



# Exploring Musical Style in the Anonymous and Doubtfully Attributed Mass Movements of the Coimbra Manuscripts: A Statistical Approach

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# Polyphonic repertoires in Portugal

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# Polyphonic repertoires in Portugal

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# Objective

- To provide insights on whether there was circulation of foreign repertoire or not, and on the possible prevalence of Franco-Dutch repertoires in the manuscripts copied in Coimbra.
  - To present an initial analysis of the anonymous and doubtfully attributed masses and loose movements.
  - To discuss a statistical analysis of these works using the jSymbolic software.

# Number and percentages of masses and works of Franco-Flemish, Iberian or unknown origin

Sources	No. of masses	No. of Franco-Flemish works	No. of Iberian works	No. of anonymous works
<i>P-Cug</i> MM 2 [c.1530-1535]?	12/12 = 100%	11/12 = 91%	0/12 = 0%	1/12 = 1,5% (only one mass movement)
<i>P-Cug</i> MM 6 [c.1540-c.1555]	1/22 = 4,5%	0/22 = 0%	4/22 = 18,1%	18/22 = 81,8%
<i>P-Cug</i> MM 7 Mid-16th century	1/24 = 4,1%	0/24 = 0%	0/24 = 0%	24/24 = 100%
<i>P-Cug</i> MM 9 [c.1545-c.1550]	6/40 = 15%	5/40 = 12,5% ?	7/40 = 17,5%	28/40 = 70%
<i>P-Cug</i> MM 12 [c.1540-c.1550]	8/64 = 12,5%	3/64 = 4,6%	30/64 = 46,8%	31/64 = 48,4%
<i>P-Cug</i> MM 32 Mid- 16th century (c.1540-c.1555) and late 16th century	0/74 = 0%	7/74 = 9,4%	21/74 = 28,3%	46/74 = 62,1%

# Janequin's *Missa La Bataille* (Agnus Dei III, bb. 66-71) in Moderne's *Liber decem missarum* (1532)

70



A - gnus De - i

A - gnus De -

A - gnus De -

A - gnus De - i, A - gnus De -

A - gnus De - i. qui tol -

Janequin's *Missa La Bataille* (Gloria bb. 34-38) in Moderne's *Liber decem missarum* (1532) (above) and in *P-Cug* MM. 9, 68v-76r

34

S

A

T

B

8

8

8

8

Detailed description: This block shows the first system of a musical score for four voices: Soprano (S), Alto (A), Tenor (T), and Bass (B). The system begins at measure 34. Each voice part is written on a five-line staff with a treble clef for Soprano, Alto, and Tenor, and a bass clef for Bass. The Alto and Tenor staves have an '8' below the staff, likely indicating an octave transposition. The music is in a key with one flat (B-flat) and a common time signature. The Soprano part features a melodic line with a long note in measure 35. The Alto part has a more active line with eighth notes. The Tenor part has a steady line with some rests. The Bass part provides a harmonic foundation with a mix of quarter and eighth notes.

34

S

A

T

B

8

8

8

8

Detailed description: This block shows the second system of the musical score, which is identical to the first system above. It covers measures 34-38 for the Soprano, Alto, Tenor, and Bass parts. The notation, including clefs, key signature, and measure numbers, is consistent with the first system.

# Berchem's *Missa da morte et fortuna* (Kyrie, bb. 1-6)

Source: P-Cug 9, ff. 88v-97r

[Jacquet de Berchem]

María Elena Cuenca Rodríguez (ed.)



The image displays a musical score for four vocal parts: Soprano (S), Alto (A), Tenor (T), and Bass (B). The score is written in a single system with four staves. The Soprano part begins with a treble clef and a key signature of one flat (B-flat). The Alto part begins with a treble clef and a key signature of one flat. The Tenor part begins with a treble clef and a key signature of one flat. The Bass part begins with a bass clef and a key signature of one flat. The music is in a common time signature (C). The Soprano part features a melodic line with a B-flat and a sharp sign. The Alto part features a melodic line with a sharp sign. The Tenor part features a melodic line with a B-flat and a sharp sign. The Bass part features a melodic line with a sharp sign. The score is presented in a clean, black and white format.

# Elaborated cadence at the end of Kyrie in *Missa* no. 3 (bb. 55-58)

55

S

A

T

B

8

#

The image displays a musical score for four vocal parts: Soprano (S), Alto (A), Tenor (T), and Bass (B). The score is written in treble clef for S, A, and T, and bass clef for B. The key signature is one flat (B-flat). The time signature is 4/4. The score begins at measure 55. The Soprano part features a melodic line with a final cadence on a whole note. The Alto part includes a sharp sign (#) above the staff and a fermata over the final note. The Tenor part has a fermata over the final note. The Bass part provides a harmonic foundation with a fermata over the final note. The score concludes with a double bar line.

# Prolonged cadence in Bruxel's Sanctus from his mass (no. 17 in Table 2) (bb. 50-55)

The image displays a musical score for the Sanctus, measures 50-55, in a four-part setting (Soprano, Alto, Tenor, Bass). The score is written in a single system with four staves. The key signature is one flat (B-flat), and the time signature is common time (C). The Soprano part (S) begins at measure 50 with a treble clef and a series of eighth notes, followed by a long note with a fermata. The Alto part (A) begins at measure 50 with a treble clef and a series of quarter notes, followed by a long note with a fermata. The Tenor part (T) begins at measure 50 with a treble clef and a series of quarter notes, followed by a long note with a fermata. The Bass part (B) begins at measure 50 with a bass clef and a series of quarter notes, followed by a long note with a fermata. The score is numbered 50 at the beginning of the first staff.

# Parallel 4ths in Bruxel's Gloria (no. 17 in the handout) (bb. 86-92)

The image displays a musical score for four voices: Soprano (S), Alto (A), Tenor (T), and Bass (B). The score is in G major (one sharp) and 4/4 time. The key signature is indicated by a single sharp (F#) on the staff. The measure number 86 is written above the Soprano staff. A red rectangular box highlights a parallel fourth interval between the Soprano and Alto parts, spanning measures 87 and 88. In measure 87, the Soprano part has a half note G4 and the Alto part has a half note C4. In measure 88, the Soprano part has a half note D4 and the Alto part has a half note F3. The interval between G4 and F3 is a perfect fourth. The Soprano part continues with a half note E4 in measure 89, and the Alto part has a half note G3. The interval between E4 and G3 is a perfect fourth. The Soprano part has a half note F#4 in measure 90, and the Alto part has a half note A3. The interval between F#4 and A3 is a perfect fourth. The Soprano part has a half note G4 in measure 91, and the Alto part has a half note B3. The interval between G4 and B3 is a perfect fourth. The Soprano part has a half note A4 in measure 92, and the Alto part has a half note C4. The interval between A4 and C4 is a perfect fourth. The Tenor and Bass parts provide harmonic support with various rhythmic patterns and rests.



# 'Et incarnatus' from Credo no. 5 in *P-Cug* MM 12, ff. 80v



S

A

T

B

7

S

A

T

B

# Agnus Dei no. 8 (above) and Tordesillas's Agnus Dei from *Missa Sine nomine* in *E-Tz* 2-3 (below)

The image displays two systems of musical notation for a four-part vocal setting of the Agnus Dei. Each system includes staves for Soprano (S), Alto (A), Tenor (T), and Bass (B). The top system is for 'Agnus Dei no. 8' and the bottom system is for 'Tordesillas's Agnus Dei from Missa Sine nomine'. Both systems begin with a measure number '6' above the Soprano staff. The notation includes various note values, rests, and accidentals (flats) across the four parts.

# Elaborated cadence at the end of Kyrie no. 9

39

Soprano (S): Treble clef, melodic line with a long note at the end.

Alto (A): Treble clef, accompaniment line with a long note at the end.

Tenor (T): Treble clef, accompaniment line with a long note at the end.

Bass (B): Bass clef, accompaniment line with a long note at the end.

The score shows four staves for Soprano (S), Alto (A), Tenor (T), and Bass (B). The Soprano part is in treble clef and features a melodic line with a long note at the end. The Alto, Tenor, and Bass parts are in treble clef (with an 8 below the staff) and feature accompaniment lines with long notes at the end. The music is in a key with one flat (B-flat) and ends with a double bar line.

# Elaborated cadence at the end of Kyrie in *Missa no. 3* (bb. 55-58)

55

S

A

T

B

8

8

8

8

The image displays a musical score for four vocal parts: Soprano (S), Alto (A), Tenor (T), and Bass (B). The score is written in treble clef for S, A, and T, and bass clef for B. The key signature has one flat (B-flat). The time signature is 8/8. The score is numbered 55 at the beginning. The Soprano part (S) starts with a treble clef and a 55 above the staff. The Alto part (A) starts with a treble clef and an 8 below the staff. The Tenor part (T) starts with a treble clef and an 8 below the staff. The Bass part (B) starts with a bass clef and an 8 below the staff. The score shows a complex cadence with various note values, rests, and accidentals, including a sharp sign in the Alto part. The final measure of each part features a long note with a fermata, indicating a sustained cadence.

# Ink corrosion in P-Cug MM 12, ff. 95v-96r (mass no. 12 in handout)



# Quantitative experiments

- We also performed a series of quantitative experiments using **features**, **statistical analysis** and **machine learning**
- Computational approaches and expert theoretical and historical analyses can complement each other extremely well
  - Many opportunities for joint future research of this kind in a wide range of early music domains

# What are “features”?

- A **feature** is a piece of statistical information that characterizes some aspect of a piece of music using a simple, consistent measurement
  - Each feature is represented as one or more simple **numerical values**
- Features can reveal meaningful patterns in music at a **macro** sense

# A basic sample feature: *Range*

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



- **Value of this feature for this music: 7**
  - G - C = 7 semitones
- In practice, of course, we want **many features**, not just one

# jSymbolic

- The **jSymbolic** software (McKay et al. 2018) can be used to automatically extract features from digital scores
- It extracts **1497 separate values** (version 2.2) measuring:
  - Pitch statistics
  - Melody / horizontal intervals
  - Chords / vertical intervals
  - Texture
  - Rhythm
  - Instrumentation
  - Dynamics
- Other jSymbolic research published at MedRen:
  - Composer attribution (McKay et al. 2017)
  - Origins of the madrigal (Cumming & McKay 2018)
  - Database search and annotation (McKay et al. 2019)

# Our dataset: 603 MIDI files

Dataset	Mass Movements	Motets
Coimbra	38	0
Franco-Flemish	245	151
Iberian	78	91

- All are 15<sup>th</sup> or early 16<sup>th</sup> century works
- Secure Franco-Flemish composers (*from the Josquin Research Project*):
  - Alexander Agricola, Antoine Busnois, Loyset Compère, Josquin des Prez, Jacob Obrecht, Johannes Ockeghem, Marbrianus de Orto, Pierre de la Rue
- Secure Iberian composers (*from the Anatomy of Late 15th- and Early 16th-Century Iberian Polyphonic Music project*):
  - Alonso de Alba, Juan de Anchieta, Pedro de Escobar, Alonso Mondejar, Francisco de Peñalosa, Antonio de Ribera, Rivafrecha, Sanabria, Tordesillas, Juan de Urrede, Vasco Pires, Juan Illario, a few anonymous works

# Experiment 1: Cross-validation

## ■ Research questions:

- How well are the secure Franco-Flemish and Iberian groups separated from one another stylistically?
- Are these stylistic differences evident in both masses and motets?
- Are the Coimbra mass movements statistically distinguishable from the Franco-Flemish and Iberian groups?

## ■ Methodology:

- Used machine learning to train classifiers to automatically distinguish between the different groups, based on the extracted jSymbolic features
- Tested masses and motets separately, as well as together

# Experiment 1: Classification accuracies

Music Being Compared	Average Classification Accuracy
FF and Ib, masses and motets	93.6%
FF and Ib, only motets	91.7%
FF and Ib, only masses	95.4%
FF, Ib and Coimbra, only masses	89.5%
FF, Ib and Coimbra, masses and motets	90.4%

- Rows 1 to 3 indicate that:

- The Franco-Flemish and Iberian works are **well-separated stylistically**
- This is true for both motets and masses, but **mass movements** are especially easily distinguishable (95.4%)

# Experiment 1: Classification accuracies

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## ■ Rows 4 and 5 suggest that:

- The Coimbra mass movements are also well-separated from the Franco-Flemish and Iberian music . . . or are they?
- Actually, we need to look at the confusion matrices to verify
  - The Coimbra mass movements only represent 6.3% of the dataset
  - Their particular performance can thus be obscured

# Experiment 1: Confusion matrices

True Label	Classified as Coimbra	Classified as FranFlem	Classified as Iberian
Coimbra masses	27	0	11
FF masses	2	236	7
Iberian masses	8	10	60

True Label	Classified as Coimbra	Classified as FranFlem	Classified as Iberian
Coimbra masses & motets	27	1	10
FranFlem masses & motets	7	377	12
Iberian masses & motets	7	21	141

- So, **only some** (a little under  $\frac{3}{4}$ ) Coimbra mass movements are separable from the Franco-Flemish and Iberian music
  - So there is something distinctive about them, but there is also overlap

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Coimbra masses & motets	27	1	10
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- For those that are “misclassified”, they are almost always (95.4% of the time) classified as Iberian!
  - This suggests that at least some of them are closer in style to Iberian than Franco-Flemish music

# Experiment 2: Classifying individual Coimbra mass movements

## ■ Research question:

- Are the **individual** Coimbra mass movements **each** more Iberian or Franco-Flemish in style?

## ■ Methodology:

- Trained two classification models on the secure Franco-Flemish and Iberian music (only)
  - One classifier was trained on both motets and mass movements
  - One classifier was trained on only mass movements
- Used these trained models to classify each Coimbra mass movement separately
  - Each could only be classified only as Franco-Flemish or Iberian

# Experiment 2: Results

Coimbra Mass Movement	Trained on Masses and Motets	Trained on Masses Only
2. Missa Salve Regina, Benedictus, P-Cug 12	Franco-Flemish	Iberian
3. Missa Kyrie P-Cug 12	Franco-Flemish	Iberian
3. Missa Sanctus P-Cug 12, f. 26v	Franco-Flemish	Iberian
4. Missa Sine nomine anónima, Kyrie P-Cug 12	Franco-Flemish	Franco-Flemish
16. Missa A Batalha. Janequin. Sanctus. P-Cug 9	Franco-Flemish	Iberian
18. Missa Da Morte e fortuna, Berchem, Kyrie P-Cug 9	Franco-Flemish	Iberian

- **6 / 38 (15.8%)** of the Coimbra mass movements were classified as Franco-Flemish by either of the 2 classifiers
  - Listed on the table above
- **97.3%** (all but one) were classified as **Iberian** by the model specialized in mass movements
  - Recall that all the Coimbra pieces are mass movements

# Experiment 2: Results

Coimbra Mass Movement	Trained on Masses and Motets	Trained on Masses Only
2. Missa Salve Regina, Benedictus, P-Cug 12	Franco-Flemish	Iberian
3. Missa Kyrie P-Cug 12	Franco-Flemish	Iberian
3. Missa Sanctus P-Cug 12, f. 26v	Franco-Flemish	Iberian
4. Missa Sine nomine anónima, Kyrie P-Cug 12	Franco-Flemish	Franco-Flemish
16. Missa A Batalha. Janequin. Sanctus. P-Cug 9	Franco-Flemish	Iberian
18. Missa Da Morte e fortuna, Berchem, Kyrie P-Cug 9	Franco-Flemish	Iberian

- These results suggests that **the Coimbra mass movements are, as a whole, more Iberian than Franco-Flemish in character**
- Although results for individual mass movements should not be interpreted as perfectly authoritative, the **overall pattern is clear and convincing**

# Closing comments (1/2)

- The Coimbra manuscripts, and Portugal, were strongly influenced by international styles (and vice versa?):
  - Spanish-style repertoires
  - Northern-style masses

# Closing comments (1/3)

- Influences include:
  - Foreign masses circulated in Portugal
  - Iberian composers influenced by Northern styles
- The Coimbra works were adapted to the performative context of the Santa Cruz chapel
  - A happened in the case of Janequin's mass

# Closing comments (3/3)

- Franco-Flemish elements in the polyphony seem to have been received mostly through Spanish masses
  - Which were influenced by Burgundian and French composers
- This **Spanish-influenced merged style** was transmitted to Portugal through numerous anonymous and doubtfully attributed masses

# Future research

- Learn more about the reception of French works by Janequin, Verdelot, or Richafort
  - And their influence on Iberian polyphony
- Extend this case study to other genres
  - e.g. motets, hymns, or anonymous lamentations in Portuguese manuscripts
  - Others are doing promising work already

# Thanks for your attention!

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