New Perspectives on the Origins of the Madrigal

Quantitatively exploring the stylistic origins of the madrigal: A feature-based approach

Cory McKay
Marianopolis College and CIRMMT, Canada

Julie Cumming
McGill University and CIRMMT, Canada

July 7, 2026. Medieval and Renaissance Music Conference (MedRen) Warsaw, Poland

Research questions

- How similar is the early madrigal to other genres that may have influenced its development?
- How similar to one another are the madrigals by the first composers of the genre?
  - Bernardo Pisano (c. 1490-1548), Sebastiano Festa (c. 1490-1524), Philippe Verdelot (c. 1485-c. 1530)
- What can we learn about the origins of the madrigal from addressing these first two questions?

- This work focuses purely on musical content
  - Using methodologies based on statistical analysis and machine learning
- Text and historical evidence are intentionally ignored
  - Creating a nice complement to the other talks in this coordinated session

Quantitative approach: Overall strategy

- Systematically study as large a quantity of relevant music as possible
  - To avoid potential bias from selecting only a few sample pieces that may or may not be representative of the larger historical reality
- Consider as broad a range of musical characteristics as possible
  - To avoid potential bias from selecting only those musical elements one might expect to be significant, but which may not be representative of broader musical patterns
- Explore madrigals in their entirety when looking for patterns
  - To avoid potential bias from focusing on local behavior that may not be representative of pieces as a whole

Quantitative approach: Methodology

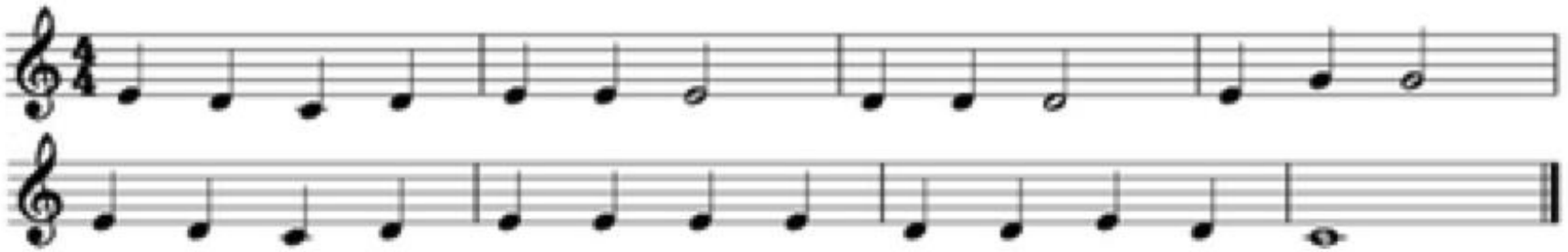
- Assembled a high-quality corpus of digitally-encoded scores
- Used computers to extract a broad range of musical measurements (called “features”) from each score
- Used statistical analysis and machine learning to explore relative similarity between different genre and composer groups within the corpus, based on these feature values
- Began an initial exploration of which specific features are particularly statistically important in characterizing madrigals from other genres or between composers
  - Subject of a future presentation

What do we mean by a “feature?” (1/2)

- Information that measures a characteristic of a segment of music in a simple, consistent and precisely-defined way
- Represented using numbers
  - Can be a single value, or can be a set of related values

Example: A simple feature

- Range: Difference in semitones between the lowest and highest pitches present



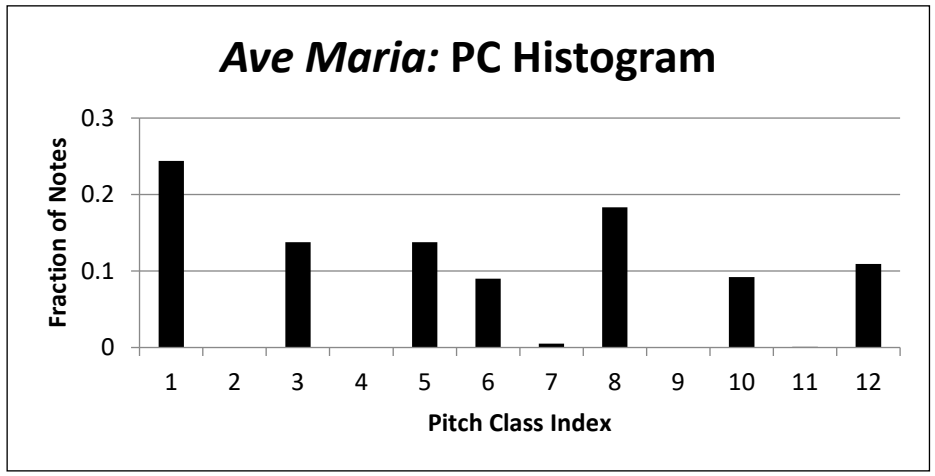
- Value of this feature for this music: 7
  - G - C = 7 semitones

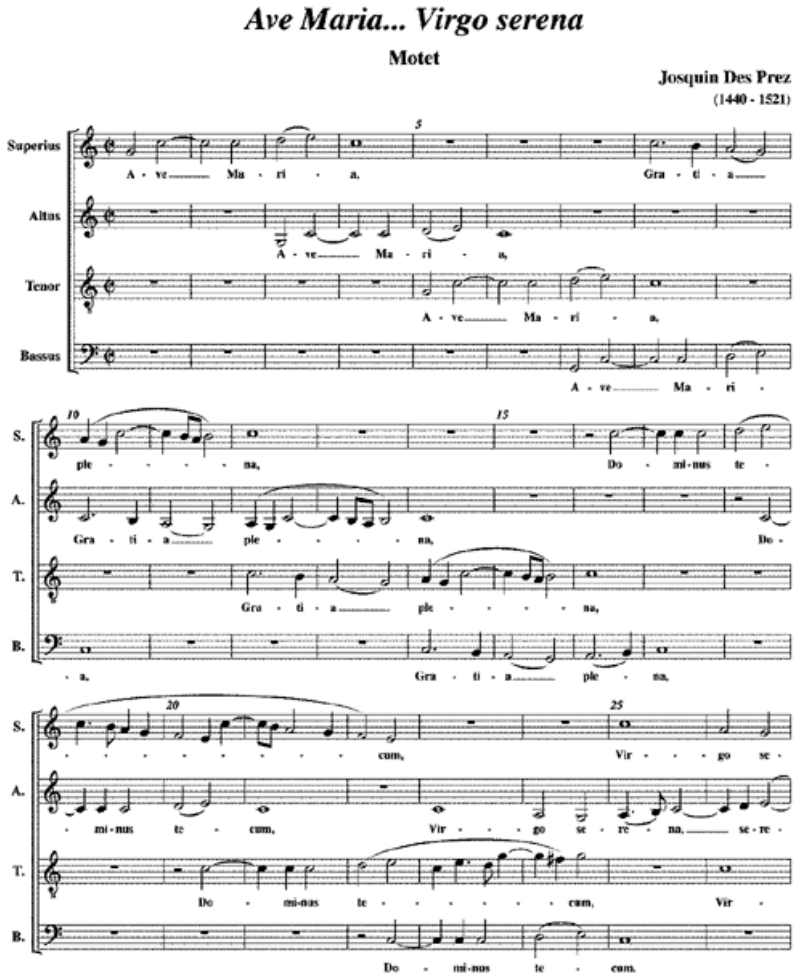
What do we mean by a "feature?" (2/2)

- Provides a summary description of the characteristic being measured
  - Typically offering a macro rather than local view
- Usually extracted from complete pieces of music in their entirety
  - But can also be extracted from smaller segments of music if desired

Josquin's *Ave Maria . . . Virgo serena*

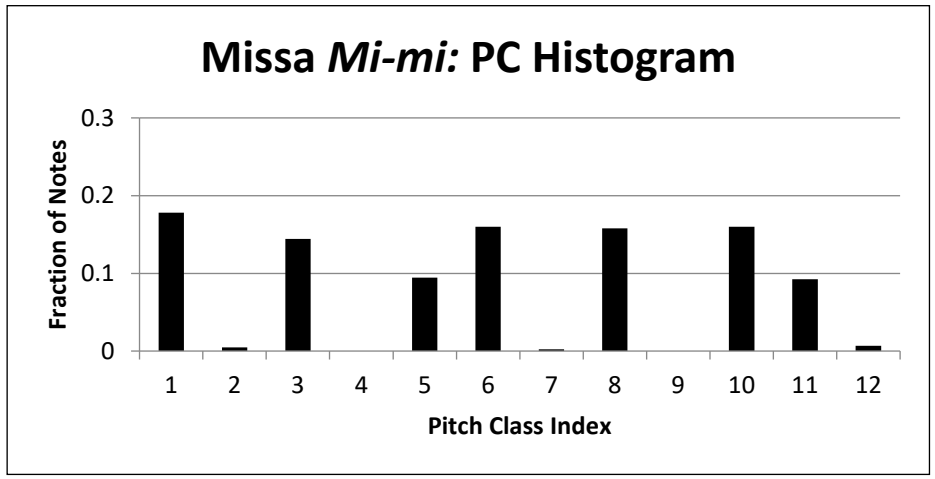
- Range: 34 (semitones)
- Repeated notes: 0.181 (18.1%)
- Vertical perfect 4^{ths}: 0.070 (7.0%)
- Rhythmic variability: 0.032
- Parallel motion: 0.039 (3.9%)

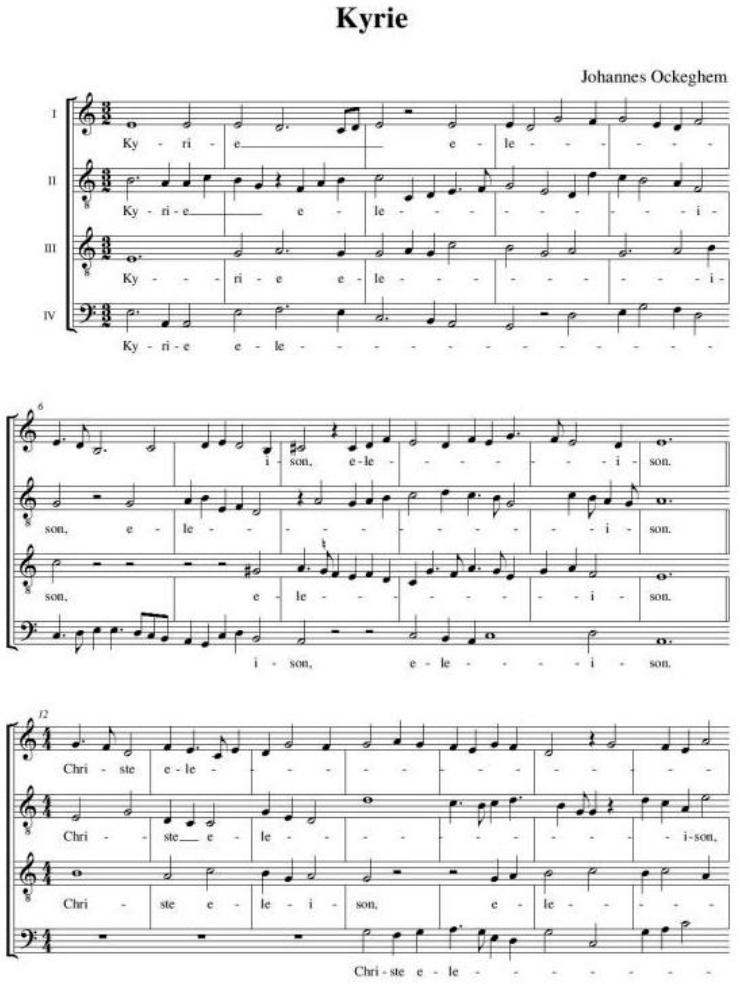




Ockeghem's Missa *Mi-mi* (Kyrie)

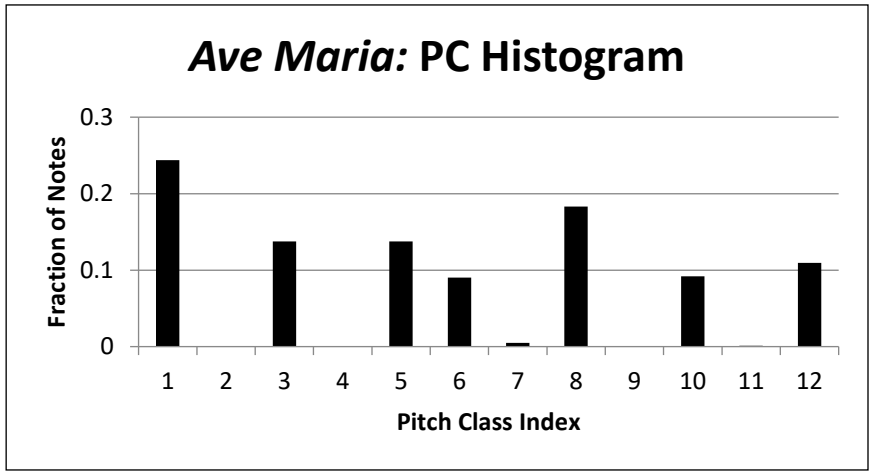
- Range: 26 (semitones)
- Repeated notes: 0.084 (8.4%)
- Vertical perfect 4^{ths}: 0.109 (10.9%)
- Rhythmic variability: 0.042
- Parallel motion: 0.076 (7.6%)

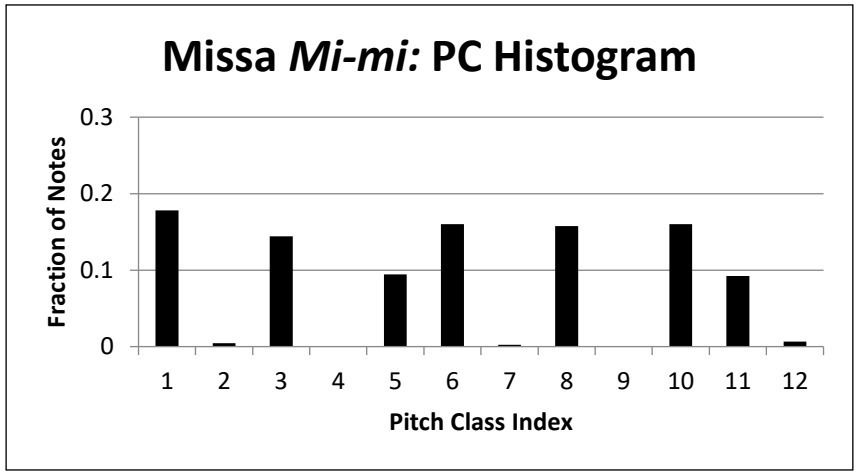




Feature value comparison

Feature	*Ave Maria*	Missa *Mi-mi*
Range	34	26
Repeated notes	0.181	0.084
Vertical perfect 4^{ths}	0.070	0.109
Rhythmic variability	0.032	0.042
Parallel motion	0.039	0.076



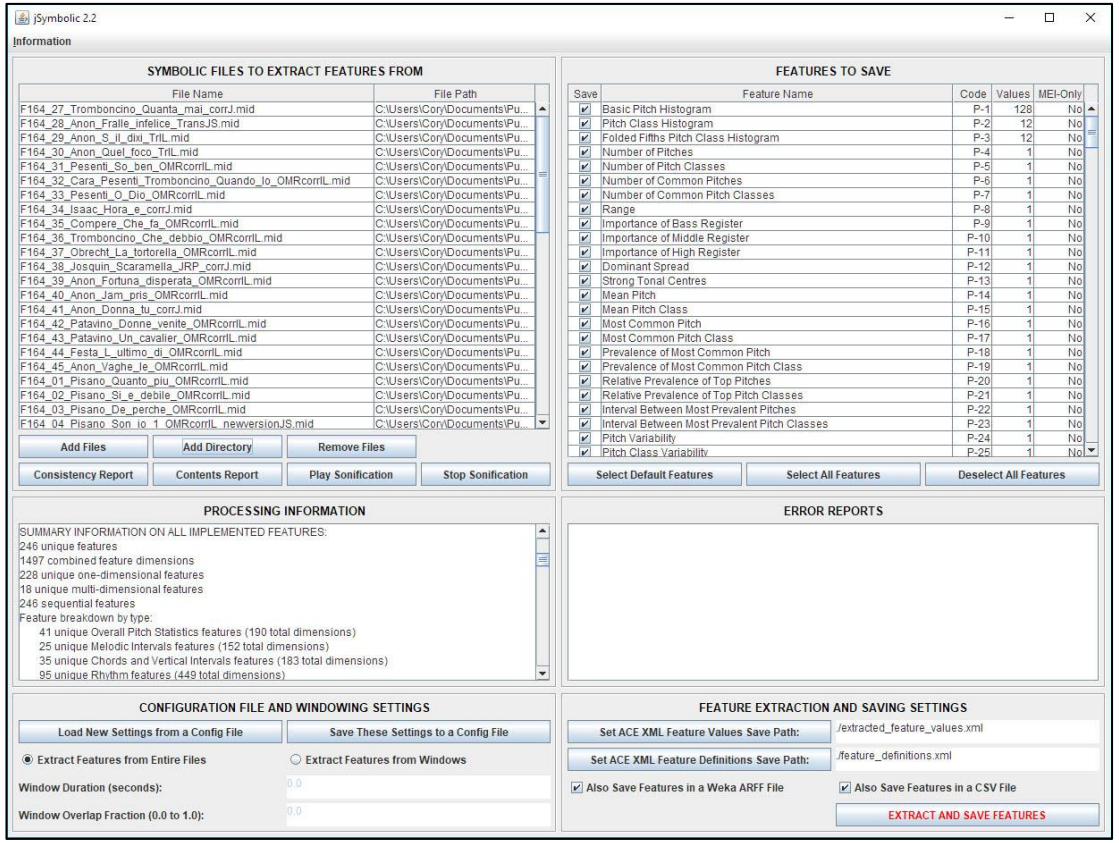


Comparing features

- Although looking at just six or so features can be interesting, comparing pieces can be even more revealing when hundreds or thousands of features are involved
  - Sometimes features we would not have expected to matter end up being significant
- Things get even more interesting when comparisons are made between hundreds or thousands of pieces, not just two
  - Especially when the music is divided into groups of interest, whose features can then be collectively contrasted with one another
  - e.g., comparing the styles of genres, composers, regions, time periods, etc.
- Comparing features manually can certainly be useful, but:
  - Automated statistical analysis and machine learning can reveal complex patterns that might be difficult to discover manually

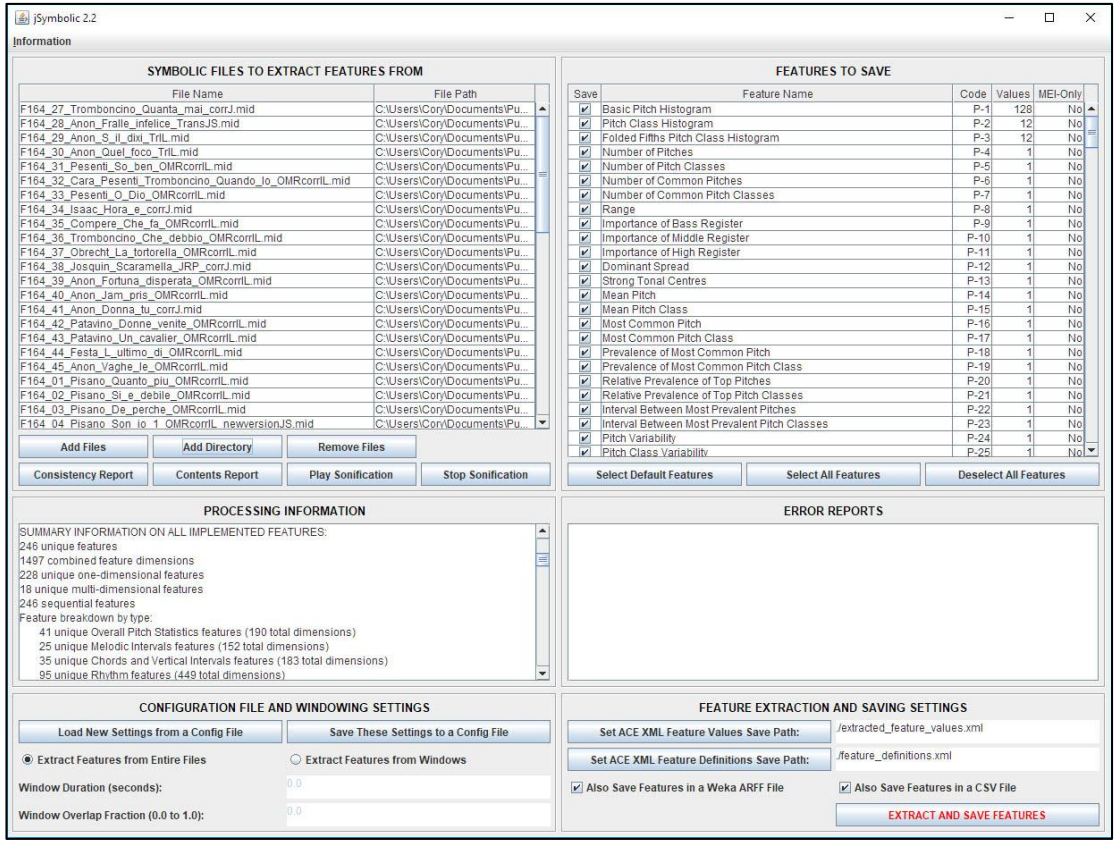
How might one calculate feature values?

- Our open-source jSymbolic research software (McKay et al. 2018) can be used to automatically extract features from symbolic digital scores (e.g., MIDI)
- Version 2.2 extracts 246 unique features
  - 1497 separate feature values, since many features are multi-dimensional (e.g. histogram vectors)
- The upcoming Version 3 extracts 533 unique features
  - 2040 feature values, including n-gram features



jSymbolic 2.2's feature types

- Pitch statistics
  - e.g. Range
- Melody / horizontal intervals
  - e.g. Most Common Melodic Interval
- Chords / vertical intervals
  - e.g. Vertical Minor Third Prevalence
- Texture
  - e.g. Parallel Motion
- Rhythm
  - e.g. Note Density per Quarter Note
- Instrumentation
  - e.g. Note Prevalence of Unpitched Instruments
- Dynamics
  - e.g. Variation of Dynamics



Earlier feature-based research on the origins of the madrigal

- We presented earlier feature-based explorations of the madrigal at:
  - MedRen (2018)
  - Future Directions of Music Cognition International Conference (2021)

Earlier feature-based research on the origins of the madrigal

- Our original digital corpus consisted of all the pieces in Florence 164 (Florence, BNC 164-167, partbooks, 4 sections c. 1520-1522):
  - 27 of the earliest madrigals
    - by Pisano, Sebastiano Festa, anon.
  - 19 Other Italian-Texted pieces ("OITs")
    - Mostly villotte
  - 24 French chansons
  - 12 motets

Earlier feature-based research on the origins of the madrigal

- Used jSymbolic 2.2 to extract features from each piece in our corpus
  - Only used 801 features, since the others were not relevant to this music
    - e.g., features related to dynamics or instrumentation were discarded
- Then used a type of machine learning called support vector machines (SVMs) to train classifiers that could automatically distinguish pairwise between the different genres in the corpus
  - Used a technique called cross-validation to explore how well each pair of genres could be distinguished by the trained classifiers while avoiding overfitting
- Classification accuracy was then interpreted as an inverse indicator of similarity
  - If it is hard to classify pieces between two genres (low classification accuracy), then these genres likely have a high similarity
  - If it is easy to classify pieces between two genres (high classification accuracy), then these genres likely have a low similarity

Earlier feature-based research on the origins of the madrigal

Comparison	Classification Accuracy
Madrigals vs. Motets	100.0%
Madrigals vs. Chansons	100.0%
Madrigals vs. OITs	71.7%

- Results suggest that early madrigals are substantially different from motets and chansons
  - Because they are easy to distinguish

Earlier feature-based research on the origins of the madrigal

Comparison	Classification Accuracy
Madrigals vs. Motets	100.0%
Madrigals vs. Chansons	100.0%
Madrigals vs. OITs	71.7%

- Results suggest that early madrigals are much more more similar to OITs (mainly villotte, in this case) than they are to motets or chansons

Earlier feature-based research on the origins of the madrigal

- So, perhaps villotte (and possibly frottole) played a more important role in influencing the early musical development of the madrigal than motets or chansons?

Earlier feature-based research on the origins of the madrigal

- Limitations of this earlier corpus:
  - Relatively small corpus from a statistical perspective (82 pieces)
    - Statistical patterns found in this dataset may not necessarily generalize to all relevant music
  - Only a few madrigal composers are represented (Pisano, S. Festa, anon.)
    - Detected patterns may be linked to differences in composers' compositional style rather than genre
  - Different OITs are grouped together (and villotte dominate)
    - Results therefore do not provide guidance on whether some types of OITs were more influential on the early madrigal than others

Our new digital corpus

- We created a new digital corpus that includes more Italian-texted music from multiple manuscripts and prints copied or printed c. 1510-1530
  - Including more madrigals, by more composers, especially:
    - Pisano (and similar)
    - S. Festa (and similar)
    - Verdelot (and similar)
  - Including more OITs (details to come in Julie Cumming's presentation):
    - Villotte
    - Frottole
    - Carnival songs
- All are four-voice pieces
- 147 pieces in total

Our combined corpus

- We joined this new corpus with the chansons and motets from our first corpus
  - These were assembled separately from our original corpus, but using a very similar methodology
  - We carefully compared them with the new corpus to make sure there was no editorial or encoding bias
- Our combined new corpus of 183 pieces therefore consists of:
  - 69 madrigals
  - 29 villotte
  - 23 frottole
  - 26 carnival songs
  - 24 chansons
  - 12 motets
- This combined corpus was used in the experiments that follow

New experiments

- Once again, we extracted 801 features using jSymbolic2 and performed cross-validation classification experiments using SVMs
  - Used classification accuracy as an inverse indicator of similarity
- Conducted 5 different sets of experiments . . .

Experiment set 1: Comparing madrigals by composer

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Pisano (14) vs. PisanoAnon (12)	73.1%	Similar
Festa (9) vs. OtherPreVerdelot (11)	70.0%	Similar
Pisano+ (26) vs. Festa+ (20)	93.5%	Quite different
Pisano+ (26) vs. Verdelot+ (23)	95.9%	Very different
Festa+ (20) vs. Verdelot+ (23)	90.7%	Quite different

- Grouping the 14 secure Pisano madrigals with the 12 attributed to him by Frank D'Accone seems reasonable, as the two groups are very similar
- Grouping the 9 secure Festa madrigals with the other 11 pre-Verdelot madrigals seems reasonable as well, since they are also similar

Experiment set 1: Comparing madrigals by composer

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Pisano (14) vs. PisanoAnon (12)	73.1%	Similar
Festa (9) vs. OtherPreVerdelot (11)	70.0%	Similar
Pisano+ (26) vs. Festa+ (20)	93.5%	Quite different
Pisano+ (26) vs. Verdelot+ (23)	95.9%	Very different
Festa+ (20) vs. Verdelot+ (23)	90.7%	Quite different

- The madrigals of Pisano, Festa and Verdelot all seem to have quite distinct styles
  - Especially Pisano and Verdelot (95.9%)
  - Festa and Verdelot are the most similar, but even they are still quite distinguishable (90.7%)

Experiment set 1: Comparing madrigals by composer

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Pisano (14) vs. PisanoAnon (12)	73.1%	Similar
Festa (9) vs. OtherPreVerdelot (11)	70.0%	Similar
Pisano+ (26) vs. Festa+ (20)	93.5%	Quite different
Pisano+ (26) vs. Verdelot+ (23)	95.9%	Very different
Festa+ (20) vs. Verdelot+ (23)	90.7%	Quite different

- These results suggest that each of the three composers took a substantially different approach to composing madrigals, with the implication that early madrigals should not be seen as stylistically unitary

Moving on to genre

- Began by combining all the madrigals (across the three composer groups)
- Compared these combined madrigals to each of the other genres under consideration
- Is grouping all the madrigals together a good idea?
  - Maybe not, because Experiment set 1 just found the three composer groups to be quite distinct?
  - But maybe so, since having more data often leads to better results in general?
- Let's look at both grouped and ungrouped approaches and see what happens . . .

Experiment set 2:
Comparing combined madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
AllMadrigals (69) vs. Villotte (29)	92.9%	Quite different
AllMadrigals (69) vs. Frottole (23)	89.1%	Somewhat different
AllMadrigals (69) vs. Carnival Songs (26)	96.8%	Very different
AllMadrigals (69) vs. Chansons (24)	96.8%	Very different
AllMadrigals (69) vs. Motets (12)	93.8%	Quite different

- These results suggest that the early madrigal overall is distinct from each of these genres
- So, the madrigal seemed to have had a clear identity of its own in terms of musical content from the start

Experiment set 2:
Comparing combined madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
AllMadrigals (69) vs. Villotte (29)	92.9%	Quite different
AllMadrigals (69) vs. Frottole (23)	89.1%	Somewhat different
AllMadrigals (69) vs. Carnival Songs (26)	96.8%	Very different
AllMadrigals (69) vs. Chansons (24)	96.8%	Very different
AllMadrigals (69) vs. Motets (12)	93.8%	Quite different

- In terms of relative similarity, it seems that the early madrigal overall was least similar to chansons and carnival songs and most similar to frottole
  - With villotte and motets in the middle

Comparing these results with our earlier work

- Recall that in our earlier experiments we were able to distinguish early madrigals from:
  - Motets 100% of the time
  - Chansons 100% of the time
- In these newer experiments, the classification rates were different:
  - Motets 93.8% of the time
  - Chansons 96.8% of the time
- Also, results changed for the OITs:
  - 71.7% accuracy for the original grouped OITs
  - 89.1% to 96.8% accuracy for the separated-out frottole, villotte and carnival songs
- Why these differences?
  - The size and makeup of the corpus changed
  - We went from 27 to 69 madrigals
  - We went from 19 to 78 OITs
    - And also broke them out by genre

Comparing these results with our earlier work

- In general, the larger a corpus, the better the results tend to be when using statistical or machine learning techniques
- The much larger amount of training data in the new experiments helped the classifiers to perform better
  - This is likely why the OIT classification rates were higher in absolute terms in the new experiments

Comparing these results with our earlier work

- But, the motet and chanson classification accuracies actually went down in the newer experiments! How can this be explained?
  - The motet results may be particularly susceptible to statistical noise, in both the original and new experiments
    - There are only 12 motets
  - Also, we now have a more diverse set of madrigals, meaning that some may be more similar to motets or chansons than was the case in the original corpus
- Perhaps we can gain additional insight by breaking out results for each of the three composer groups
  - Recall that Experiment set 1 showed that they are quite distinct

Experiment set 3:
Comparing Pisano+ madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Pisano+ (26) vs. Villotte (29)	87.3%	Somewhat different
Pisano+ (26) vs. Frottole (23)	89.8%	Somewhat different
Pisano+ (26) vs. Carnival Songs (26)	98.1%	Extremely different
Pisano+ (26) vs. Chansons (24)	88.0%	Somewhat different
Pisano+ (26) vs. Motets (12)	92.1%	Quite different

- Pisano's madrigals seem to be especially different from carnival songs

Experiment set 3: Comparing Pisano+ madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Pisano+ (26) vs. Villotte (29)	87.3%	Somewhat different
Pisano+ (26) vs. Frottole (23)	89.8%	Somewhat different
Pisano+ (26) vs. Carnival Songs (26)	98.1%	Extremely different
Pisano+ (26) vs. Chansons (24)	88.0%	Somewhat different
Pisano+ (26) vs. Motets (12)	92.1%	Quite different

- Villotte may have influenced Pisano's madrigals more than the other genres
  - Although frottole and chansons (and maybe even motets) may have had some influence too

Experiment set 4:
Comparing Festa+ madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Festa+ (20) vs. Villotte (29)	95.9%	Very different
Festa+ (20) vs. Frottole (23)	90.7%	Quite different
Festa+ (20) vs. Carnival Songs (26)	95.7%	Very different
Festa+ (20) vs. Chansons (24)	100.0%	Extremely different
Festa+ (20) vs. Motets (12)	100.0%	Extremely different

- Festa's madrigals seem to be more stylistically distinct from the other genres than Pisano's madrigals in general
- They are especially different from the chansons and motets
  - 100% accuracies return!

Experiment set 4:
Comparing Festa+ madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Festa+ (20) vs. Villotte (29)	95.9%	Very different
Festa+ (20) vs. Frottole (23)	90.7%	Quite different
Festa+ (20) vs. Carnival Songs (26)	95.7%	Very different
Festa+ (20) vs. Chansons (24)	100.0%	Extremely different
Festa+ (20) vs. Motets (12)	100.0%	Extremely different

- Festa's madrigals seem to be more similar to frottole than to the other genres, so frottole may have had some influence on his madrigals

Experiment set 5:
Comparing Verdelot+ madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Verdelot+ (23) vs. Villotte (29)	88.5%	Somewhat different
Verdelot+ (23) vs. Frottole (23)	97.8%	Extremely different
Verdelot+ (23) vs. Carnival Songs (26)	98.0%	Extremely different
Verdelot+ (23) vs. Chansons (24)	100.0%	Extremely different
Verdelot+ (23) vs. Motets (12)	100.0%	Extremely different

- For the most part, Verdelot's madrigals seem to be even more distinct from the other genres that was the case with Pisano or Festa

Experiment set 5:
Comparing Verdelot+ madrigals to other genres

Composer Comparison	Classification Accuracy	Qualitative Interpretation
Verdelot+ (23) vs. Villotte (29)	88.5%	Somewhat different
Verdelot+ (23) vs. Frottole (23)	97.8%	Extremely different
Verdelot+ (23) vs. Carnival Songs (26)	98.0%	Extremely different
Verdelot+ (23) vs. Chansons (24)	100.0%	Extremely different
Verdelot+ (23) vs. Motets (12)	100.0%	Extremely different

- Verdelot's madrigals seem to be much closer to villotte than to the other genres, so villotte may have influenced him

Overall conclusions (with respect to musical content)

- The early madrigal seems to have had a clear identity of its own, distinct from other genres
- The madrigals of Pisano, Festa and Verdelot are stylistically distinct
  - Their madrigals should not be treated as a single group, as each composer seems to have maintained his own approach
- Among the three, Pisano may have been most influenced by other genres
  - Villotte, frottole, chansons (and maybe even motets) all potentially influenced his madrigals
- Festa's madrigals seem less likely to have been influenced by other genres
  - Although the frottola may have played a role
- Verdelot seems even less likely to have been influenced by other genres overall
  - Although villotte in particular may have influenced his madrigals

Future work

- Explore even more music
  - Including an additional 23 transitional frottole that we have already encoded
- Use more varied and sophisticated statistical tools for examining similarity and causality more directly
  - And with more care paid to statistical significance
- Dive deeper into specific feature differences between the madrigals and the various genres
  - We have already looked at this in our earlier publications on the original corpus
  - There is a wealth of data left to dive into with the new corpus

Thanks to the many students and former students who worked on assembling our corpora and maintaining jSymbolic

- Ian Lorenz
- Jonathan Stuchbery
- Linda Pearse
- Sara Sabol
- Vi-An Tran
- Zoey Cochran
- Tristan Tenaglio
- Rían Adamían
- Mayu Egan
- Sylvain Margot
- James Renwick
- Ellis Reyes
- Leah Weitzner
- Thomas Yakey

Thanks for your attention

cory.mckay@mail.mcgill.ca

julie.cumming@mcgill.ca