter the points according to these four positions; in Example 12 I marked the numbering scheme I adopted.



Example 12. The four positions (0, 1, 2, 3) in a semibreve.

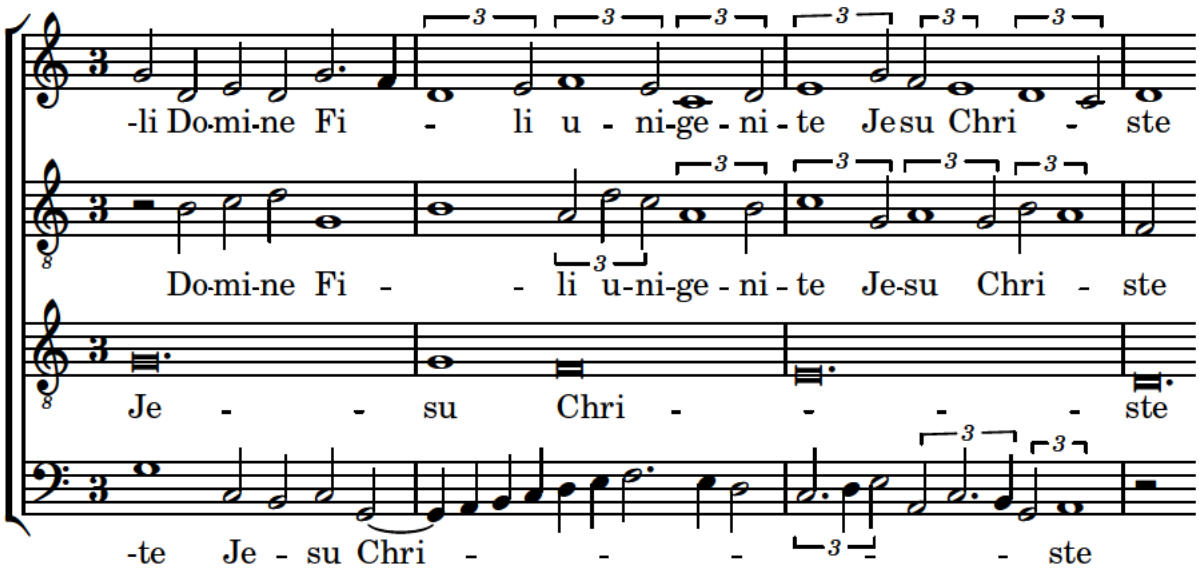
This works fine for the vast majority of the music included in the repertoire, but it has some drawbacks. First, this does not take into account *fusae*. Ornamental figures in *fusae* are relatively rare in the repertoire, but not unseen. However, when looking at music from the harmonic viewpoint, they usually do not play a decisive role. I decided therefore not to allow for specific filtering on the 2nd, 4th, 6th, 8th possible position of a *fusa* in a *semibrevis*. When employing ReDiX without rhythmic filters, all the positions are in any case taken into account.

Another drawback is that pieces with *prolatio maior* do not have four positions for a semiminim inside a semibreve, but rather six. On the other hand, mensurations with a perfect *semibrevis* are in ReDiX's repertoire so rare, that the possibility of specifying filters for the rhythmic positions in all the other pieces outweighed this drawback in my vision. Indeed, in ReDiX's repertoire, out of 2870 pieces there are only 3 pieces in *prolatio maior*. These are: an anonymous italian secular piece, "Visin visin visin", also provided in the *lauda* version texted "Jesu, Jesu, Jesu"; Dufay's *ballade* "Resvellies

[32] These figures are part of the common repertoire of semiminim ornaments, *cf.* for instance Menke 2015, pp. 190–203.

vous et faites chiere lye"; the (unsecure) Josquin's motet "O admirabile commercium / Verbum caro factum est". Once again, by not specifying any rhythmic position, it is possible to get a complete picture for these pieces as well.

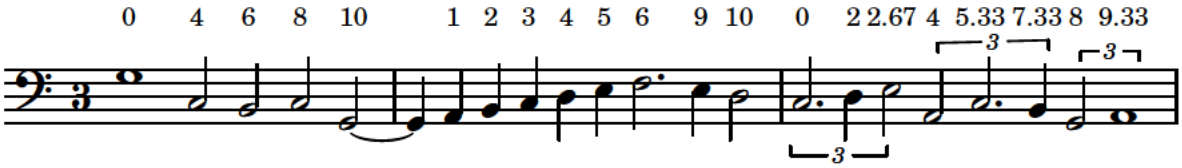
A much more challenging problem is represented by polyrhythmic passages and proportions, which are instead far from uncommon. Consider for instance the excerpt in Example 13 from Josquin's *Missa "L'homme armé" super voces musicales.*



Example 13. Josquin des Prez, *Missa "L'homme armé" supre voces musicales*, Gloria, bars 41–44.

In the first bar, the proposed division of the semibreve in four semiminims works fine. In the second, the *cantus* (and then the *altus*) changes the meter, while *tenor* and *bassus* keep the mensuration. The division of a semibreve in four equal parts is therefore still meaningful, by referencing to the bass, but it is not possible to clearly define canonical positions for the different type of dissonances any more. The third bar is effectively in *tempus perfectum, prolatio maior.* What should be the rhythmical reference here? If one wants to switch to a division of the semibreve in six semiminims, when should the switch take place?

To add to the difficulty, the encoding of the pieces is made in such a way, that this rhythmic nuances are difficult to recognise. Indeed, to encode proportions, the regular quarter beat is kept, and the positions of the notes are defined as rational numbers, instead of integers. To clarify this, in Example 14 I marked the position relative to the measure in the *bassus* part.



Example 14. *Ibid.*, *bassus.*

This method of denoting rhythmic proportions by maintaining an absolute reference makes the new grouping in perfect semibreves invisible and, most importantly, indistinguishable from other groupings. A more faithful representation of this phenomenon would be to redefine the *semibrevis* duration and division (in relation to the previous one) at the point of change in meter. But once again, in polyrhythmic passages, it is not possible to establish a common reference for the position of the different dissonance types.

In light of the current encoding system and the inherent complexity of rhythmic patterns, it is not possible to achieve a satisfactory solution for filtering rhythmic positions in all cases. Consequently, I have adopted the solution described above (four regularly distributed semiminims in a semibreve) for the time being. However, I believe this aspect is a highly interesting and still open research field in digital musicology, which will require further investigation. A revision of the current system for encoding rhythmic information may also be necessary in order to more accurately represent the complex spectrum of proportions and polyrhythm in Renaissance music.

2.6 A user's guide to ReDiX

In this section, I will provide a complete user's guide to ReDiX. This tool is based on the search form displayed in Figure 2.3.

The behaviour of the numbered search fields is described in the following list.

1 The button *Select composers*, when clicked, allows to select one or more composers from a drop-down menu. The list includes all the composers with at least one piece in the database and the composers' names are annotated with a * if the attribution is not secure. See section 2.1 for a complete list of the composers, and a discussion about doubtful pieces.

2 This search field allows to specify a text; only pieces which contain exactly that text in the title are selected. Note: this field is case insensitive, that is, there is no distinction between capital and non-capital letters.

3 It is possible to specify which intervals (greater than or equal to an octave) should not be reduced within the octave for the purpose of *basso-continuo* ciphering. If

Figure 2.3: ReDiX's search form.

more than one interval is given, they must be separated by white spaces. For example, if `10` is given, then `[5,10]` and `[3,5]` are considered different chords; if nothing is given (default), all intervals are reduced within an octave (and an interval of an octave is reduced to nothing, *i.e.*, unison).

4 Only those points which contain all of these numbers in the figured-bass are returned; the numbers must be separated by white spaces. If a number is written normally, then also its octave-multiples are counted. If a number is followed by a *, then only exact occurrences count. For example, `3` returns chords containing a 3rd and/or a 10th and/or a 17th above the lowest note, and so on; `3*`, on the other hand, returns only chords containing a 3rd above the lowest note.

5 Only those points which do not contain any of these numbers in the figured-bass are returned; the numbers must be separated by white spaces. Without any other specification, also the octave-multiples are considered. If however, in the field number 3 ("do not reduce") a specific octave-multiple is asked not to be reduced, then this multiple is not excluded. For example, a `3` in this field excludes all chords containing a 3rd or a 10th or a 17th and so on; if, however, a `10` is given in field 3, then only the chords containing a 3rd are excluded.

6 In this field it is possible to specify which note(s) should be the lowest one in the filtered chords. A note is given as a letter for the pitch (*a, b, c, d, e, f, g*) and a number for the octave (the number 3 corresponds to the octave rising from the middle *c*). Single notes can be separated by white spaces, and note ranges can be specified by giving the starting and ending note separated by a dash.

Collected 2844 points on beats 0 1 2 3 from the following composer(s): Obrecht, Jacob.

Root chords: 628 (22.08 %) sixth chords: 1035 (36.39 %) dissonances: 1181 (41.53 %)

Figure	# points	Ratio
[6]	1035	36.39 %
[]	628	22.08 %
[4]	273	9.6 %
[7]	241	8.47 %
[2]	161	5.66 %
[4,6]	132	4.64 %
[2,4]	92	3.23 %
[4,7]	75	2.64 %
[2,6]	65	2.29 %
[2,7]	56	1.97 %
[2,4,6]	31	1.09 %
[2,4,7]	27	0.95 %
[6,7]	23	0.81 %
[4,6,7]	3	0.11 %
[2,6,7]	2	0.07 %

Figure 2.4: Chords which do not contain 3 or 5 in Obrecht.

7 This field allows to specify in which rhythmic position the chords should be filtered (see the discussion in section 2.5, and especially Example 12 therein). If nothing is selected (default), all the possible rhythmic positions are considered.

Once the search filters have been set, the button *Search* explores the database and prints the results. Notice that, after every search, the filters remain set to the previous values; this allows to quickly ask similar questions, what in practice often occurs. The button *Clear* allows to reset all the filters to the default value (empty).

The results are displayed in a long interactive table similar to the one displayed in Figure 2.4. In this example case, I asked for all the chords in Obrecht's pieces which do not contain 3 or 5.

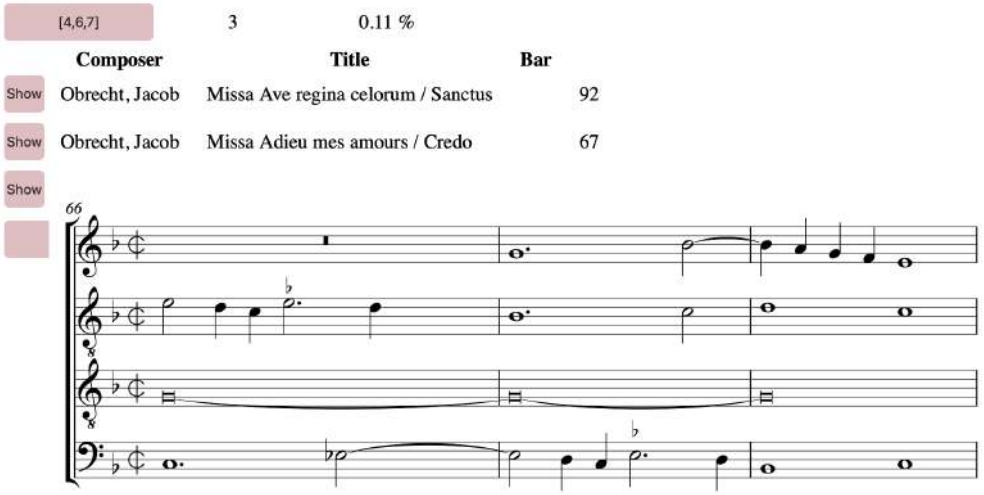


Figure 2.5: One of the three chords in Obrecht figured `[4,6,7]`: *Missa "Adieu mes amours"*, Credo, bar 67.

The first line is a quick check that the search result matches the question: it indicates the total number of chords found in the database, which rhythmic positions were considered and the name(s) of the composers. The second line provides some basic statistics indicating the percentage of root-chords, sixth-chords and dissonances in the search results. In this example, since we excluded 3 and 5 from the chords, root-chords are only given by chords in which only the octave and its multiple are present (denoted by an empty ciphering `[]`). This statistic might not always be relevant, but I found myself asking the question quite often, and including it always in the results required little work.

In the subsequent table, the first column indicates the chord (in figured-bass form), the second column indicates the number of points which match the corresponding figure, and the third column computes the percentage with respect to the total points in the search result.

By expanding the figure-button, it is possible to obtain a list of the corresponding places in the repertoire, and to view them as shown in Figure 2.5.[33]

The score excerpt always consists of three bars, and features the selected chord in the middle one.[34] In this case the very uncommon dissonant sonority `[4,6,7]` occurs in the Credo of the *Missa "Adieu mes amours"*, on the last note of the bass in bar 67: it is a combination of a *cambiata* figure in the bass, a pedal-note in the tenor, a *minima* passing note in the *altus* and a consonant jump in the *cantus*.

[33]This feature requires the local server to have an internet connection.

[34]With the exception, that if the selected chord appears in the first or last bar of a piece, only two bars are displayed.

Chapter 3

ReDiX in practice: three case studies

In this chapter, I will discuss three case studies that I tackled using ReDiX. I deliberately chose problems that are well studied to show how digital tools can offer new perspectives and open new frontiers of exploration even where much is already understood.

I will start in section 3.1 by discussing the use of sixth-chords in Renaissance polyphony, and specifically its evolution in time by looking at four composers of different generations. My interest in this problem first arose as a curiosity to compare the styles of different composers through numerical analysis. In this context I started looking at different statistics about the employment of root-chords, sixth-chords and dissonances in some famous composers of the time, and I soon realized that the topic deserved a deeper study.

In section 3.2, I will then present some insights on two well-known attribution cases. The first revolves around the motet *Absalon, fili mi*, whose authorship is disputed between Josquin des Prez and Pierre de La Rue. The second case is that of the motet *Celi enarrant gloriam Dei*, whose attribution to Josquin is nowadays strongly doubted by scholars. Although both cases concern the attribution of a musical piece, they are very different in nature. In the first case, we dispose of a great amount of material from both composers, Josquin and La Rue, and the task consists in deciding between one and the other. In the second case, basing solely on the knowledge of one composer (Josquin), we have to judge whether the piece is likely to be by him or not. As will become apparent, the differing natures of the problems will necessitate the use of distinct techniques.

I do not claim to offer in this chapter a complete and detailed review of the three aforementioned complex problems. Rather, my aim is to integrate the discussion with

new insights that have not previously been considered, given the amount of time that would be required to perform this sort of analysis without the use of digital tools and digital editions.

The application of digital tools (in my particular case, ReDiX) necessitates a general knowledge of the subject and a specific study of the topic in order to pose meaningful questions to the software. The interpretation of the results and the implications they suggest are also strongly dependent on human knowledge, as the examples will demonstrate. The interaction between the various components of a digitally-aided analysis, as discussed in chapter 1, will therefore be a central theme in the following discussion.

3.1 Quantifying style evolution: sixth-chords between "dissonance" and "consonance"

Starting in the 14$^{\text{th}}$ century, the different effect of imperfect consonances (3$^{\text{rd}}$ and 6$^{\text{th}}$) compared to perfect ones is clearly tangible in the repertoire and explained in music-theoretical treatises. Petrus dictus Palma Otiosa, in his *Compendium de discantu mensurabili* (1336), explains that perfect consonances "generate a complete and conclusive consonance"[1], while imperfect consonances "generate an incomplete and inconclusive consonance"[2]. Even more drastic is the position of Paolo da Firenze in his *Ars ad discantandum contrapunctum* (early 15$^{\text{th}}$ century), as at the very beginning he states that in 2-voice music there are six consonances (unison, 5$^{\text{th}}$, 8$^{\text{th}}$, 12$^{\text{th}}$, 15$^{\text{th}}$ and 19$^{\text{th}}$), and six dissonances (3$^{\text{rd}}$, 6$^{\text{th}}$, 10$^{\text{th}}$, 13$^{\text{th}}$, 17$^{\text{th}}$ and 20$^{\text{th}}$).[3] He then explains that every "dissonance" (that is, imperfect consonance) must occur between two perfect consonances, or, only licensed by the practice, two or more "dissonances" might appear one after the other; in any case, there should not be a sixth if the *tenor* does not descend by step.[4] The third will lose quite quickly its "non-finality" during the 15$^{\text{th}}$ century, and, even though the sixth-chord never got to have a conclusive value, around 1600 it is emancipated as independent chord, and the need to resolve it as explained by Paolo has faded.[5] Already Zarlino explains that imperfect and perfect consonances may both "be called Perfect, when they are contained in their true and natural form:

[1] "[P]erfectam generant consonantiam et finalem." Wolf 1914, p. 512.

[2] "[I]mperfectam generant consonantiam et infinalem." *Ibid.*

[3] "[...] consonantie biscantus sunt sex, videlicet unisonus, quinta, octava, duodecima, quintadecima et decimanona. Disonantie vero equaliter sunt sex, videlicet tercia, sexta, decima, terciadecima, decimaseptima et vigessima." Scattolin 1975, p. 63.

[4] "Est igitur advertendum quod omnis disonantia ut inquiunt periti huius scientie debet consistere in medio duarum consonantiarum, quamvis interdum propter licenciam pratice fiant multe insimul dissonantie et non debet fieri sexta si tenor non descendit per unam solam." *Ibid.*, p. 70.

[5] For a more detailed presentation of the *contrapunctus* doctrine in the 14$^{\text{th}}$ and 15$^{\text{th}}$ century, see Sachs 1974, especially Cap. III about the role of the sixth in 2-voice counterpoint.

that is, in their own proportion".[6] In fact, he is much more interested in discussing the aesthetic difference between major and minor imperfect consonances, a clear shift of emphasis that anticipates the transition from modality to tonality.[7]

The period between Paolo's *Ars* and 1600 represents the scope of ReDiX's repertoire. Can a numeric analysis contribute to the description of this evolution? In view of the aforementioned theoretical discussion, one could think that the amount of sixth chords during the period 1450–1600 increased, especially on strong beats. The progressive emancipation of the sixth-chord, could imply that its treatment gradually tends towards the one reserved for root-chords. In order to slightly simplify the study, I will focus on four representative composers of four different generations: Johannes Ockeghem (ca. 1420–1497), Josquin Des Prez (ca. 1450–1521), Adrian Willaert (ca. 1490–1562), Giovanni Pierluigi da Palestrina (1525-1594). On the one hand, famous composers develop such an evolved personal style, that it is not always representative for their whole generation; on the other hand, however, the large amount of pieces that are present in ReDiX's repertoire for these composers ensures that the collected data has statistical relevance. In Table 3.1 I display the amount of sixth-chords that appear on the *semibrevis* beat (position 0, see section 2.5).

	Ockeghem	Josquin	Willaert	Palestrina
All chords	24072	42260	10080	114554
6^{th} chords	21.6% (5202)	14.5% (6134)	13.5% (1365)	12.5% (14365)

Table 3.1: Sixth-chords on the semibreve beat in four "big names".

The results do not match the naive interpretation of the emancipation of the sixth-chord mentioned above. Ockeghem employs quite often sixth-chords on the beat, actually far more often than the other three composers. But even between Josquin and Palestrina, the relative usage of sixth-chords on the beat decreases in time. This surprising result prompted a deeper inspection. I first decided do distinguish between sixth-chords with the third (*i.e.*, `[3,6]`-chords) from chords containing just the sixth. This simple distinction, represented in Table 3.2, already shows a richer picture.

It is possible to observe a definite drop in the usage of sixths. This is to be expected, since it is related to a general phenomenon in style evolution during this time. Duos, *i.e.*, sections of polyphonic pieces where only two voices are singing at the same time, are a favored setting in the old generations of composers. Even the technique of "pair imitation", the imitation of a whole duo by another pair of voices, is frequent practice

[6] "[...] [N]ondimeno tutte si possono chiamare Perfette, quando sono contenute nella vera et naturale forma loro: cioè nella lor propia proporzione." Zarlino 1573, Cap. 6 of the third Part, p. 179.

[7] *Cf.* Zarlino 1573, Cap. 9–10 of the third Part, p. 181–182.

	Ockeghem	Josquin	Willaert	Palestrina
All	24072	42260	10080	114554
[6]	8.3% (2003)	7% (2950)	5.2% (530)	3.5% (3992)
[3,6]	13.3% (3199)	7.5% (3184)	8.3% (835)	9.1% (10373)

Table 3.2: Sixth-chords on the semibreve beat in four "big names": complete vs incomplete.

Position	Ockeghem	Josquin	Willaert	Palestrina
0	13.3	7.5	8.3	9.1
1	8.1	4.1	8.0	6.6
2	14.2	10.5	16.7	17.5
3	8.5	6.8	11.5	7.8

Table 3.3: [3,6]-chords in the four different rhythmic positions (%).

until the 1520s. In duo-passages, parallel thirds and sixths are among the most commonly used progressions, which in turn causes a lot of [6]-chords (that is, sixths) to be detected. The gradual disappearance of this texture, in favor of a more homogeneous and richer setting where many voices are singing together, causes all of these "naked" sixths to die out in the practice. Indeed, when writing for 3 or more voices, sixths are often either filled with a 3rd above the lowest note, generating a [3,6] *faux-bourdon* sonority, or covered by a 5th below the lowest note, originating a root chord.

In the second row of Table 3.2 it is possible to observe that Ockeghem's absolute preference for [3,6]-chords is still valid, but in the later generations there is a very slight increase in the use of complete sixth-chords on the beat. This corresponds possibly to the original intuition, but the increment's size is minimal.

It then seemed important to integrate into the analysis some rhythmic information, since a sixth chord appearing on the *thesis* surely has a different effect than one appearing on the *arsis*. In order to achieve this, I exploited ReDiX's ability to filter points in the four different positions inside each semibreve (see section 2.5).

The results are shown in Table 3.3 and correspondingly in Figure 3.1.

In the graph, I rescaled the percentages on positions 0, 1, 2, 3 relative to position 0, in order to better compare the different composers. For all composers except Willaert, a complete sixth-chord on positions 1 and 3 (very weak beats) is a rare occurrence. These beats, on the other hand, are the typical positions for dissonances, since *semiminima* passing and neighboring notes, and the *cambiata* figure, always generate a dissonance on position 1 or 3.[8] It is therefore not surprising that [3,6]-chords do not appear as often. The case of Willaert is special, as it appears that he has a preference for writing

[8]Confirmation comes once again from ReDiX. As an example, in Josquin the most common chord on position 1 is a [4]-chord, 7.9%, followed by a [2]-chord, 7.4%.

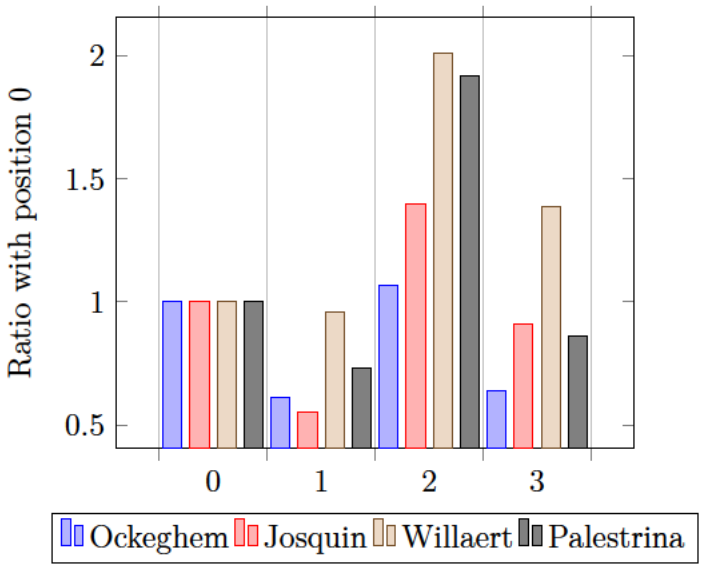


Figure 3.1: `[3,6]`-chords in the four different rhythmic positions (rescaled to position 0).

`[3,6]`-chords on the odd beats. This probably represents a personal touch in the typical melodic figures at the level of semiminims; a comparison with other composers of the same generation could be an interesting topic for future research.

A generational gap is clearly to be observed on position 2; this requires careful consideration. In Ockeghem and Josquin, this rhythmic position is barely used as a place to create harmonic tension through the use of a sixth, although the clause $6 \to 8$ in contrary motion appears to be the most common 2-voice module in both composers' music.[9] On the other hand, in Willaert and Palestrina, a complete sixth chord on the weak *minima* beat occurs twice as frequently as one on the beat. This produces the effect of a rhythmic pendulum between root-chords (on-the-beat) and sixth-chords (off-the-beat). Paradoxically, this corresponds more closely to Paolo da Firenze's prescriptions than what happens in Ockeghem and Josquin.

Conclusion

Much remains to be done in order to understand the use of sixth-chords between 1400 and 1600. The quantitative analysis discussed above, much facilitated by digital tools, has yielded sometimes surprising results, which may offer an alternative view of a phenomenon that has perhaps not been so well studied by numerical methods. The "tension" of the imperfect sixth on a weak beat in Willaert and Palestrina is an especially interesting connection between the late middle age theory and the late

[9] See the examples of application of the `humdrum` command `cint` at `https://extras.humdrum.org/man/cint/` (May 2024).

Renaissance practice. The role played by the mid-generation composers such as Josquin and Ockeghem, which evidently perceived and employed the `[3,6]`-chords in a different way, remains open to exploration.

I believe that the investigation presented in this section offers many avenues for future research. One possibility would be to compare pieces with the same number of voices across the repertoire. The preference for 4-voice settings in the older generations, and the later preference for 5- and 6-voice settings, may have implied a change in the use of sixth-chords for contrapuntal reasons. The bass-movements must also be included in the discussion, both in relation to the increase in the number of voices and in relation to the typical cadential progressions. The *tenorizans* cadence, widely adopted in the 15$^{\text{th}}$ century, brings a significant contribution to the number of sixth-chords. The gradual tendency to adopt more perfect cadences, and the shifting of the *tenorizans* function from *penultima* to *antepenultima*, certainly affects the frequency of use and the rhythmic position of sixth chords. The impossibility of having a perfect cadence in the Phrygian mode could lead to a study of the use of sixth chords limited to Phrygian pieces. As stated above, far from having covered the topic in full detail, I hope to have highlighted the potential impact of digital analysis on this research question, and the mind-opening directions that are open to exploration.

3.2 Attribution problems: two case studies

3.2.1 Detecting La Rue's fingerprints in *Absalon fili mi*

The celebrated motet *Absalon, fili mi* (NJE 14.01) has been the subject of considerable scholarly attention. The work's main source is the manuscript GB-Lbl Royal 8 G. vii (folios 56r–58r), copied by a Netherlands court scribe in the 1510s; the piece is anonymous there. Three later German prints dating from 1540, 1558, and 1559 present the work as Josquin's; the reliability of these late attributions is however somewhat questionable, since (especially in mid 16$^{\text{th}}$ century Germany) the trend of sticking Josquin's name to printed pieces for commercial reasons was rather common.[10] Doubts on the attribution to Josquin were first cast by Joshua Rifkin and Jaap van Benthem in the 1980s, who proposed instead the name of Pierre de la Rue as a more probable composer.[11] In the 90s, Nigel Davison first proposed some reconsiderations which reopened the question, to which Honey Meconi replied restating the attribution to La Rue as the most likely.[12] The debate is not yet settled, as more recent other

[10] On Josquin's legacy in sixteenth-century Germany, *cf.* Meyer 2016.
[11] *Cf.* Rifkin 1991; Benthem 1989.
[12] *Cf.* respectively Davison 1996 and Meconi 1998.

contributions put again wood into the fire.[13]

Up to now, the attribution problem was debated on two main fronts: on the one hand, stylistic analysis of the piece (form, imitation, text underlay, etc.), and on the other, study of the main source, Royal 8 G (dating, geographic origin, diplomatic history). My aim is to enrich the discussion by proposing a new approach to the stylistic analysis, based on the use of ReDiX. The aspects I will discuss in this section are, to my knowledge, yet to be included in the debate, and will aim to demonstrate how some key harmonic features point in La Rue's direction.

"Clusters" of low notes: thirds and triads

Absalon, fili mi is exceptional in the use of a very low clef combination and an unusual key signature with many flats (see Table 3.4).

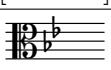
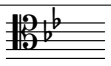
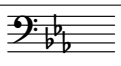
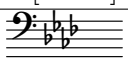
[Cantus]	C[ontratenor]	Tenor	B[assus]
			

Table 3.4: Clef combination in GB-Lbl Royal 8 G. vii, f. 56v–57.

This, as many scholars have noticed, points in La Rue's direction, as he explored low ranges and flatted key signatures far more often than Josquin.[14] However, some important points about the use of low register often escapes the analysis: the key difference is not the use of low register itself, but rather *how* it is harmonically treated. With the help of ReDiX, this can be made quantitatively tangible.

Pierre De La Rue was especially keen in employing low thirds in his compositions, a characteristic he might have copied from Ockeghem. That the latter played an inspiring role for many composers of La Rue's generation, Josquin included, is certain; on the specific connections of Ockeghem to the Habsburg-Burgundian court, where La Rue was employed, and his influence on the younger composer, see Meconi 2003. It is therefore not surprising to find common stylistic traits between the two, and one of them might indeed be the employment of low-written thirds.

More common chord dispositions, described also later by Zarlino[15] are usually composed of larger interval in the low region (octaves, fifths) and smaller intervals in the high regions (thirds). Having thirds or triads directly above the bass is therefore more striking, and even more so if the bass note is a very low one. In Table 3.5, I collected

[13] *Cf.* Thompson 2001; Urquhart 2004.

[14] In this section I will always refer to *written pitch*. If low-written pieces were meant to be transposed up for performance remains a largely open question: on use of low register, clefs, pitch and transposition in the Renaissance, *cf.* among others Meconi 2007 and Metcalfe 2022.

[15] *Cf.* Zarlino 1573, Cap. 8 of the third book, p. 180–181.

some data about the occurrence of low thirds and low triads in *Absalon, fili mi*, Ockeghem, La Rue and Josquin (secure). The selected chords have a lowest note which is lower than *Gamma-ut*, and sit on any rhythmical position.[16]

	Absalon, fili mi	Ockeghem	La Rue	Josquin
All chords	365	47456	103182	91917
Low chords[17]	39.2% (143)	3.06% (1452)	3.67% (3784)	0.86% (795)[18]
with 3rd	6.3% (9)	9.8% (142)	8.3% (315)	-
with 3rd and 5th	11.1% (1)	6.2% (9)	12.1% (38)	-

Table 3.5: Low "clusters" in Ockeghem, La Rue, Josquin and *Absalon*.

The scarce interest of Josquin in the exploration of the low range is clearly visible: he rarely descends below the *Gamma-ut*, and when so, never with a third just above the base note. Quite the opposite happens with Ockeghem and La Rue: not only the amount of low notes is much higher, but they also harmonize low notes with a third, or even with a triad.

The amount of low-chords in *Absalon* is obviouly biased by the fact that it is a low-written piece. However, the similarity of the proportion of low thirds and low triads with the *opera omnia* of La Rue is striking. Notice that the bias on these percentages is negligible, since in both cases they refer just to the number of low chords (*i.e.*, the previous row).

Harmonic variety beneath the *Gamut*

After discussing the interval-structure of chords based on a very low note, I would like to point out another important feature which clearly distinguishes La Rue from Josquin in the treatment of the low register: harmonic variety.

In Table 3.6, I collected data of chords on the *semibrevis* beat whose lowest note is below *Gamma-ut*.

Chord type	La Rue	Josquin
All	1796	385
Root-chords	81.0% (1455)	93.0% (358)
Sixth-chords	12.1% (217)	6.0% (23)
Dissonances	6.9 (124)	1.0% (4)

Table 3.6: Chords based on low-notes in Josquin (secure) and La Rue.

For Josquin, descending out of the *Gamut*, which (as discussed above) is in itself already exceptional, implies almost exclusively the use of root-chords, rarely of sixth-chords; only four times in the whole repertoire, a dissonance is used. In the Agnus Dei

[16] The percentages in each row refer to the numbers in the row directly above.

of the *Missa "Malheur me bat"* (bar 78) and in the motet *Missus est Gabriel angelus* (bar 41) he employs 4–3 suspensions; in the Gloria of the *Missa "L'homme armé" sexti toni*, he employs twice a 9–8 suspension (bars 131, 145). In short, a low note in the *bassus* is in Josquin strongly connected to harmonic stability.

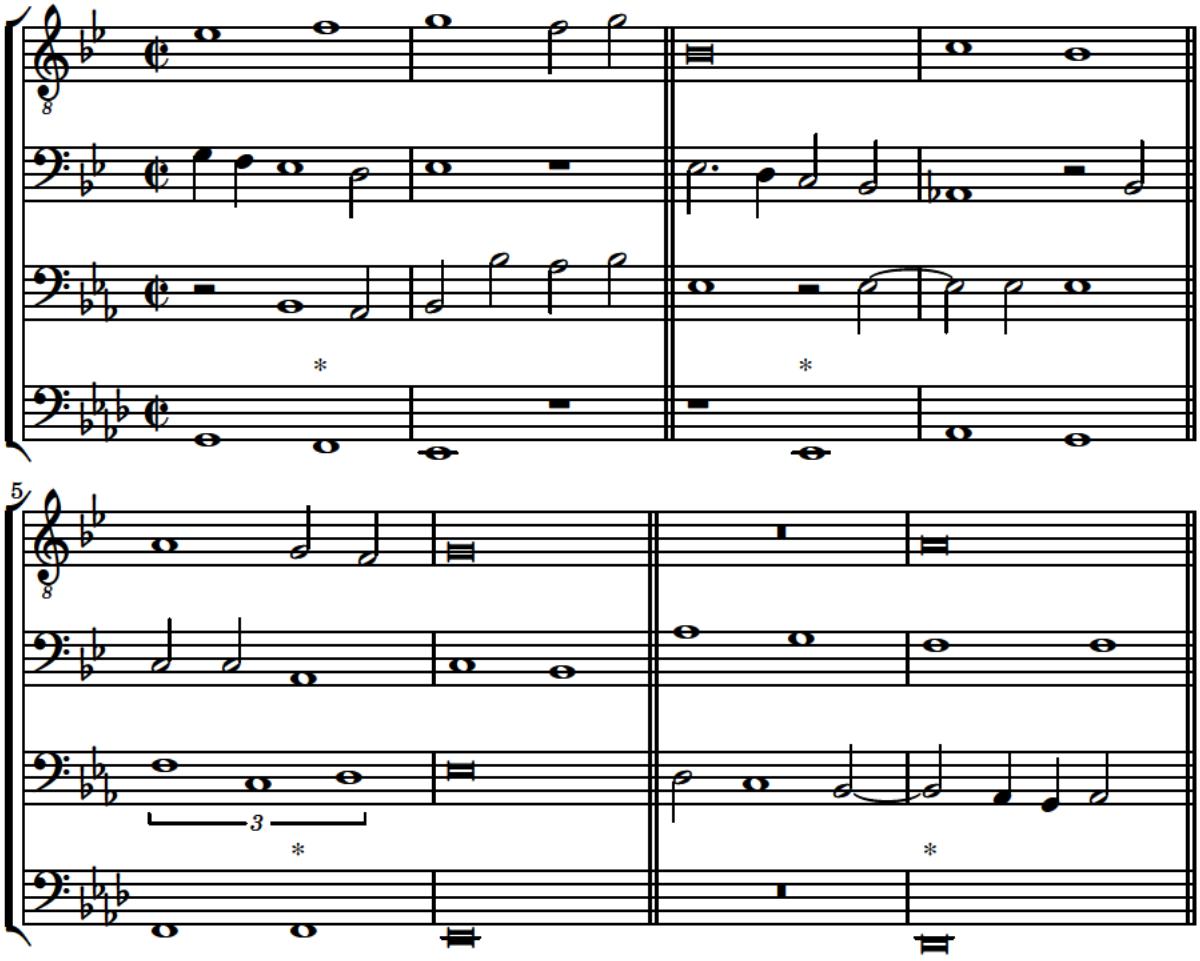
On the contrary, for La Rue, the harmonic world remains rich also in these low regions, with a relatively high proportion of sixth-chords and dissonances. For comparison, the overall percentage of root-chords (resp. sixth-chords) on position 0 in La Rue's music is 69.9% (resp. 17.4%).[19] This picture of variegated harmony in the low regions fits perfectly with *Absalon*'s style. In Table 3.7 I gathered statistics on the vertical sonorities on the *semibrevis* beat in *Absalon*, La Rue and Josquin (secure), when the lowest note of the chord is below the *Gamma-ut*.

Chord	*Absalon, fili mi*	La Rue	Josquin
All	62	1796	385
`[3,5]`	32.3% (20)	48.1% (864)	50.1% (193)
`[3]`	14% (22.6)	16.5% (296)	19.0% (73)
`[3,6]`	16.1% (10)	10.1% (182)	2.9% (11)
`[5]`	8.1% (5)	13.5% (243)	19.5% (75)
`[4,5]`	8.1% (5)	2.3% (41)	0.52% (2)
`[6]`	3.2% (2)	1.95% (35)	3.1% (12)
`[]`	3.2% (2)	2.9% (52)	4.4% (17)
`[4,7]`	1.6% (1)	0.45% (8)	-
`[5,6]`	1.6% (1)	0.22% (4)	-
`[2,3,5]`	1.6% (1)	0.22% (4)	-
`[3,5,6]`	1.6% (1)	0.33% (6)	-

Table 3.7: Chords with out-of-*Gamut* lowest note in *Absalon*, La Rue and Josquin (secure).

The harmonic spectrum of *Absalon, fili mi* is clearly at least as diverse as La Rue's in the low region. Especially striking is the use of many dissonances which can be found in La Rue's music more than once in the deep register, but are never used by Josquin (last four rows of the table). The corresponding passages, bars 28, 46, 48, 52, are shown in Example 15, where the * marks the *agens*. Among the other chords, in the cases where the difference between the two composers is glaring, namely `[3,6]`, `[5]` and `[4,5]`, *Absalon* also matches La Rue's writing much more closely than Josquin's.

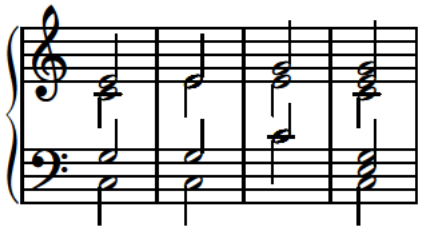
[19] This percentages were obtained by a query in ReDiX.



Example 15. *Absalon, fili mi*, bars 28–29, 46–47, 48–49, 51–52.

Voice-disposition in complete root-chords

Having established that the harmonic treatment of the low register in *Absalon* corresponds to La Rue's practice, I will now focus on a different aspect, that is: voice-disposition in `[3,5]`-chords. A complete root-chord can be set in many different ways, of which some are shown in Example 16.



Example 16. Some possible dispositions of a `[3,5]`-chord.

In secure Josquin pieces one can count a total of 76 different dispositions, while in La Rue this number goes up to 113.[20] Each of the two composers has slight preferences

[20]This counting ignores voice doublings, see section 2.2.

Disposition	*Absalon, fili mi*	La Rue	Josquin
All	93	23555	23538
[5,8,10]	23.66% (22)	17.5% (4132)	14.95% (3518)
[5,10]	16.13% (15)	14.95% (3522)	15.5% (3652)
[3,5]	11.83% (11)	8.5% (1998)	15.4% (3624)
[8,10,12]	8.6% (8)	7.2% (1702)	9.0% (2114)
[5,10,12]	8.6% (8)	3.05% (718)	2.2% (528)
[3,5,10]	7.53% (7)	6.3% (1490)	10.2% (2411)
[3,12]	6.45% (6)	2.4% (555)	2.6% (606)
[3,5,12]	4.3% (4)	2.45% (577)	2.7% (634)
[10,12]	4.3% (4)	3.6% (854)	3.1% (727)
[8,12,17]	2.15% (2)	2.4% (566)	1.9% (438)
[3,8,12]	2.15% (2)	3.3% (782)	3.3% (787)
[5,8,17]	1.08% (1)	0.84% (198)	0.62% (146)
[10,12,17]	1.08% (1)	0.68% (159)	0.36% (84)
[3,10,12]	1.08% (1)	1.6% (371)	1.3% (303)
[10,12,15]	1.08% (1)	1.8% (419)	0.95% (224)

Table 3.8: [3,5]-chords in *Absalon*, La Rue and Josquin (secure): voice disposition.

for some dispositions over others; in Table 3.8, I reported all dispositions appearing in *Absalon, fili mi*, and the corresponding data for La Rue and Josquin (secure). In this case the rhythmic position is not a deciding factor, since root-chords might appear on any beat without restrictions, unlike dissonances; therefore, I allowed for all possible rhythmic positions.

I find the three highlighted rows of Table 3.8 particularly telling. As it is possible to see, in Josquin there is no preference between a [5,8,10], a [5,10] and a [3,5] disposition (first three cases in Example 16): they are all equally likely with a percentage of about 15%. They are also the preferred dispositions, followed by [3,5,10] and [8,10,12] at about 10%. As the subsequent drop in percentage shows, other settings are clearly less used.

On the contrary, La Rue prefers quite clearly the [5,8,10] disposition. In comparison, the [3,5] disposition is used almost exactly half of the times. This proportion of 2:1 between the first and the third row corresponds exactly to *Absalon, fili mi*: there, the disposition [5,8,10] appears 22 times, and [3,5] 11 times.

I find this argument particularly effective in pointing towards a La Rue attribution for the following reasons. First, it is independent from the key signature. Since ReDiX, as discussed in subsection 2.2.1, works diatonically, the counting of dispositions of complete root-chords is neither biased by flatted key signatures, nor from the preference of a composer for some modes. Second, since the statistic is independent from the lowest note in the chords, there is also no bias towards low- or high-pitched pieces.

Conclusion

Thanks to the digitally provided data, it is possible to dive deep into the world of low-written pieces, such as *Absalon*; this analysis is rather independent from the problem of performance pitch for low-written pieces, since all the data are based on written records.[21] The treatment of low register in *Absalon, fili mi* under the viewpoint of interval-structure and harmonic variety corresponds almost perfectly to the average data of Pierre de La Rue's more securely attributed pieces, suggesting a more likely attribution of the motet to him. Moreover, a second argument based on the analysis of voice disposition in root-chords, independent from low-clefs and key signatures, also points in the same direction. I believe that the results of this analysis, though far from providing a conclusive settlement of the debate, could be a useful contribution to the discussion, and stimulate further investigation of similar numeric nature.

3.2.2 New clues backing up the misattribution of *Celi enarrant* to Josquin

The motet *Celi enarrant gloriam Dei* (NJE 15.7) is a 4-voice setting of Psalm 18. The piece appears in two main sources: the four manuscript part-books conserved in Kassel, Murhard'sche und Landesbibliothek (Ms 4°Mus. 24, 1–4) and a print by J. Petreius, *Tomus primus psalmorum selectorum* (Nurenberg, 1538). Since the date of both sources is more than 15 years after Josquin's death, and the prints by Petreius are notoriously "generous" in attaching Josquin's name to the pieces they contains (probably due to commercial reasons), the attribution of this motet to Josquin is quite doubtful. The piece was included in Josquin's *opera omnia* edited by Albert Smijers[22], but already in the 1980s Patrick Macey started questioning the attribution to Josquin.[23] When editing the motets volume of the New Josquin Edition, Macey declared the piece as misattributed, based on stylistic grounds: after a long and detailed analysis, which touches upon text underlay, imitation structure, note-for-note citations of other Josquin motets and other arguments, he summarized the situation as follows.[24]

> *Celi enarrant* clearly presents elements of Josquin's style, as seen in the quotations from motets attributed to him at the opening of each of the

[21] This is true thanks to the fact that the editions in JRP are based on the primary available sources (often manuscripts). Later prints are more keen on transposing low pieces up. Coherence in this respect is of uttermost importance for the reliability of the statistical data.

[22] *Werken van Josquin des Prés*, edited by Albert Smijers, Myroslaw Antonowycz and Willem Elders. Amsterdam: Alsbach/Vereniging voor Nederlandse Muziekgeschiedenis, 1922–1969.

[23] *Cf.* Macey 1991.

[24] *Cf.* Macey 2009, pp. 76–108.

> three *partes*, but it also contains further polished and effective passages that extend ideas from Josquin's securely attributed motets and Masses. Other passages, however, appear less accomplished, and thus the motet presents a curios mix of elements. *Celi enarrant* bears the signs of a not always successful imitator of Josquin, and it is therefore excluded from the *New Josquin Edition*.[25]

When I studied this motet, I had to agree with Macey in doubting the attribution to Josquin based on stylistic features, but I wondered, whether a quantitative analysis of the harmony could support the qualitative arguments. The first operation I did was collecting data about the piece, comparing them with the corpus of securely attributed Josquin pieces. In Table 3.9 I gathered the chords which appear on the *semibrevis* beat (with reference to section 2.5, on position 0).

Chord	*Celi enarrant*	Josquin
All	680	42260
[3]	26.3% (179)	24.8% (10485)
[3,5]	22.9% (156)	32.0% (13531)
[5]	12.5% (85)	10.5% (4443)
[6]	11.9% (81)	6.98% (2950)
[]	10.7% (73)	9.37% (3959)
[3,6]	6.62% (45)	7.53% (3184)
[4,5]	1.91% (13)	2.36% (996)
[7]	1.76% (12)	1.42% (598)
[3,7]	1.76% (12)	1.32% (556)
[3,4,7]	0.88% (6)	0.12% (50)
[2]	0.59% (4)	1.03% (434)
[3,5,6]	0.44% (3)	0.13% (56)
[4]	0.29% (2)	0.24% (100)
[2,5]	0.29% (2)	0.13% (56)
[5,6]	0.15% (1)	0.24% (103)
[2,3,6]	0.15% (1)	0.03% (12)
[2,6]	0.15% (1)	0.09% (38)
[4,6]	0.15% (1)	0.32% (134)
[2,4,7]	0.15% (1)	0.0% (2)
[2,3,5]	0.15% (1)	0.19% (80)
[4,7]	0.15% (1)	0.2% (83)

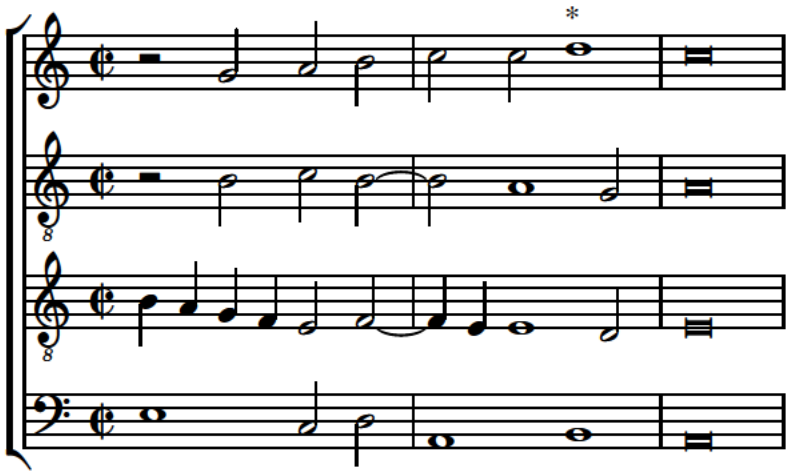
[25] Macey 2009, p. 108.

Table 3.9: All vertical sonorities of *Celi enarrant* on position 0; their frequency is compared with the average frequency in Josquin (secure).

Compared to Josquin's average, the particularly high (resp. low) percentage of `[6]`-chords (resp. `[3,5]`-chords), highlighted in yellow in Table 3.9, supports the impression that the piece's style does not adhere completely to Josquin's. The former datum, which refers to sixth-chords without the third, makes a particular impression, as their presence in *Celi enarrant* almost doubles Josquin's average. As discussed in section 3.1, the employment of empty sixths, often in duo-passages, is a typical stylistic feature of the earlier part of ReDiX's repertoire (about 1470–1520), which decreases in popularity towards mid-16th century. If we assume that *Celi enarrant* was written in the 1520–30s, the composer might have tried to imitate his/her model not only by borrowing musical material from Josquin's motets, but also by purposely making a more abundant use of duos, what might have resulted in an overdose. This may already be a small clue pointing towards the misattribution, but it is possible to gather even more evidence.

The uncommon `[3,4,7]` suspension

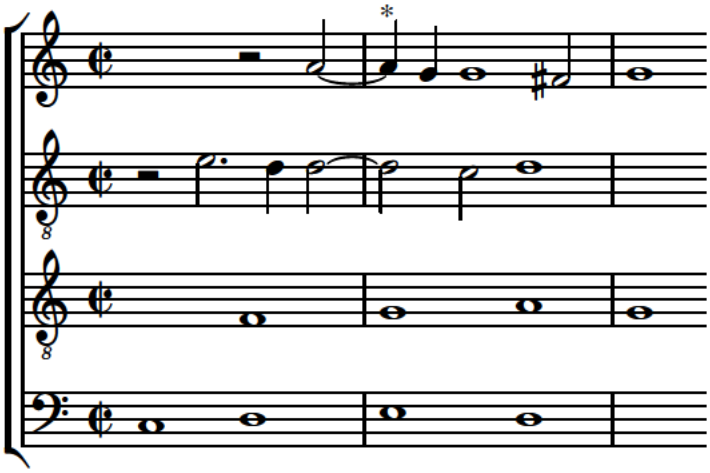
A much more intriguing datum is connected to the `[3,4,7]`-chord, highlighted in orange in Table 3.9. This combination occurs 6 times in *Celi enarrant* as a double suspension (4,7)–(3,6) leading to a perfect cadence in the next beat, as in Example 17 (marked with *).



Example 17. Josquin des Prez (?), *Celi enarrant*, bars 98–100.

In securely-attributed Josquin pieces, this suspension can be found in total only 50 times (0.12%), which already indicates a high unlikelihood of the phenomenon. Adding to this is the fact that of these 50 occurrences, 13 are concentrated in the *Salve Regina à 4* (5.22%) and 4 in *Une musque de Biscaye* (5.97%), and in both pieces for a very

specific reason. The Marian motet is conceived as a double canon, that is: the *tenor* follows the *bassus* after one semibreve, and so does the *cantus* after the *altus*; the canonic entrances are set a fourth apart. In the chanson, this *canon* is limited to the pair of upper voices. Building a perfect cadence with a 4–3 suspension in this setting is contrapuntally challenging, and the above mentioned double suspension (4,7)–(3,6) offers a good possibility. In Example 18 I present a model version of this cadence, which is incorporated in several examples in *Salve Regina* and *Une musque*.



Example 18. A double canon at the upper fourth leads to a perfect cadence with suspensions.

Notice the anticipation (*portamento*) which elegantly disguises the direct parallel fifths between the upper voices, and that Josquin employs invariably, unlike the author of *Celi enarrant*. Repetition (or, quoting Tinctoris, *redicta*) is surely one of Josquin's stylistic traits, but when he repeats, he does it unashamedly. In this case, the obsessive presence of this cadence model in Josquin's *Salve Regina* (bars 39, 51, 63, 66, 69, 75, 81, 85, 90, 93, 102, 108, 122) and *Une musque* (bars 4, 12, 20, 33), is justified by the contrapuntal constraint and it is so patent, that it becomes a piece-signature. Even more so, considering that all the other occurrences of this pattern are sporadic, and no other piece securely attributed to Josquin comes even close to the *Salve Regina* and the *Musque* regarding the frequency of appearances of this suspension. I reported in Table 3.10 all occurrences of `[3,4,7]`-chords on a *semibrevis* beat (position 0, see section 2.5) in Josquin's (secure) pieces.

Piece	Bar(s)
Missa De beata virgine / Gloria	111, 159, 194
Missa Gaudeamus / Credo	31, 174
Missa Gaudeamus / Gloria	25
Missa Gaudeamus / Agnus	116

Missa L'homme armé sexti toni / Gloria	82, 132
Missa L'homme armé sexti toni / Credo	40, 246, 247, 250
Missa Malheur me bat / Sanctus	136
Missa Pange lingua / Credo	203
Missa Sine nomine / Credo	190
Missa Sine nomine / Sanctus	93
Domine, ne in furore	93
Factum est autem	48, 231, 325
Gloria De beata virgine	50
Magnificat tertii toni	109
Miserere mei, deus	55
Nardi Maria pistici / Honor decus imperium	8
Virgo prudentissima	20
Vultum tuum deprecabuntur [7 sections]	326, 535
Baisiez moy	32
Faulte d'argent	42
Plusieurs regretz	48, 56

Table 3.10: Every `[3,4,7]`-chord on the beat in Josquin (secure).

The author of *Celi enarrant* finds himself (herself) in no man's land: on the one hand, the repeated occurrence of this cadence is outstandingly anomalous; on the other hand, this abundance is justified neither by contrapuntal constraints (as in Josquin's *Salve Regina* and *Une musque*), nor by a formal structure which would support such repetitions.

A further remark on this `[3,4,7]`-chord deserves attention. Its appearance in the works not-securely attributed to Josquin (levels 3-4 of attribution accordingly to the Josquin Research Project, Josquin* in ReDiX) is three times more frequent than in secure Josquin pieces (0.36%, with 259/ points). Some unsecure 4-voice pieces also share with *Celi enarrant* a quite abundant use of this chord. In Table 3.11 I report the ones with a higher percentage than *Celi enarrant* of `[3,4,7]`-chords on a *semibrevis* beat (position 0, see Example 12).

Among these, only *En l'ombre d'ung buissonnet* is built as a double canon like Josquin's *Salve Regina à 4*, what justifies the abundance. The very short doubtful (according to JRP and NJE) *frottola* "In te, domine, speravi" has only two occurrences of the (4,7)–(3,6) suspension, but the brevity and the repetition of musical material cause the percentage to be very high. The two motets *Tulerunt dominum* and *Mirabilia testimonia tua Domine* are excluded from the NJE as misattributed, in similar fashion

Piece	Frequency of `[3,4,7]` on the beat
In te, domine, speravi	7.94% (5)
En l'ombre d'ung buissonnet	7.89% (6)
Tulerunt dominum	2.28% (9)
Domine, ne projicias me	1.79% (7)
Mirabilia testimonia tua Domine	1.05% (6)

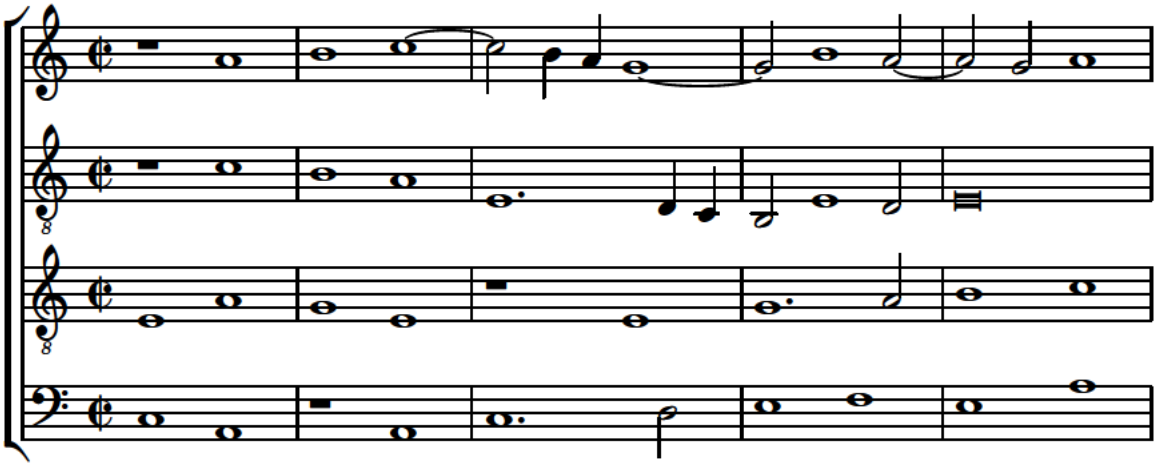
Table 3.11: Pieces by Josquin (unsecure) with a wealth of `[3,4,7]`-chords on the beat.

to *Celi enarrant*, while *Domine, ne projicias me* is included, but declared as doubtful.

The precarious situation of Josquin-attributions shows that care must be taken in the above arguments. On the one hand, comparison with secure Josquin pieces indicate that the above-average use of the `[3,4,7]`-suspension in *Celi enarrant* is foreign to Josquin style. On the other hand, there are unsecure pieces which make use of this harmony in similar quantity. The more one tends towards discarding these pieces as Josquin's, the stronger the argument becomes for *Celi enarrant* as well. If, on the contrary, future scholarly research[26] shows that one or more of these pieces are actually attributable to Josquin, then the above argument will lose in strength, and a revised comparison of *Celi enarrant* to that (those) piece(s) under this specific aspect will possibly refine our understanding.

The exceptional `[2,4,7]` suspension

I will now direct my attention to the following passage of the motet *Celi enarrant*, which corresponds to the sole occurrence of a `[2,4,7]`-chord, highlighted in red in Table 3.9.



Example 19. *Celi enarrant*, bars 291–295.

[26]Especially focusing on source and document evidence.

In the fourth bar, we can observe a somewhat bizarre combination of dissonances. *Cantus* and *altus* sing the (4,7)–(3,6) suspension discussed above, what in itself, as shown, is a rare combination, especially when employed (as here) with the open parallel fifths in the upper voices. The *tenor* meanwhile resolves a 2nd upwards to the third. In works securely attributed to Josquin, not only do these resolutions not occur concurrently, but a `[2,4,7]`-chord in fact never appears on the beat. The two occurrences given by ReDiX (see table above) appear indeed in the two *sesquialtera* passages of Figure 3.2.

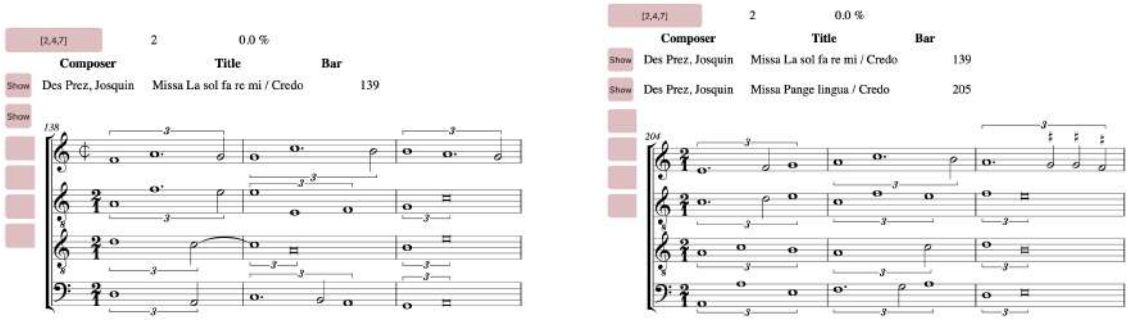
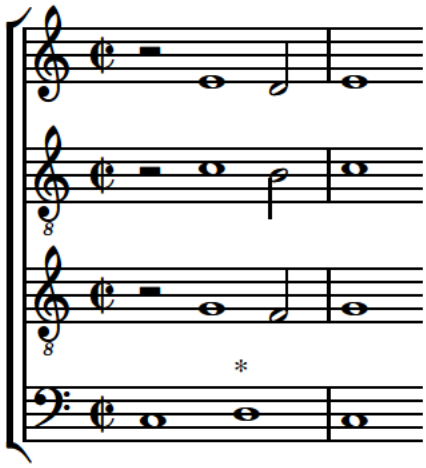


Figure 3.2: The only two instances of `[2,4,7]` in Josquin provided by ReDiX, both within *sesquialtera*-passages.

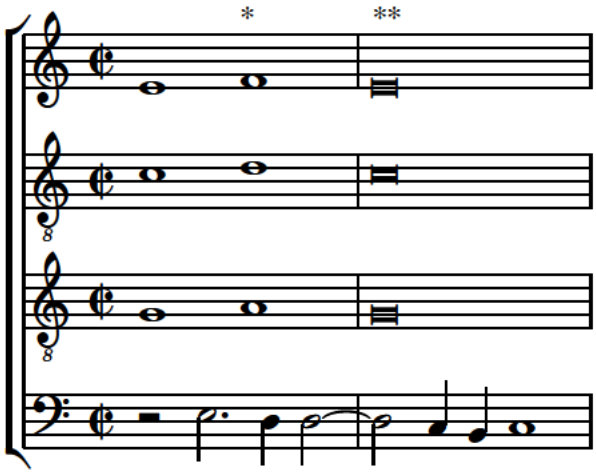
As one can see, the occurrence of the `[2,4,7]`-chords is in the middle of a 𝅵, so theoretically on the beat of a *semibrevis*: however, the 3:2 proportion makes this beat a weak beat. The dissonant vertical combination is therefore generated by a normal non-accented passing note in the *bassus*. On the difficulty of automatically distinguishing and classifying proportions, and especially of redefining weak and strong beats, see section 2.5.

The `[2,4,7]`-chord is therefore never found on the beat in secure Josquin works. In unsecure pieces, there are 13 occurrences of this chord. The upwards resolution of the 2nd featured in *Celi enarrant* is nevertheless even there not to be found. Most of the passages are instances of the harmonic progression shown in Example 20, or slight variants thereof, where the three dissonances resolve downwards as customary.



Example 20. The (4,7,9)–(3,6,8) suspension.

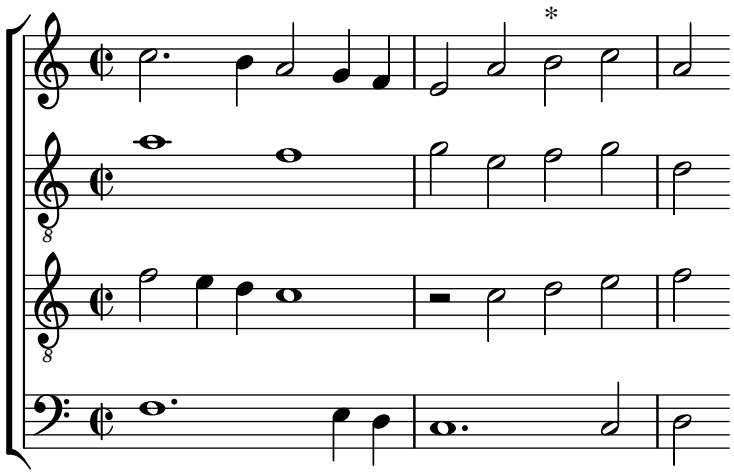
The passages featuring this (4,7,9)–(3,6,8) suspension are in *Laudate pueri dominum* (bar 188), *Victime paschali laudes* (169), *Planxit autem David* (315), *Celorum decus Maria* (48), *Ave verum corpus* (41), *Regina celi letare* (52, 54, 141). Other pieces feature the `[2,4,7]`-chord as a 2–3 suspension in the bass; the dissonance can in this case last a minim or a semiminim.



Example 21. The `[2,4,7]`-chord as a 2–3 suspension in the bass, in two different rhythmic variants.

The quicker resolution (marked * in Example 21) can be found in *Propter peccata quae peccatis* (bar 82) and the Sanctus of the *Missa Sub tuum presidium* (11); the longer one (marked **) in *Gloria laus et honor* (bar 8), *Ave festiva ferculis* (17).

A spectacular treatment of the dissonant `[2,4,7]`-chord is to be observed in the motet *Bonitatem fecisti cum servo tuo*, bar 37.



Example 22. A remarkable passage: Josquin des Prez (??), *Bonitatem fecisti cum servo tuo*, bars 36–38.

There is clearly no explanation for this dissonance treatment inside standard Renaissance theory: if we consider the three upper voices to be dissonant, we must admit an upwards *transitus irregularis* on the *minima* level. An upwards accented dissonant passing note is already rare in this style, and so is a descending *transitus irregularis* at the rhythmic level of the *minima*. The combination of the two is more than exceptional. If, on the other hand, the *c* in the bass is considered as the dissonant note, it is not resolved according to any common treatment. In both cases, the passage remains exceptional in this repertoire, anticipating the much later progression of *cadentia stabilis*, or a form of pedal point.

Thus, the upwards-resolving dissonance in *Celi enarrant* stands out not only as a rare (if existent at all) vertical sonority for Josquin, but also as unique example of voice leading where in such a `[2,4,7]`-chord the dissonance is resolved upwards.

Conclusion

The foregoing analysis seems to support the stylistic incoherence of the motet *Celi enarrant*, when compared to the typical Josquin features. Such a pointed and selective harmonic analysis, which allows to locate and quickly compare similar passages extracted from a large repertoire, is much facilitated by digital tools. However, the human eye must remain open: exclusion of false positives (like in the case of the *sesquialtera*), and knowledge of contrapuntal technique are required in order to evaluate the relevance and oddities of the different passages. Relying on high-profile critical editions such as the NJE, and on top-notch attribution projects such as the JRP is also of crucial importance, in order to assess the trustworthiness of the pieces to compare our sample with. Remarkably, this process is not unidirectional, as the discussion

on *Celi enarrant* impacts in turn the likelihood of corresponding passages in unsecure pieces, thus advancing the knowledge of the attribution problem on those as well.

Conclusion

As demonstrated in the case studies presented in the previous chapter, the incorporation of digital tools and their application to musicological problems does not merely facilitate statistical analysis of large *corpora* of music. It also necessitates the formulation of very precise analytical queries, thereby enforcing a distinct analytical approach. This necessity for a logical and systematic approach to stylistic and music-theoretical considerations is even more pronounced when developing such a digital tool.

In the course of the development process, it was necessary to define the repertoire on which ReDiX operates. While this was constrained by the limitations of the available data, given that not all known music has yet been digitised, the choice involved a careful examination of the Renaissance polyphonic repertoire. As discussed in section 2.1, the initial step was to gather basic biographical data for each composer, which clarified my awareness of the different generations and the various pseudonyms present in the sources. Subsequently, I proceeded to examine the individual pieces and excluded certain fragments that I deemed to be of lesser importance. This decision required careful reflection and resulted in the acquisition of new knowledge regarding the transmission history and status of numerous fragments. The attribution problem, in particular with regard to Josquin des Prez, led me to engage actively with the decisions of the Josquin Research Project. This ultimately resulted in a discussion of the examples of *Celi enarrant* and *Absalon, fili mi* in section 3.2. The distinction between securely and insecurely attributed pieces is not merely a consequence of the JRP work; it is, in fact, an important methodological decision that significantly influences the results of the analysis. It is, of course, possible to work differently than how I did, and it might be more meaningful for different problems; however, the fact alone that I was faced with this choice, and the reflections on how to treat it, greatly reinforced my expertise and forced me to delve into the argument.

Once the repertoire had been selected, the subsequent process of encoding the pieces (or, more accurately, all the chords within the pieces) proved to be a highly enlightening experience. The issue of *musica ficta*, in particular, proved to be a paradigmatic example of the difficulties that can arise in this context. Initially, I had not considered

this problem and had assumed that each note could be encoded with its respective accidental. In a second stage, I tried to find solutions to automatically assign *ficta* accidentals. I investigated in the direction of avoiding augmented and diminished steps in the melodic movement, and in the direction of applying classic conventions to sharpen/flatten notes in typical harmonic chord-progressions. However, the difficulty in combining these two, along with many other cases where standard solutions would not be applicable or would lead to unsound results, led me to conclude that the problem could not be solved by an algorithm. This in itself required a comprehensive study of the *musica ficta* problem in Renaissance polyphony. The realisation that it is possible to work with diatonic intervals, and that it can nonetheless generate meaningful results prompts a reflection on the role of accidentals in music in general. Working diatonically would not be applicable to the majority of Baroque music. Even within the context of Renaissance polyphony, Gesualdo's madrigals would lose a significant portion of their meaning if deprived of accidentals. When is it possible to treat music diatonically and when not? This question, which emerged as a natural consequence of ReDiX's development process, is just one of the manifestations of the necessity to "digitally think" music.

The challenge of encoding rhythm (see section 2.5) forced me not only to identify a technical solution which would make ReDiX a good analytical tool, but also triggered the investigation of some interesting theoretical arguments. What is the minimum number of voices required to sing in *sesquialtera* proportion in order for the composer to alter the manner in which he/she sets dissonances? Is it at all possible to define "canonical" rhythmical positions of suspensions for a polyrhythmic passage?

The problem of encoding rhythm is arguably one of the most challenging open problems in digital musicology, as it involves a multitude of interrelated factors. Even when considering just Western classical music from 1100 to 1900, a faithful and meaningful representation of the rhythmical components is a highly complex endeavour. On the one hand, musical notation has evolved over time: the same rhythmic unit has a different role (especially in relation to text) across multiple systems, and has a variable internal division in smaller note values according to the mensuration, the proportion, the tuplet, and so forth. On the other hand, it is possible to define for each piece a rhythmic pulse, on which performers base their interpretation: this determines the position of up- and downbeats. The nominal (notated) length of this pulse is dependent on the repertoire, as well as the time signature/mensuration of the piece. In some instances, the length of the pulse is not even uniquely defined (*e.g.*, the same piece could be played "in two" or "in four"). The internal division (and subdivision) of the pulse into smaller units adds to the challenge, as the coexistence of different partitions

in the same passage must be taken into account. Notable examples include the *ars subtilior* repertoire and proportions in Renaissance music in general, but polyrhythm or superposition of different divisions are not uncommon in Romantic music. Humans are quite flexible, and able to interpret and adapt the rhythmical signs; however, the intrinsic rigidity of any digital encoding necessitates precise and univocal definitions for each component. A completely satisfactory way of encoding rhythmic information is, I believe, still ahead of us, if at all possible to find.

Another open problem concerns the search for specific chord progressions. ReDiX's approach is to consider one vertical sonority at a time, but for some research problems it may be useful to explore sequences of two or more chords matching a certain pattern. To recall the example briefly discussed in chapter 1, let the pattern be V–I. A first obstacle appears if it is necessary to assign specific rhythmic positions to the chords. If, for example, it is required that the V is on an upbeat, and the I on a downbeat, then one must be able to specify the positions of downbeats. This would fall into the problems discussed above about rhythm and its encoding. Is a variant of the pattern allowed, as for instance V–V^7–I? The precise definition of which sequences are searched after could be much more involved than at first sight might appear. In this example, another relevant problem arises: which note is a first degree (I)? Can a software program automatically assign a tonality to a musical excerpt, that is, recognize modulations? Given that even among humans there are numerous unresolved discussions about the precise beginning and end of modulations, it seems unlikely that an algorithm can provide a universally accepted answer. If a method for automatically characterising and recognising modulations is defined, the results of any subsequent analysis may be influenced by the specific algorithm employed, thus introducing a potential bias.

As these and many other open questions demonstrate, the introduction of digital tools into musicological research has the potential to yield two distinct benefits. On the one hand (as the discussion in chapter 3 has shown), it allows for the generation of statistics, the extrapolation of information, and the identification of specific locations with unparalleled efficiency. When coupled with human expertise, this can bear new insights and refined understanding in scholarly research topics. On the other hand, the discussions in chapter 2 have shown that, by posing the challenge of translating music to numbers and requiring mathematical precision, the introduction of digital tools into musicological research has the potential to modify and enhance our general perception of music. This opens up many points for discussion, and forces the researchers to make conscious methodological choices in their analysis. The implications of these choices, and the progress of digital tools based on the open challenges will direct the future of digital musicological analysis.

Bibliography

Articles and books

Benthem, Jaap van (1989). "Lazarus versus Absalon: about Fiction and Fact in the Netherlands Motet". In: *Tijdschrift van de Vereniging voor Nederlandse Muziekgeschiedenis* 39, pp. 54–82. DOI: 10.2307/938705.

Calvo-Zaragoza, Jorge, Jan Hajič Jr, and Alexander Pacha (2020). "Understanding optical music recognition". In: *ACM Computing Surveys (CSUR)* 53.4, pp. 1–35. DOI: 10.1145/3397499.

Casey, Michael A, Remco Veltkamp, Masataka Goto, Marc Leman, Christophe Rhodes, and Malcolm Slaney (2008). "Content-based music information retrieval: Current directions and future challenges". In: *Proceedings of the IEEE* 96.4, pp. 668–696. DOI: 10.1109/JPROC.2008.916370.

Cuthbert, Michael Scott and Christopher Ariza (2010). "music21: A toolkit for computer-aided musicology and symbolic music data". In: *Proceedings of the 11th International Society for Music Information Retrieval Conference (ISMIR 2010)*. Ed. by John Stephen Downie and Remco C. Veltkamp, pp. 637–642. URL: http://hdl.handle.net/1721.1/84963.

Davison, Nigel (1996). "Absalom fili mi Reconsidered". In: *Tijdschrift van de Koninklijke Vereniging voor Nederlandse muziekgeschiedenis* 1, pp. 42–56. DOI: 10.2307/939131.

Freedman, Richard, Philippe Vendrix, David Fiala, Micah Walter, Emilio Sanfilippo, Raffaele Viglianti, and Daniel Russo-Batterham (2020). "Citations: The Renaissance Imitation Mass (CRIM)". In: *LE STUDIUM Multidisciplinary Journal*, pp. 22–26. DOI: 10.34846/le-studium.188.05.fr.01-2020.

Huron, David (2002). "Music information processing using the Humdrum toolkit: Concepts, examples, and lessons". In: *Computer Music Journal* 26.2, pp. 11–26. URL: https://www.jstor.org/stable/3681454.

Macey, Patrick (1991). "Celi enarrant: An Inauthentic Psalm Motet Attributed to Josquin". In: *Proceedings of the International Josquin Symposium, Utrecht 1986.*

Ed. by Willem Elders and Frits de Haen. Utrecht: Vereniging voor Nederlandse Muziekgeschiedenis, pp. 25–44. ISBN: 9063751486.

Macey, Patrick (2009). *Motets on texts from the Old Testament 2: Texts from the Psalms 1. Critical Commentary*. New Josquin Edition. Utrecht: Koninklijke Vereniging voor Nederlandse Muziekgeschiedenis. ISBN: 978-90-6375-128-9.

Meconi, Honey (1998). "Another look at Absalon". In: *Tijdschrift van de Koninklijke Vereniging voor Nederlandse Muziekgeschiedenis* 1, pp. 3–29. DOI: 10.2307/939154.

— (2003). *Pierre de la Rue and musical life at the Habsburg-Burgundian court*. Oxford-New York: Oxford University Press, USA. ISBN: 9780198165545.

— (2007). "The Range of Mourning: Nine Questions and Some Answers". In: *Tod in Musik und Kultur. Zum 500. Todestag Philipp des Schönen*. Ed. by Stefan Gasch and Birgit Lodes. Cambridge: Hollitzer Verlag, pp. 141–156. DOI: 10.2307/j.ctvg8p5xn.

Menke, Johannes (2015). *Kontrapunkt I: Die Musik der Renaissance*. Laaber: Laaber-Verlag. ISBN: 978-3-89007-825-0.

Metcalfe, Scott (2022). "Clefs, Pitch, and Transposition in Vocal Music before 1600". In: *Journal of the Alamire Foundation* 14, pp. 285–329. DOI: 10.1484/j.jaf.5.131813.

Meyer, Michael (2016). *Zwischen Kanon und Geschichte: Josquin im Deutschland des 16. Jahrhunderts*. Turnhout: Brepols. ISBN: 9782503569154.

Quercu, Simon de (1513). *Opusculum musices perquam brevissimum de Gregoriana et figurativa atque contrapuncto simplici percommode tractans: omnibus cantu oblectantibus utile, ac necessarium*. Nurenberg: Johann Weyssenburger.

Rebelo, Ana, Ichiro Fujinaga, Filipe Paszkiewicz, Andre RS Marcal, Carlos Guedes, and Jaime S Cardoso (2012). "Optical music recognition: state-of-the-art and open issues". In: *International Journal of Multimedia Information Retrieval* 1, pp. 173–190. DOI: 10.1007/s13735-012-0004-6.

Rifkin, Joshua (1991). "Problems of authorship in Josquin: some impolitic observations, with a Postscript on Absalon, fili mi". In: *Proceedings of the International Josquin Symposium, Utrecht 1986*. Ed. by Willem Elders and Frits de Haen. Utrecht: Vereniging voor Nederlandse Muziekgeschiedenis, pp. 45–52. ISBN: 9063751486.

Rodin, Jesse (2015). "Josquin and epistemology". In: *The Cambridge history of fifteenth-century music*. Ed. by Anna Maria Busse Berger and Jesse Rodin. Cambridge: Cambridge University Press, pp. 119–136. ISBN: 9781139057813.

Sachs, Klaus-Jürgen (1974). *Der Contrapunctus im 14. und 15. Jahrhundert: Untersuchungen zum Terminus, zur Lehre und zu den Quellen*. Wiesbaden: Franz Steiner Verlag. ISBN: 3-515-01952-9.

Scattolin, Pier Paolo (1975). *Mensurabilis musicae tractatuli. Il trattato teorico di Jacopo da Bologna. Il trattato teorico di Paolo da Firenze*. Bologna: Antiquae musicae Italicae Studiosi, pp. 63–79.

Thompson, Douglas E. (2001). "A Summary of Current Debates Regarding Josquin's Biography and the Attribution of 'Absalon, fili mi'". In: *The Choral Journal* 42.1, pp. 25–31. URL: https://www.jstor.org/stable/23553882.

Tinctoris, Johannes (1495). *Terminorum musicae diffinitorium*. Treviso: Gerardus de Lisa.

Urquhart, Peter (2004). "Another Impolitic Observation on Absalon, fili mi". In: *The Journal of Musicology* 21.3, pp. 343–380. DOI: 10.1525/jm.2004.21.3.343.

— (2021). *Sound and Sense in Franco-Flemish Music of the Renaissance: Sharps, Flats, and the Problem of* Musica Ficta. Leuven-Paris-Bristol: Peeters Publishers. ISBN: 9789042945968.

Wolf, Johannes (1914). "Ein Beitrag zur Diskantlehre des 14. Jahrhunderts". In: *Sammelbände der internationalen Musikgesellschaft* 15.3, pp. 504–534. URL: https://www.jstor.org/stable/929496.

Zarlino, Gioseffo (1573). *Le Istitutioni Harmoniche*. Third edition. Venice: Francesco De i Franceschi Senese.

Online resources

Last visited: May 12th, 2024.

Bindini, Ugo (2024–). *ReDiX: source code and installation instructions*. URL: https://github.com/ugobindini/redix.

Drescher, Wolfgang (2023–). *Lassus Tricinium Project*. URL: https://lassus.mh-freiburg.de.

Freedman, Richard (2016–). *CRIM Project. Citations: The Renaissance Imitation mass*. URL: https://sites.google.com/haverford.edu/crim-project/home.

music21: a Toolkit for Computer-Aided Musicology. URL: https://web.mit.edu/music21/.

Ory, Benjamin and Craig Sapp (2019–). *The 1520s Project*. URL: https://1520s-project.org.

Ricciardi, Emiliano and Craig S. Sapp (2016–). *Tasso in Music Project*. URL: https://www.tassomusic.org.

Rodin, Jesse and Craig Sapp (2010–). *The Josquin Research Project*. URL: https://josquin.stanford.edu.

The Humdrum Toolkit. URL: https://www.humdrum.org.

Appendix

ReDiX's repertoire: list of the pieces

The following table presents the complete list of pieces coming from the Josquin Research Project and the 1520s project which are included in the database. The anonymous pieces annotated with a "1520" come from the 1520s project database; the others, from the JRP database.

The JRP database provides pieces from the following composers (in the table, a * after the composer's name indicates that the attribution is doubtful):

Agricola, Alexander	Des Prez, Josquin	Obrecht, Jacob
Brumel, Antoine	Du Fay, Guillaume	Ockeghem, Johannes
Busnoys, Antoine	Frye, Walter	Pipelare, Matthaeus
Compére, Loyset	Isaac, Heinrich	Regis, Johannes
De Févin, Antoine	Japart, Jean	Tinctoris, Johannes
De la Rue, Pierre	Martini, Johannes	
De Orto, Marbrianus	Mouton, Jean	

The 1520s project database provides pieces from the following composers:

Arcadelt, Jacques	De Sermisy, Claudin	Gombert, Nicolas
Barra, Hotinet	De Silva, Andreas	Hellinck, Lupus
Bauldeweyn, Noel	De Therache, Pierrequin	Jachet of Mantua
Bisgueria	De la Fage, Jean	Jacotin
Champion, Nicolas	Erasmus	Le Santier, Jean
Conseil, Jean	Festa, Costanzo	Lhéritier, Jean
Daser, Ludwig	Festa, Sebastiano	Lupi, Johannes
De Lanoy, Colinet	Gascongne, Mathieu	Maistre Jan

Moulu, Pierre	Senfl, Ludwig	Willaert, Adrian
Renaldo	Verdelot, Philippe	
Richafort, Jean	Vinders, Jheronimus	

Some pieces, mostly from the database of the 1520s project, carry a source indication. I suppose this indicates the main source used for the digital edition, though I have no absolute confirmation of this; I also do not know why the source is not indicated for all the pieces. When the source indication was present, I reported it in the table.

Composer	Title	Alternative titles / Sections	Source
Agricola, Alexander	Missa In myne zin	Gloria, Credo, Sanctus, Agnus Dei	
	Missa Malheur me bat	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Tout a par moy I		
Anonymous	À cheval		
	A ceste derraine venue		
	Aime qui vouldra		
	Avertissiez	Averte oculus	
	Ben venga Maggio		
	Canto delle parete		
	Che fai qui core	Lauda on Ben venga Maggio	
	Congratulamini mihi omnes[1520]		
	Da pacem domine III		
	De ma griefve maladie	Se je ne suis mariée	
	De sartor nui sian maestri		
	Dies est laetitiae[1520]		
	Domine quis habitabit[1520]		Motetti novi e chanzoni
	Donne vidue	Tarrach barach / Jeus diray	
	Du bon du cueur		
	Ecce tu pulcra es[1520]		
	Eccol Messia	Lauda on Ben venga Maggio	
	Escu d'ennuy		
	Fama malum		
	Fortuna desperata (à 4)		
	Gardez le trait de la fenestre		
	Helas mon cueur tu m'occiras		
	J'ay pris amours a ma devise		
	J'ay pris deux poux a ma chemise		
	Jamais ne seray amoureulx		
	Jamais nul jour de ma vie		
	Jamais si bien ne me peut advenir		
	Je le prens sur ma consience		
	Je ne suis plus si esbatant		
	Jen ay le deul et vous la joie		
	Jesu Jesu Jesu		
	Joyeulx espoir et bon vouloir		

Composer	Title	Alternative titles / Sections	Source
	L'aie bien frique	J'ayme une dame / Galoise	
	L'aumosne au povre desireulx		Dijon Chansonnier
	L'autrier	Hé amy / Adieu l'abesse	
	La plus dolente qui soit nee		
	La plus grant chiere de jamais		
	La plus mignonne de mon cueur		
	Las, quel plaisir	Or y vient / La mousque	
	Laudate Dominum omnes gentes[1520]		Motetti novi libro II
	Le mois de may fort me contraint		
	Les tres des plus heureulx du monde		
	Maintenons nous	Resveille, qui dort	
	Missa Gross senen	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa L'ardant desir	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa [Bergerette savoysienne]	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Mon cueur a demy se depart		
	N'esse pas bien pour departir		
	N'oés vous point le coc	Cocq en l'orge	
	Nigra sum[1520]		
	Nul ne me doit de ce blamer		
	O Belle dyane		
	O beate Sebastiane		
	O infame desleaute		
	O rosa bella	He Robinet	
	Ostez la moi de mon oreille		
	Ou beau chastel		
	Oublie oublie		
	Par Dieu ma dame c'est a tort		
	Par malle bouche		
	Pavane III[1520]		Second livre contenant trois Gaillardes
	Puis quaultrement	Marchez la dureau	
	Puisque à chascun ris	Pardonnez moi / L'autrier m'aloie	
	Puisque vous	Je ne vous ameray	
	Quant je suis seullecte		
	Ravy d'amours despourveu de bon sens		

Composer	Title	Alternative titles / Sections	Source
	Robinet	Se tu te marie / Hélas pourquoy	
	Rolet	La tricotée / Maistre Pière	
	S'il vous plaist bien que je vous tiegne		
	Sanctus Super iste puer magnus		
	Sans jamais	Allez à la fougère	
	Se je mue	Adieu pour mésouen	
	Se je suis despourveu	Veni veni	
	Si vous voullez		
	Soubz les branches	En la rousée / Jolis mois	
	Tambur tambur		
	Textless piece à 3		
	Visin visin visin		
Arcadelt, Jacques	Il bianco e dolce cigno		
Barra, Hotinet	Peccantem me cotidie		
Bauldeweyn, Noel	En douleur en tristesse		
	Gloriosus Dei apostolus Bartholomeus		Motetti de la corona IV
	Missa En douleur en tristesse	Kyrie, Gloria, Agnus Dei	
	Missa Inviolata	Kyrie	
	Quam pulchra es		
Bisgueria	Confirma hoc deus		
Brumel, Antoine	Missa Et ecce terre motus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Pro defunctis	Dies Irae	
Busnoys, Antoine	A qui vens tu tes coquilles		
	A une dame		
	A vous sans aultre		
	Acordés moy		
	Advegne que venir pourra		
	Amors nous traite	Je m'en voy	
	Anima mea liquefacta est	Stirps Jesse	
	Anthoni usque limina		
	Au gré de mes ieulx		
	Au povre par necessité		
	Bel Acueil le sergent d'Amours		
	Bone chere		
	C'est bien malheur		

Composer	Title	Alternative titles / Sections	Source
	C'est vous en qui j'ay esperance		
	Ce n'est pas moy		
	Con tutta gentileça		
	Corps digne	Dieu quel mariage	
	En soustenant vostre querelle		
	En tous les lieux		
	En voyant sa dame		
	Est-il merchy		
	Faites de moy		
	Faulx mesdisans		
	Ha que ville I		
	Ha que ville II		
	In hydraulis		
	In myne zynn		
	J'ay mains de biens		
	Ja que li ne si attende		
	Je mesbais de vous		
	Je ne demande aultre degre		
	Joye me fuit		
	Lautrier la pieca		
	Lautrier que passa		
	Le corps s'en va		
	Le monde est tel		
	M'a vostre cueur		
	Ma demoiselle m'a maistresse		
	Ma plus qu'assez		
	Ma tres souveraine princesse		
	Maintes femmes		
	Missa L'homme armé	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Mon mignault	Gracieuse plaisante muniere	
	Mon seul et cele souvenir		
	O Fortune trop tu es dure		
	On a grant mal	On est bien malade	
	Pour entretenir mes amours		
	Pucellotte que dieu vous gart		

Composer	Title	Alternative titles / Sections	Source
	Quant j'ay au cueur		
	Quant vous me ferez		
	Quelque pauvre homme I		
	Quelque pauvre homme II		
	Resjois toy terre de France	Rex pacificus	
	Seule a par moy		
	Soudainement mon cueur a pris		
	Terrible dame		
	Une filleresse d'estouppes	Sil y a compagnon / Vostre amour	
	Ung grand povre homme		
	Ung plus que tous II		
	Ung que plus tous I		
	Vostre gracieuse acointance		
	Vous marchez	Marionnette	
Busnoys, Antoine*	J'ay pris amours		
	Quant ce viendra		
Champion, Nicolas	De profundis clamavi		
Compére, Loyset	Alons fere nos barbes		
	Chanter ne puis chieux la mynonne		
	Che fa la ramacina		
	Hodie nobis cycle	Hodie nobis	
	Ne vous hastez pas en malheure		
	Nous sommes de l'ordre de Saint Babouin		
	Pensant au bien que m'a dame m'a fait		
	Pleut or a Dieu que n'aymasse jamais		
	Pour estre ou nombre des loyaulx		
	Puis que si bien m'est advenu		
	Reveille toy franc cuer joyeulx		
	Scaramella fa la galla		
	Se mieulx ne vient d'amours peu me contente		
	Se pis ne vient d'amours je me contente		
	Si j'ay parlé aucunement		
	Sourdes regretz avironez mon cueur		
	Tant ha bon oeul		
	Tout mal me vient Dieu mercy et fortune		

Composer	Title	Alternative titles / Sections	Source
	Un franc archier a la guerre s'en va		
	Une plaisante fillette		
	Va t'en regret celuy qui me convoye		
	Venés regretz venés il en est heure		
	Vive le noble roy de France		
	Volés oïr une chanson		
	Vostre bargeronette m'amiette		
	Vous me faittes morir denvie		
	Vray Dieu quel payne messe		
Conseil, Jean	Adiuva me, Domine		
	Assumpta est Maria		
	Ego sum qui sum		
	Nigra sum		
Daser, Ludwig	Missa Preter rerum	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
De Févin, Antoine	Missa Ave Maria	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Sancta trinitas		
De Lanoy, Colinet	Cela sans plus		
De Orto, Marbrianus	Ave Maria gratia plena		
	Ave Maria mater gratie		
	Credo à 5		
	Credo Le serviteur		
	D'ung aultre amer		
	Descendi in ortum meum		
	Domine non secundum peccata nostra		
	Dulces exuvie		
	Fors seulement		
	Je ne suis poinct		
	Kyrie De beata virgine		
	La mi la sol		
	Lamentatio Jeremie prophete		
	Lucis creator optime		
	Missa Dominicalis	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa J'ay pris amours	Kyrie, Gloria, Credo, Credo (1st setting), Sanctus, Agnus Dei	
	Missa La belle se siet	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	

Composer	Title	Alternative titles / Sections	Source
	Missa Mi mi (Missa Petite camusette)	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa [Ad fugam]	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Si j'ay perdu mon amy		
	Ut queant laxis		
	Venus tu m'a pris		
De Orto, Marbrianus*	Salve regis mater sanctissima	Hic est sacerdos	
De Sermisy, Claudin	Aspice, Domine		
	Hau, hau, hau le boys		
	Impetum inimicorum		
	In te Domine speravi		
	Je ne fais rien que requerir		
	Jouyssance vous donneray		
	Languir me fais		
	Quosque non reverteris pax		
	Secourez moy ma dame		
	Si bona suscepimus		
	Tant que vivray		
	Vox in rama		
De Silva, Andreas	Ave ancilla trinitatis		
	Ave regina celorum II		
	In illo tempore		
	Intonuit de celo Dominus		
	O virgo benedicta		
	Omnis pulchritudo Domini		
	Puer natus est		
	Tota pulchra es		
	Virgo carens criminibus		
De Therache, Pierrequin	Clare sanctorum		
	Verbum bonum et suave		
De la Fage, Jean	Partus et integritas		
De la Rue, Pierre	A vous non autre		
	Autant en emporte le vent		
	Ave regina celorum		
	Ce n'est pas jeu		
	Considera Israel		

Composer	Title	Alternative titles / Sections	Source
	Credo		
	Credo L'amour de moy		
	Credo Sex vocum		
	Credo de villagiis		
	Da pacem Domine		
	De l'oeil de la fille du roy		
	Delicta iuventutis		
	Gaude virgo mater Christi		
	Il est bien heureux		
	Il viendra le jour désiré		
	Kyrie In festo pasche		
	Lauda anima mea dominum		
	Laudate dominum		
	Magnificat Octavi toni		
	Magnificat Quarti toni		
	Magnificat Secundi toni		
	Magnificat Sexti toni		
	Mijn hert altijt heeft verlanghen		
	Missa Alleluia	Kyrie, Gloria	
	Missa Almana	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Assumpta est Maria	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ave Maria	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ave sanctissima Maria	Kyrie, Gloria, Credo, Sanctus, Agnus Dei, Loco Deo Gratias	
	Missa Conceptio tua	Kyrie, Gloria, Credo, Agnus Dei	
	Missa de Sancto Antonio	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de Sancto Job	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de beata virgine	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de feria	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de sancta cruce	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de virginibus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Incessament	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Inviolata	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ista est speciosa	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Nunca fué pena mayor	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	

Composer	Title	Alternative titles / Sections	Source
	Missa O gloriosa domina	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa O salutaris hostia	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Pascale	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Pro fidelibus defunctis	Introit, Kyrie, Tractus, Offertorium, Sanctus, Agnus Dei, Communio I, Communio II	
	Missa Puer natus est nobis	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Sancta Dei genitrix	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Sine nomine I	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Tandernaken	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Tous les regretz	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de septem doloribus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	O domine Jesu Christe		
	O salutaris hostia		
	Pater de celis deus		
	Pour ce que le suis		
	Pour ung jamais		
	Pourquoy non		
	Pourquoy tant		
	Quis dabit pacem		
	Regina celi		
	Salve regina I		
	Salve regina II		
	Salve regina III		
	Salve regina IV		
	Salve regina VI		
	Tous les regretz		
	Tous nobles coeurs		
	Trop plus secret		
Des Prez, Josquin	A l'heure		
	A la mort	Monstra te esse matrem	
	A l'ombre d'ung buissonnet		
	Adieu mes amours		
	Alma redemptoris mater	Ave regina celorum	
	Ave Maria...benedicta tu		
	Ave Maria...virgo serena		

Composer	Title	Alternative titles / Sections	Source
	Ave maris stella	Verse 4: Monstra te esse matrem	
	Ave verum corpus		
	Baisiez moy		
	Benedicta es, celorum regina		
	Bergerette savoysienne		
	Ce povre mendiant	Pauper sum ego	
	Cela sans plus		
	Comment peult avoir joye		
	Credo De tous biens playne		
	Credo [Quarti toni]		
	Cueur langoreulx		
	De profundis clamavi		
	De tous biens plaine (à 3)		
	De tous biens plaine (à 4)		
	Domine, ne in furore		
	Domine, non secundum peccata		
	Douleur me bat		
	Du mien amant		
	Ecce tu pulchra es		
	En l'ombre d'ung buissonnet		
	Entré je suis		
	Entrée suis en grant pensée		
	Factum est autem		
	Faulte d'argent		
	Fors seulement III		
	Fortuna d'un gran tempo		
	Gaude virgo		
	Gloria De beata virgine		
	Homo quidam fecit cenam		
	Huc me sydereo (à 5)	Plangent eum	
	Ile fantazies de Joskin		
	Illibata dei virgo nutrix	La mi la	
	In exitu Israel de Egypto		
	In principio erat verbum		
	Incessament livré		

Composer	Title	Alternative titles / Sections	Source
	Inviolata, integra et casta es		
	Je n'ose plus		
	Je sey bien dire		
	La Bernardina		
	La plus des plus		
	Le villain		
	Liber generationis		
	Magnificat tertii toni		
	Memor esto verbi tui		
	Miserere mei, deus		
	Missa Ave maris stella	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa D'ung aultre amer–Tu solus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de beata virgine	Sanctus, Agnus Dei	
	Missa Faisant regretz	Gloria, Credo, Sanctus, Agnus Dei	
	Missa Fortuna desperata	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Gaudeamus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Hercules dux Ferrarie	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa L'ami Baudichon	Kyrie, Gloria, Sanctus, Agnus Dei	
	Missa L'homme armé sexti toni	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa L'homme armé super voces musicales	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa La sol fa re mi	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Malheur me bat	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Pange lingua	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Sine nomine	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missus est Gabriel angelus		
	Nardi Maria pistici	Verse 2: Honor decus imperium	
	Nimphes, napées	Circumdederunt me	
	Nymphes des bois	Requiem	
	O admirabile commercium [5 sections]		
	O domine Jesu Christe [5 sections]		
	O virgo prudentissima	Beata mater	
	Parfons regretz		
	Pater noster		
	Petite camusette		
	Plaine de deuil		

Composer	Title	Alternative titles / Sections	Source
	Plus nulz regretz		
	Plusieurs regretz		
	Pour souhaitter		
	Preter rerum seriem		
	Que vous madame	In pace	
	Qui belles amours		
	Qui habitat in adjutorio altissimi		
	Qui velatus facie fuisti [6 sections]		
	Salve regina (à 4)		
	Salve regina (à 5)		
	Sanctus D'ung aultre amer–Tu lumen		
	Sanctus De passione–Honor et benedictio		
	Scaramella		
	Se congie prens		
	Si j'ay perdu mon amy		
	Stabat mater	Comme femme desconfortee	
	Tu solus qui facis mirabilia		
	Une musque de Biscaye		
	Ut Phebi radiis	Ut re mi fa sol la	
	Victime paschali laudes	D'ung aultre amer / De tous biens plaine	
	Virgo prudentissima		
	Virgo salutiferi	Ave Maria	
	Vive le roy		
	Vous l'arez		
	Vultum tuum deprecabuntur [7 sections]		
Des Prez, Josquin*	Absalon, fili mi		
	Absolve, quesmus, domine		
	Ach hulff mich leid		
	Agnus Dei		
	Allegez moy		
	Alleluia. Laudate dominum		
	Alma redemptoris mater		
	Anima mea liquefacta est (secunda pars)		
	Au bois au bois ma dame		
	Ave Maria		

Composer	Title	Alternative titles / Sections	Source
	Ave Maria...virgo serena (à 6)		
	Ave Maria...virgo serena (à 8)		
	Ave caro Christi cara		
	Ave festiva ferculis		
	Ave maris stella		
	Ave mundi spes Maria		
	Ave nobilissima creatura		
	Ave verum corpus		
	Ave verum corpus	Ecce panis / Bone pastor / O salutaris hostia	
	Ave virgo sanctissima		
	Baisiez moy		
	Beati omnes		
	Beati omnes		
	Beati quorum remisse sunt		
	Belle pour l'amour de vous		
	Benedicite, omnia opera		
	Benedicta sit sancta trinitas		Regensburg 76
	Bonitatem fecisti cum servo tuo		
	Cantate domino canticum novum		
	Cela sans plus		
	Celi enarrant gloriam dei		
	Celorum decus Maria		
	Cent mille regretz		
	Christus mortuus est		
	Clamavi ad dominum cum tribularer		
	Confitemini domino	Per singulos dies benedicimus te	
	Congratulamini mihi omnes		
	Conserva me domine		
	Credo Chascun me crie		
	Credo La belle se siet		
	Credo Vilayge I		
	Credo Vilayge II		
	Crucifixus		
	Cueurs desolez		
	Cueurs desolez par toute nation	Plorans ploravit	

Composer	Title	Alternative titles / Sections	Source
	De profundis clamavi		
	De profundis clamavi [high]		
	De profundis clamavi [low]		
	Descendi in ortum meum		
	Deus in adiutorium		
	Deus in nomine tuo		
	Deus pacis reduxit		
	Dictez moy bergere		
	Dilectus Deo et hominibus		
	Dixit dominus		Rostock 71/1
	Domine dominus noster		
	Domine exaudi orationem meam auribus		
	Domine quis habitabit		
	Domine, ne in furore I		
	Domine, ne in furore II		
	Domine, ne projicias me		
	Domini est terra		
	Dominus regnavit		
	Dulces exuviae		
	Ecce dominus veniet		
	Ecce video celos apertos		
	El grillo		
	En l'ombre d'ung buissonnet		
	En non saichant		
	Et incarnatus est		
	Et trop penser		
	Exultent et letentur		
	Fama malum		
	Fors seulement I		
	Fors seulement II		
	Fortuna desperata		
	Gloria De beata virgine		
	Gloria laus et honor		
	Guillaume se va chaufer		
	Hec est vita eterna		

Composer	Title	Alternative titles / Sections	Source
	Helas madame		
	Helas que pourra		
	Huc me sydereo (à 6)	Plangent eum	
	Il n'est plaisir		
	Illumina oculos		
	In domino confido		
	In illo tempore Maria Magdalena		
	In illo tempore assumpsit Jesus		
	In illo tempore stetit Jesus		
	In nomine Jesu		
	In pace in idipsum		
	In te, domine, speravi		
	Incessament mon povre cueur		
	Inter natos mulierum		
	Inviolata integra et casta es		
	Ite in mundum		
	J'ay bien nourry		
	Jay bien cause de lamenter		
	Je me (Je [me] suis si trestourte)		
	Je me complains		
	Je ne demande		
	Je ne me puis tenir d'aimer		
	Je ris		
	Jubilate deo omnis terra		
	Judica me deus		
	Kyrie Pascale		
	L'heure est venue	Circumdederunt me	
	L'homme armé		
	La belle se siet		
	Lauda Jerusalem dominum		
	Laudate dominum omnes gentes		
	Laudate pueri dominum		
	Leal schray tante		
	Lectio actuum apostolorum	Dum complerentur	
	Letare nova Syon		

Composer	Title	Alternative titles / Sections	Source
	Levavi oculos meos		
	Lourdault, Lourdault		
	Lugebat David Absalon		
	L'amye a tous	Je ne viz oncques	
	Ma bouche rit (à 5)		
	Ma bouche rit (à 6)		
	Madame helas		
	Magnificat Quarti toni		
	Magnificat Tertii toni		
	Magnificat septimi toni		
	Magnus es tu domine		
	Marguerite		
	Mes pensees		
	Mi lares vous tousjours languir		
	Mille regretz		
	Mirabilia testimonia tua Domine		
	Misericordias domini		
	Miserimini mei		
	Missa Ad fugam	Kyrie, Gloria, Credo, Sanctus (I and II), Agnus Dei (I and II)	
	Missa Allez regretz I	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Allez regretz II	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Cum iocunditate (=Missa Dirige)	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Da pacem	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de beata virgine	Kyrie, Gloria, Credo	
	Missa Di dadi	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Faisant regretz	Kyrie	
	Missa Ferialis	Kyrie, Sanctus, Agnus Dei	
	Missa Inviolata	Osanna	
	Missa L'ami Baudichon	Credo	
	Missa L'homme armé quarti toni	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Mater patris	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Mi mi	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Missus est Gabriel Angelus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Mon seul plaisir	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	

Composer	Title	Alternative titles / Sections	Source
	Missa Pro defunctis	Introit, Kyrie, Gradual, Offertory, Sanctus, Agnus Dei, Communion	
	Missa Quem dicunt homines	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Rosina	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Sub tuum presidium	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Une mousse de Biscaye	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Veni Sancte Spiritus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missus est Gabriel angelus		
	Mittit ad virginem		
	Mon mary m'a diffamée		
	Mon seul plaisir		
	N'avez point neu [=Mala se nea]		
	N'esse pas ung grant deplaisir		
	Nesciens mater virgo virum		
	Nunc dimittis		
	O Venus bant		
	O admirabile commercium	Verbum caro factum est - Magnum nomen	
	O bone et dulcis domine	Pater noster / Ave Maria...benedicta tu	
	O bone et dulcissime Jesu		
	O dulcis amica		
	O virgo virginum		
	Obsecro te, domina		
	Pange, lingua, gloriosi		
	Paratum cor meum		
	Pensif mari		
	Petite camusette		
	Planxit autem David		
	Pleni Comment peult		
	Pleni [from the Missa Ave Maria]		
	Plus n'estes ma maistresse		
	Proch dolor		
	Propter peccata quae peccatis	La Spagna	
	Puer natus est nobis		
	Quam dilecta tabernacula		
	Quam pulchra es		

Composer	Title	Alternative titles / Sections	Source
	Quant je vous voye		
	Queramus cum pastoribus		
	Qui edunt me		
	Qui habitat in adjutorio altissimi		
	Qui regis Israel		
	Recordare, virgo mater		
	Regina celi letare (3 versions)		
	Regretz sans fin		
	Responde mihi		
	Responsum acceperat Simeon		
	Salva nos domine		
	Salve mater salvatoris		
	Salve regina		
	Salve sancta facies		
	Sancta Maria virgo virginum		
	Sancta mater istud agas		
	Sancta trinitas		
	Sancti dei omnes		
	Scimus quoniam diligentibus	De tous biens plaine / Per omnia secula	
	Se congie prens		
	Si bibero		
	Si dormiero		
	Si j'ay perdu mon amy		
	Si jeusse Marion		
	Si vous n'avez		
	Sic deus dilexit mundum	Circumdederunt me	
	Sit nomen domini		
	Stetit autem Salomon		
	Tant vous aimme		
	Te deum laudamus (2 versions)		
	Tenez moy en voz bras		
	Textless pieces (2)		
	Tous les regretz		
	Tribulatio et angustia		
	Tua est potentia		

Composer	Title	Alternative titles / Sections	Source
	Tulerunt dominum		
	Usquequo domine oblivisceris me		
	Veni sancte spiritus		
	Venit Jesus	Tu es Petrus	
	Verbum bonum et suave		
	Verbum caro factum est		
	Victime paschali laudes		
	Vivrai je tousjours		
	Vous ne l'aurez pas		
	Vray dieu d'amour		
Du Fay, Guillaume	Adieu ces bons vins de Lannoys		
	Adieu m'amour adieu ma joye		
	Adyeu quitte le demeurant		
	Ave maris stella	Verse, hymn	
	Ave regina celorum III		
	Belle vueillez moy vengier		
	Bon jour bon mois bon an et bonne estraine		
	Craindre vous vueil doulce dame de pris		
	Helas mon dueil a ce cop sui je mort		
	Malheureulx cueur que vieulx tu faire		
	Missa Ave regina celorum	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ecce ancilla domini	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa L'homme armé	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Se la face ay pale	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Nuper rosarum flores	Terribilis est locus iste	
	Puisque vous estez campieur		
	Resvellies vous et faites chiere lye (ballade)		
	Resvelons nous resvelons amoureux	Alons en bien tos au may	
Du Fay, Guillaume*	Hic iocundus sumit mundus		
	Se la face ay pale		
Erasmus	Gloriosi principes		
Festa, Costanzo	Angelus ad pastores		
	Congratulamini mihi		
	Deduc me, Domine		
	Ecce Deus salvator meus		

Composer	Title	Alternative titles / Sections	Source
	Elisabeth beatissima		
	Felix Anna		
	In illo tempore		
	Inviolata, integra, et casta es		
	Lieto non hebbi mai		
	Maria virgo, prescripta		
	Nunc dimittis		
	O pulcherrima virgo		
	Petrus apostolus		
	Quam pulchra es		
	Quis dabit oculis		
	Regem archangelorum		
	Regem regum Dominum		Bologna Q19
	Regina celi		
	Regina celi, letare		
	Sub tuum presedium		
	Super flumina babilonis		Medici Codex
	Tribus miraculis		
	Vidi speciosam		
Festa, Sebastiano	Angele Dei		
	Hec est illa dulcis rosa		
	In illo tempore postquam		
	O passi sparsi		
Frye, Walter	O florens rosa		
	Tout a par moy		
Gascongne, Mathieu	Christus vincit, Christus regnat		
	Letatus sum		
	Quare tristis		
Gombert, Nicolas	Alleluya my fault chanter		
	Angelus Domini		
	Aspice Domine		
	Dicite in magni		
	Gris et tanné me fault porter		
	Missa Media Vita	Kyrie	
	Missa Quam pulchra es	Kyrie, Gloria	

Composer	Title	Alternative titles / Sections	Source
	Qui colis Ausoniam		
Hellinck, Lupus	Esto nobis		
	In convertendo Dominus		
	In nomine Jesu		
	Letetur omne seculum		
	Miserere mei Deus		
	Miserere mei Domine		
	Postquam consummati sunt		
Isaac, Heinrich	Alla battaglia		
	Credo I		
	Credo II		
	Credo III		
	Credo IV		
Jachet of Mantua	Alleluia surrexit Dominus		
	Ave mater matris Dei		Bologna Q19
	Ave regina celorum		
	Cantate Domino		
	Domine bonum est		
	Ecclesiam tuam Deus		Bologna Q19
	Noe noe hodie salvator mundi		
	O Jesu Christe miserere mei		
	O vos qui transitis		
	Omnes sancti tui quesumus		
	Ploremus omnes et lacrimemur		
	Retribuere dignare, Domine		
	Sancta Trinitas		
	Sufficiebat nobis paupertas		
	Veni sancte spiritus		
	Visita, quesumus Domine		
Jacotin	A tout jamais		
	Hellas, pourquoy		
	Interveniat pro Gabrieli		
	Interveniat pro Gabrieli		
	J'ay un billard		
	Robin fit tant		

Composer	Title	Alternative titles / Sections	Source
	Rogamus te		
	Vostre beaulté		
Japart, Jean	Amours amours amours		
	Amours fait moult tant	Il est de bonne heure né / Tant que nostre argent	
	Cela sans plus ne souffi pas		
	De tous biens plaine		
	Et qui la dira	Dieu gard celle	
	Famene un poco		
	Fortuna d'un gran tempo		
	Hellas qu'elle est a mon grè		
	Il est de bonne heure né	L'homme armé	
	J'ay bien nori		
	J'ay pris amours I		
	J'ay pris amours II		
	Je cuide	De tous biens plaine	
	Loier mi fault		
	Nenciozza mia		
	Pour passer temps		
	Prestes le moy		
	Si congié pris		
	T'meiskin		
	Tan bien mi son pensada		
	Trois filles estoient		
	Vray dieu d'amours	Sancte Iohanes baptista / Ora pro nobis	
Le Santier, Jean	Alma redemptoris mater		
Lhéritier, Jean	Ascendens Christus		
	Ave Domina mea		
	Ave Maria, gratia plena		
	Ave mater matris Dei		
	Ave regina celorum		
	Deus in nomine tuo		
	Dum complerentur		
	Hodie salvator mundi		
	Nigra sum (à 4)		

Composer	Title	Alternative titles / Sections	Source
	Nigra sum (à 5)		
	Nigra sum (à 6)		
	Salvator mundi		
	Sancta Maria succurre miseris		
	Sub tuum presidium		
	Te matrem		
	Virgo Christi egregia		
Lupi, Johannes	Credo		
	Gloria		
	Kyrie		
Maistre Jan	Ave gloriose beatissime Antoni		
	Ave stella matutina		
	Johannes Jesu Christo		
	Lauda Jerusalem Dominum		
	O Domine Jesu Christe		
	O benignissime Domine Jesu		
	O magnum misterium		Bologna Q19
	O sacrum convivium		Bologna Q19
	Vox de celis		Bologna Q19
Martini, Johannes	Ad Dominum cum tribularer		
	Ad te levavi		
	Audi benigne conditor		
	Aures ad nostras		
	Ave decus virginale		
	Ave maris stella		
	Beati omnes		
	Beatus vir		
	Benedictus dominus deus (à 2)		
	Benedictus dominus deus (à 3)		
	Biaulx parle tousjours		
	Confitebimur tibi deus		
	Confitebor tibi (2 versions)		
	Confitemini domino		
	Conserva me Domine		
	Credidi propter quod locutus		

Composer	Title	Alternative titles / Sections	Source
	Cum invocarem		
	Da pacem Domine		
	De la bonne chiere		
	De profundis clamavi		
	Des biens d'amours		
	Deus in adjutorium		
	Deus in nomine tuo		
	Deus tuorum militum I		
	Deus tuorum militum II		
	Dilexi quoniam		
	Dixit Dominus		
	Domine clamavi ad te		
	Domine exaudi orationem meam		
	Domine non est exaltatum		
	Domine non secundum		
	Domine quis habitabit		
	Domini est terra		
	Ecce quam bonum		
	Eripe me domine		
	Exaltabo te		
	Exaltabo te domine		
	Exultet celum laudibus		
	Fault il que heur soye		
	Festum nunc celebre		
	Fortuna d'un gran tempo		
	Fortuna desperata		
	Fuga ad quatuor		
	Fuge la morie		
	Il est tel		
	Il est tousjours		
	In convertendo		
	Iste confessor		
	J'ay pris amours I		
	J'ay pris amours II		
	J'espoir mieulx		

Composer	Title	Alternative titles / Sections	Source
	Je remerchi dieu		
	Jesu corona virginum		
	Judica me deus		
	La Martinella		
	La fleur de biaulté		
	Lauda Jerusalem		
	Laudate Dominum quoniam bonus est		
	Laudate nomen domini		
	Laudate-pueri		
	Le pouverté		
	Letatus sum		
	Levavi oculos meos		
	Memento domine David		
	Miserere mei deus		
	Missa Cela sans plus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Coda di pavon	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Cucu	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Dio te salvi Gotterello	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ferialis	Kyrie, Sanctus, Agnus Dei	
	Missa In feuers hitz	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa La Martinella	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ma bouche rit	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Nenciozza mia		
	Nisi Dominus		
	Nisi quia Dominus		
	Non per la		
	Notus in Judea deus		
	O beate Sebastiane		
	O intemerata		
	Quare fremuerunt gentes		
	Qui confidunt		
	Sanctorum meritis		
	Sepe expugnaverunt me		
	Super flumina Babilonis		
	Textless I Fa mi re ut re		

Composer	Title	Alternative titles / Sections	Source
	Vexilla regis		
Martini, Johannes*	Perfunde celi rore		
	Salve regina		
	Tibi Christe		
Moulu, Pierre	Et dont venés vous		
	Fiere attropos		
	Mater floreat		
	N'aymés jamais ces gens		
	O dulcis amica		
	Quam pulchra es		
	Salve, regina Barbara		
	Vulnerasti cor meum		
Mouton, Jean	Adieu mes amours		
	Alleluia confitemini Domino		
	Ave Maria gratia plena (à 4)		
	Ave Maria gratia plena (à 5)		
	Benedicta es celorum regina		
	Dieu gard de mal de deshonneur		
	En venant de Lyon		
	Gaude Barbara		
	Je le laray puisqu'il my bat		
	Jocundare Jerusalem		
	L'ort vilain jaloux		BolC Q19
	Lectio actuum apostolorum		
	Missus est angelus Gabriel		
	Moriens lux		
	Nesciens mater		
	Peccata mea		
	Per lignum salvi facti sumus		
	Puer natus est		
	Qui ne regrettroit le gentil Fevin		
	Salva nos, Domine		
	Tua est potentia		
Obrecht, Jacob	Factor orbis	Veni Domine	
	Inter preclarissimas virtutes		

Composer	Title	Alternative titles / Sections	Source
	Mille quingentis	Requiem	
	Missa Adieu mes amours	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ave regina celorum	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de Sancto Martino	Kyrie	
	Salve crux		
Ockeghem, Johannes	Alma redemptoris mater		
	Aultre Venus		
	Aultre Venus		
	Ave Maria		
	Baisies moy		
	Baisies moy		
	Credo [Village]		
	D'ung aultre amer		
	Departés vous		
	Fors seulement l'attente		
	Fors seullement contre		
	Il ne men chault		
	Intemerata dei mater		
	Je n'ay dueil		
	Je n'ay dueil		
	L'autre d'antan		
	La despourveue		
	Les desléaulx		
	Ma bouche rit		
	Ma maistresse		
	Missa Au travail suis	Kyrie, Gloria, Credo, Sanctus	
	Missa Caput	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Cuiusvis toni (on D)	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Cuiusvis toni (on E)	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Cuiusvis toni (on F)	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa de plus en plus	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ecce ancilla domini	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Fors seulement	Kyrie, Gloria, Credo	
	Missa L'homme armé	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Ma maistresse	Kyrie, Gloria	

Composer	Title	Alternative titles / Sections	Source
	Missa Mi mi	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Prolationum	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Quinti toni	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Sine nomine	Kyrie, Gloria, Credo	
	Mort tu as navré / Miserere		
	O rosa bella		
	Prenez sur moy		
	Presque transi		
	Presque transi		
	Qu'es mi vida		
	Qu'es mi vida		
	Quant de vous seul		
	Requiem	Introit, Kyrie, Gradual, Tract, Offertory	
	Salve regina I		
	Se vostre cuer		
	Selle m'amera	Petite camusette	
	Tant fuz gentement		
	Ung aultre l'a		
Ockeghem, Johannes*	Malheur me bat		
	Permanent vierge	Pulchra es / Sancta Dei genitrix	
Pipelare, Matthaeus	Missa Fors seulement	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
Regis, Johannes	Ave Maria ... benedicta tu		
	Clangat plebs flores	Sicut lilium	
	Lauda Sion salvatorem	Ego sum panis	
	Lux solemnis	Repleti sunt omnes	
Renaldo	Hec dies quam fecit		
	Regina celi		
Richafort, Jean	Christus resurgens		
	Cognoscimus, Domine		
	Consolator captivorum		
	D'amours je suis desheritée		
	De mon triste et desplaisir		
	Ego sum qui sum		
	Emendemus in melius		
	Exaudiat te Dominus		

Composer	Title	Alternative titles / Sections	Source
	Gloriosi principes		
	Homo quidam		
	Jam non dicam		
	Jerusalem luge		
	Miseremini mei		
	Ne vous chaille, mon cueur		
	O Beata infantia		
	Pater noster		
	Philomena praevia		
	Quem dicunt homines		
	Requiem	Introit, Kyrie, Gradual, Offertory, Sanctus, Agnus, Communion	
	Sufficiebat		
	Sur tous regretz		
	Veni, sponsa Christi		
Senfl, Ludwig	A subitanea et improvisa morte		Zwickau 1676-1788
	Assumpta est Maria		
	Beati omnes qui timent Dominum I		
	Beati omnes qui timent Dominum II		
	Completi sunt dies Mariae		
	Cum aegrotasset Job		Munich 16
	Da pacem, Domine I		
	De profundis clamavi I		Zwickau 1676-1788
	Dum steteritis		
	Ecce Maria genuit I		Regensburg C120
	Ecce Maria genuit II		
	Egregie Dei martyr		Zwickau 1676-1788
	Hic accipiet benedictionem		Regensburg C120
	Nativitas tua, Dei genitrix virgo		
	Nesciens mater virgo virum		
	Non moriar sed vivam		
	Nunc, Deus, ad requiem		
	O bone Jesu		
	O mundi Domina		Zwickau 1676-1788
	Pange, lingua, gloriosi I		Regensburg C120

Composer	Title	Alternative titles / Sections	Source
	Pange, lingua, gloriosi II		Sacrorum hymnorum liber primus
	Patris sapientia, veritas divina		
	Rubum quem viderat Moyses		Zwickau 1676-1788
	Sancta Maria Virgo, intercede		
	Sancta et immaculata virginitas I		Regensburg C120
	Sancta et immaculata virginitas II		Zwickau 1676-1788
	Suscepimus Deus misericordiam tuam		
	Tristia fata boni		
	Virgo prudentissima, quo progrederis		Munich 10
	[Fragment]		Herdringen 9820
Tinctoris, Johannes	Alleluia		
	Fecit potentiam		
	Lamentationes Jeremie		
	Le souvenir II		
	Le souvenir i		
	Missa L'homme armé	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	Missa Sine nomine i	Kyrie, Gloria, Credo, Sanctus, Agnus Dei	
	O invida fortuna		
	O virgo miserere mei		
	Vostre regart		
Verdelot, Philippe	Ad Dominum cum tribularer		
	Afflicti spiriti mei		
	Altro non e el mio amor'		
	Amor se d'hor in hor la doglia		
	Amor, io sento l'alma		
	Ave gratia plena		
	Ave sanctissima Maria		
	Con l'angelico riso		
	Con lacrim' et sospir'		
	Con suave parlar		
	Donna che sete		
	Donna ligiadra e bella		
	Donna, se fera stella		
	Gaudeamus omnes in Domino		

Composer	Title	Alternative titles / Sections	Source
	Hesterna die		
	I vostri acuti dardi		
	In te, Domine, speravi		
	Italia mia, bench'el parlar'		
	La bella donna		
	Lasso, che se creduto		
	Madonna quando io v'odo cantar		
	Madonna, io v'amo et taccio		
	Madonna, per voi ardo		
	Madonna, qual certeca		
	Non pò far morte		
	O dolce nocte		
	O dulcissime Domine Jesu Christe		
	Piove da li occhi		
	Pur troppo, donna		
	Quando nascesti, amore?		
	Quant'hai lass'il morir		
	Quanto sia lieto il giorno		
	Recordare, Domine		
	Sancta Maria, succurre miseris		
	Sancta Maria, virgo virginum		
	Se mai provasti donna		
	Si bona suscepimus		
	Tanto tempore		
	Ultimi mei sospiri		
	Victime pascali laudes		
	Vita della mia vita		
Vinders, Jheronimus	Missa Stabat mater	Kyrie, Gloria, Agnus	
Willaert, Adrian	Beata viscera Maria virginis		
	A l'aventure, l'entrepris		
	Allons, allons gay		
	Ave regina celorum		
	Baisés moy tant tant I		
	Baisés moy tant tant II		
	Beata dei genitrix Maria		

Composer	Title	Alternative titles / Sections	Source
	Beatus Johannes apostolus		
	Beatus Stephanus		
	Congratulamini mihi omnes		
	Dessus le marche d'arras		
	Dessus nostre treille de may		
	Domine Jesu Christe, fili dei		
	Dominus regit me		
	He Dieu, Helayne		
	In tua patientia		
	Intercessio, quesumus, Domine		
	Irons nous tous jours coucher		
	J'ay veu le regnart II		
	J'ayme bien mon amy (I)		
	J'ayme bien mon amy (II)		
	J'ayme par amours		
	Jan, Jan, quant tu t'en iras		
	Je l'ay aymée bien sept ans et demy		
	Je ne sçaroys chanter ne rire		
	La jeusne dame va au molin		
	La rousé du moys de may		
	Mirabile misterium		
	Missa Laudate Deum	Kyrie	
	Missa Mente tota	Kyrie, Gloria	
	Missa Queramus cum pastoribus	Kyrie	
	Mon cueur mon corps		
	Mon mary m'a diffamee		
	Mon petit cueur		
	N'a tu point veu la viscontine		
	O Salutaris hostia		
	O gemma clarissima		
	O magnum misterium		
	Omnipotens sempiterne Deus		
	Or suis je bien au pire		
	Patefacte sunt		
	Pater noster (à 4)		

Composer	Title	Alternative titles / Sections	Source
	Pater noster (à 6)		
	Perot, viendras tu aux nopces?		
	Petite camusette		
	Precatus est Moyses		
	Quant le joly Robinet		
	Qui est celuy qui a dit mal du con		
	Qui la dira la peine de mon cueur		
	Qui veult aymer il fault estre joyeulx		
	Saluto te		
	Salva nos ab excidio		
	Salve, crux sancta		
	Si je ne voy m'amie		
	Sire dondieu		
	Veni sancte spiritus		
	Verbum bonum		
	Videns Dominus		
	Vous marchez du bout du pié		

The following table presents the masses by Giovanni Pierluigi da Palestrina which are included in the database. The date in brackets (when present) indicates the year of first publication; this annotation was already present in the Music21 database, probably as a way to distinguish between homonymous pieces. Where no movements are indicated, all the five ordinary sections are included.

Title	Movements
Missa Ad coenam Agni	
Missa Ad fugam	
Missa Aeterna Christi munera	
Missa Alma Redemptoris mater	
Missa Ascendo ad Patrem	
Missa Aspice Domine	
Missa Assumpta est Maria	
Missa Ave Maria (1594)	
Missa Ave Maria (1596)	
Missa Ave regina coelorum	
Missa Beatus Laurentius	
Missa Benedicta es	
Missa Brevis	
Missa Confitebor tibi	
Missa De Beata Marie Virginis (I)	Kyrie, Gloria, Sanctus, Agnus Dei
Missa De Beata Marie Virginis (II)	
Missa De Beata Marie Virginis (III)	
Missa De beata virgine (1567)	
Missa De beata virgine (1570)	
Missa De feria	Kyrie, Sanctus, Agnus Dei
Missa Descendit angelus Domini	
Missa Dies sanctificatus	
Missa Dilexi quoniam	
Missa Dum complerentur	
Missa Dum esset summus pontifex	
Missa Ecce ego Joannes	
Missa Ecce sacerdos magnus	
Missa Emendemus in melius	
Missa Eripe me de inimicis	
Missa Fratres Ego Enim Accepi	Kyrie, Gloria, Sanctus, Agnus
Missa Gabriel Archangelus	
Missa Gia fu chi m'ebbe cara	
Missa Hodie Christus Natus Est	
Missa Illumina oculos meos	
Missa In duplicibus minoribus (I)	
Missa In duplicibus minoribus (II)	
Missa In festis Apostolorum (I)	
Missa In festis Apostolorum (II)	
Missa In illo tempore	
Missa In majoribus duplicibus	
Missa In minoribus duplicibus	
Missa In semidupl. maj. (I)	
Missa In semidupl. maj. (II)	
Missa In te Domine speravi (1593-4)	
Missa In te Domine speravi (1599)	
Missa Inviolata	

Title	Movements
Missa Io mi son giovinetta (1570)	
Missa Iste confessor	
Missa Jam Christus astra ascenderat	
Missa Je suis desheritee	
Missa Jesu Nostra Redemptio	
Missa L'homme arme (1570)	
Missa L'homme arme (1582)	
Missa Lauda Sion	
Missa Laudate Dominum	
Missa Memor esto	
Missa Nasce la gioia mia	
Missa Nigra sum	
Missa O Regem coeli	
Missa O Rex gloriae	
Missa O admirabile commercium	
Missa O magnum mysterium	
Missa O sacrum convivium	
Missa O virgo simul et mater	
Missa Octavi toni	
Missa Panem nostrum	
Missa Panis quem ego dabo	
Missa Papae Marcelli	
Missa Pater noster	
Missa Petra sancta	
Missa Primi toni	
Missa Pro Defunctis / Agnus I	Kyrie, Offertorium, Benedictus, Agnus Dei
Missa Qual e il piu grande'amore	
Missa Quam pulchra es	
Missa Quando lieta sperai	
Missa Quem dicunt homines	
Missa Quinti toni	
Missa Regina coeli (1600)	
Missa Regina coeli (1601)	
Missa Repleatur os meum laude	
Missa Sacerdos et pontifex	
Missa Sacerdotes Domini	
Missa Salve regina	
Missa Salvum me fac	
Missa Sanctorum meritis	
Missa Sicut lilium inter spinas	
Missa Sine nomine (1567)	
Missa Sine nomine (1591)	
Missa Sine nomine (1599)	
Missa Sine nomine (Mantuan)	
Missa Spem In Alium	
Missa Te Deum laudamus	
Missa Tu es Petrus (1601)	
Missa Tu es Petrus (1887)	
Missa Tu es pastor ovium	
Missa Ut re mi fa sol la	
Missa Veni Sancte Spiritus	
Missa Veni creator Spiritus	
Missa Vestiva i colli	
Missa Viri Galilaei	Kyrie, Gloria, Sanctus, Agnus Dei
Missa Virtute magna	

ANHANG B

Selbständigkeitserklärung

Name BINDINI

Vorname UGO

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