Musical influences on the masses of Pedro Fernández Buch (c. 1574-1648): A stylistic comparison using statistical analysis

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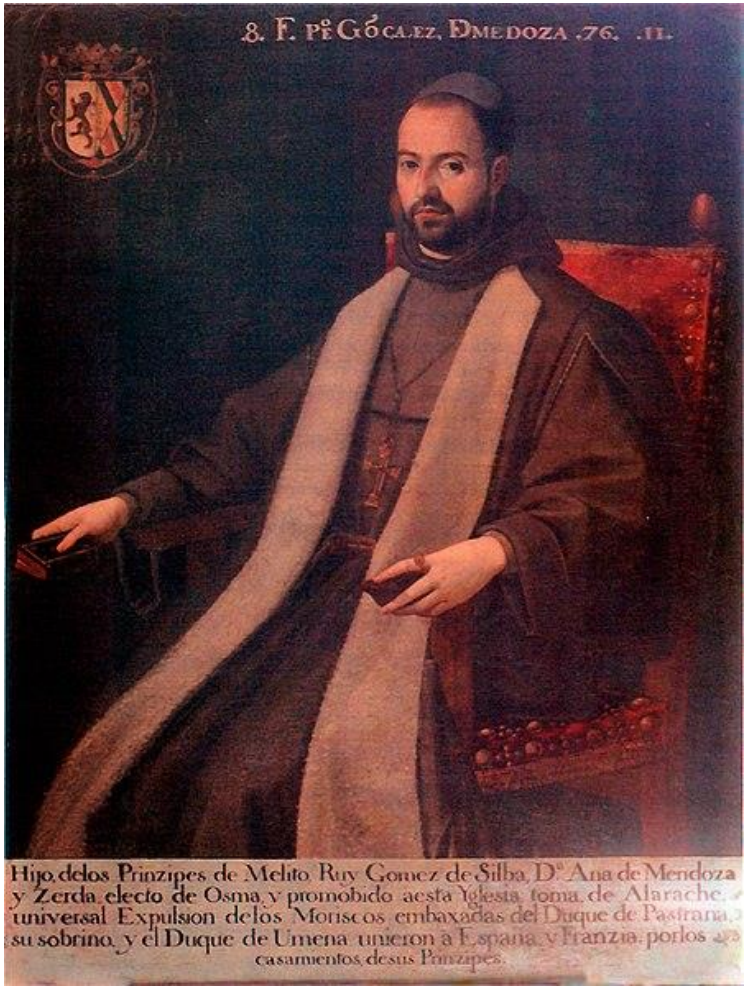
Pedro Fernández Buch *(c.* 1574-1648)

- Maestro de capilla at the Toro cathedral
- Maestro de capilla at the Santo Domingo de la Calzada catedral (1601-1608)
- **Maestro de capilla at the Sigüenza catedral (1608-1648)**

Fernández Buch's masses

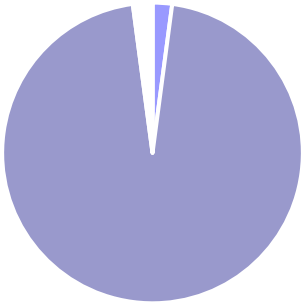
Ítem	Work	Nº vv.	VV.	Source
[1]	*Missa* [incompleta]	5	S-S-A-T-B	*E-PAS 2*
[2]	*Missa Tota pulcra*	5	S-S-A-T-B	*E-PAS 2*
[3]	*Missa Virgines prudentes*	4	S-A-T-B	*E-PAS 2*
[4]	*Missa Gloriose confesor Domini*	4	S-A-T-B	*E-PAS 2*
[5]	*Missa Sancta Maria sucurre*	4	S-A-T-B	*E-PAS 2*
[6]	*Missa de Batalla*	8	SS-AA-TT-BB	*E-Zac*
[7]	*Missa de Requiem*	5	S-S-A-T-B	*E-Zac*

Fray Pedro González de Mendoza (1570-1639) and the cult of the virgin



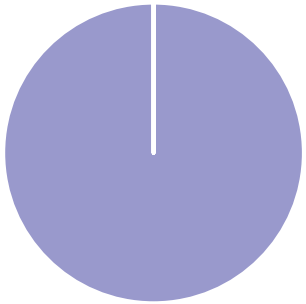
Types of presentation of the *soggetti* in %

Buch's *Missa Tota pulchra est Maria*



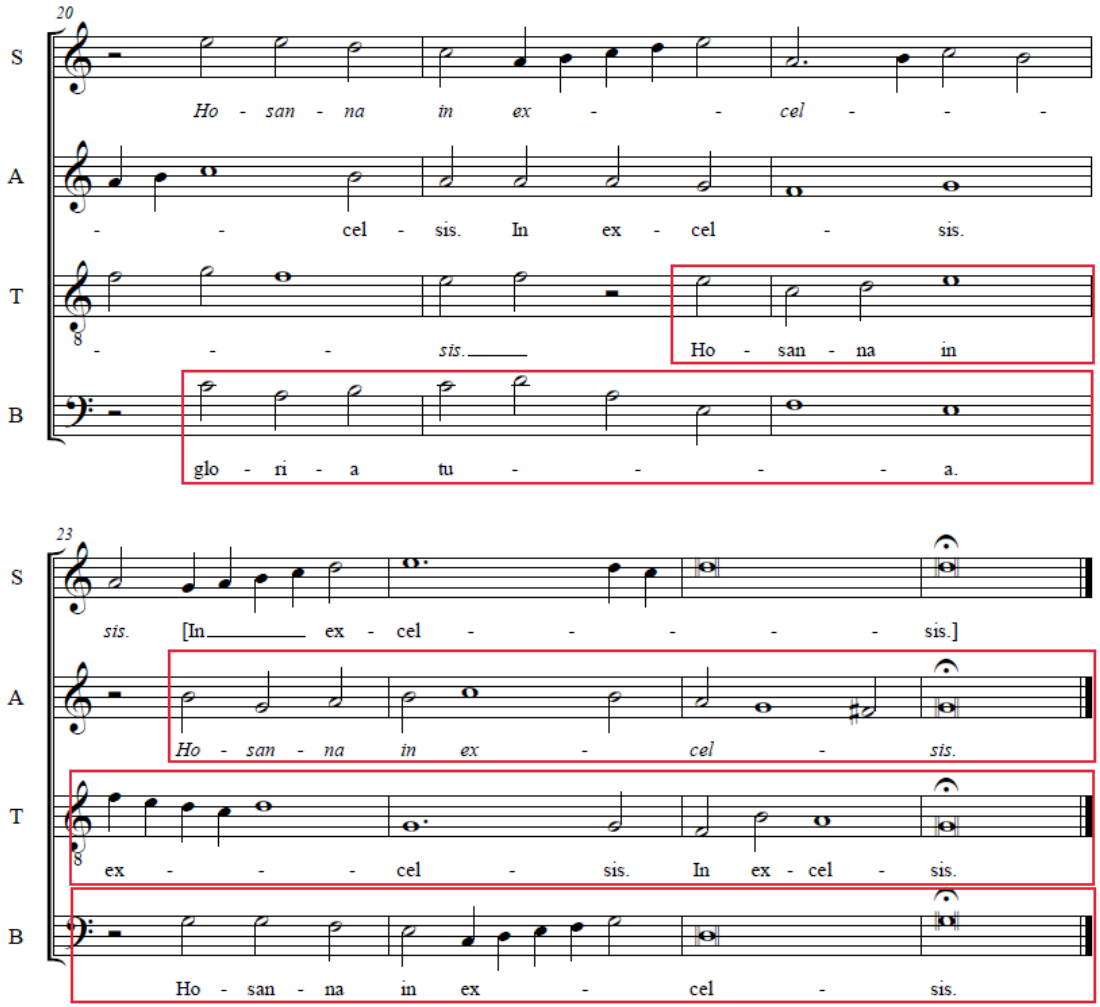
- Imitative Duos (ID)
- Fuga (Fg)
- Periodic Entries (PEn)
- Non-Imitative Duos (NIM)

Guerrero's *Tota pulchra est Maria*

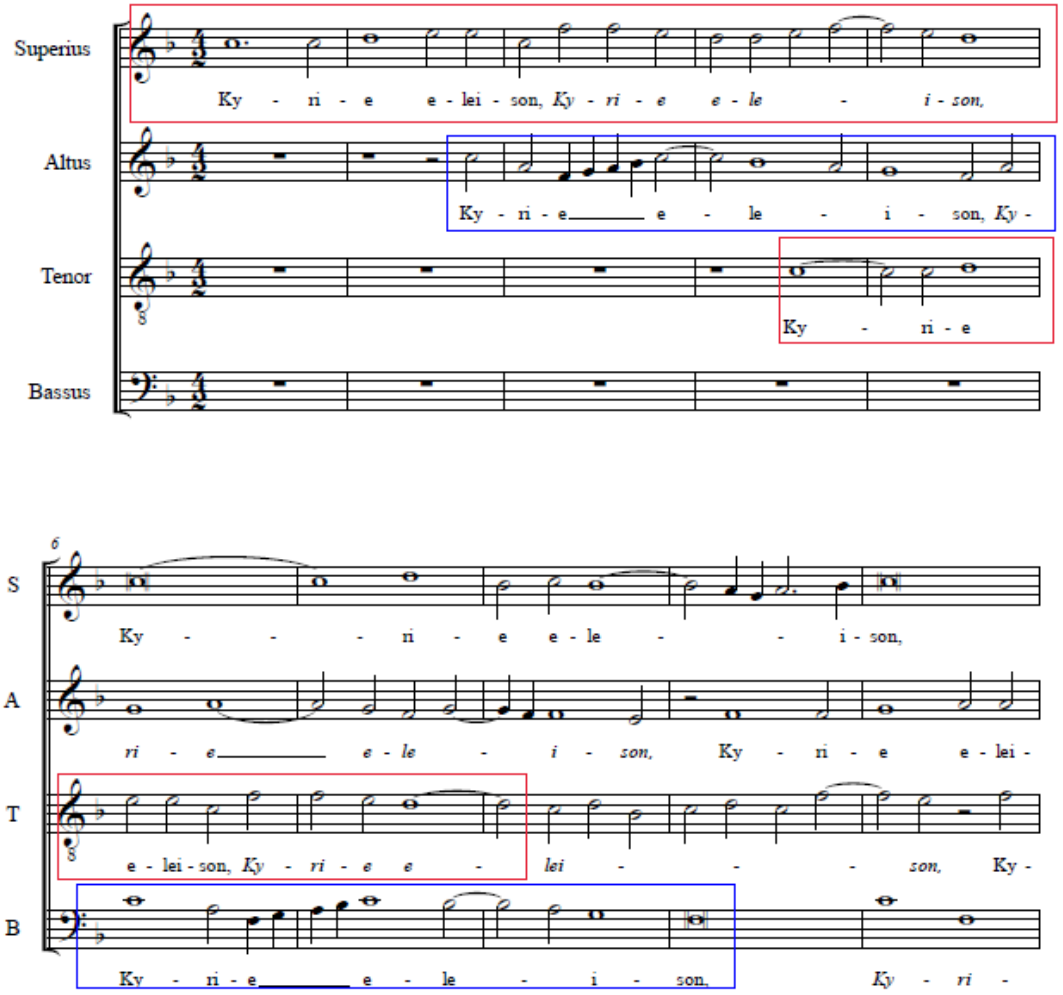


- Dúos imitativos (ID)
- Fuga (Fg)
- Entradas Periódicas (PEn)
- Dúos no imitativos (NIM)

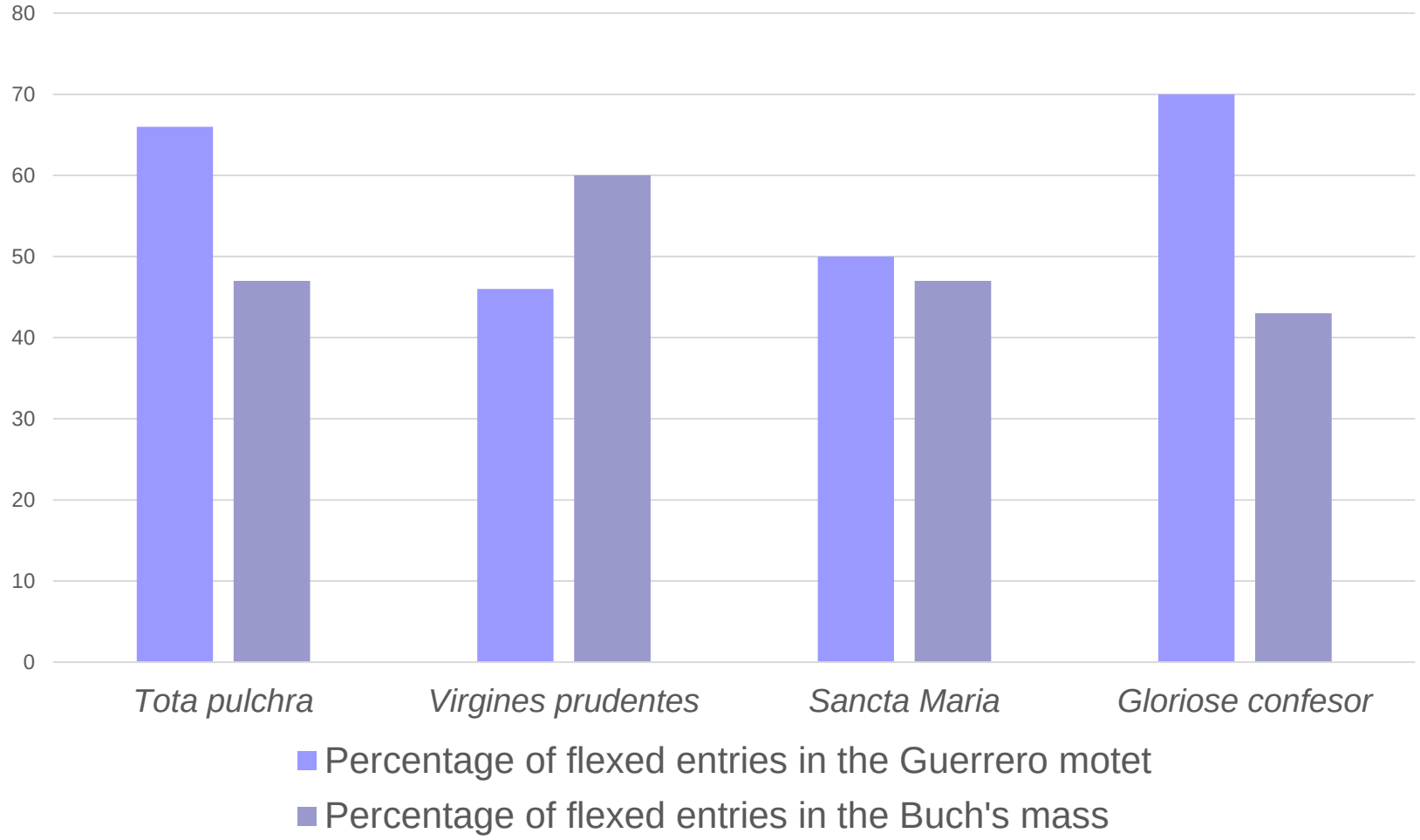
Periodic entry (B-T-A) at the end of the Sanctus of the Fernández Buch's *Missa Virgines prudentes* (cc. 20-26)



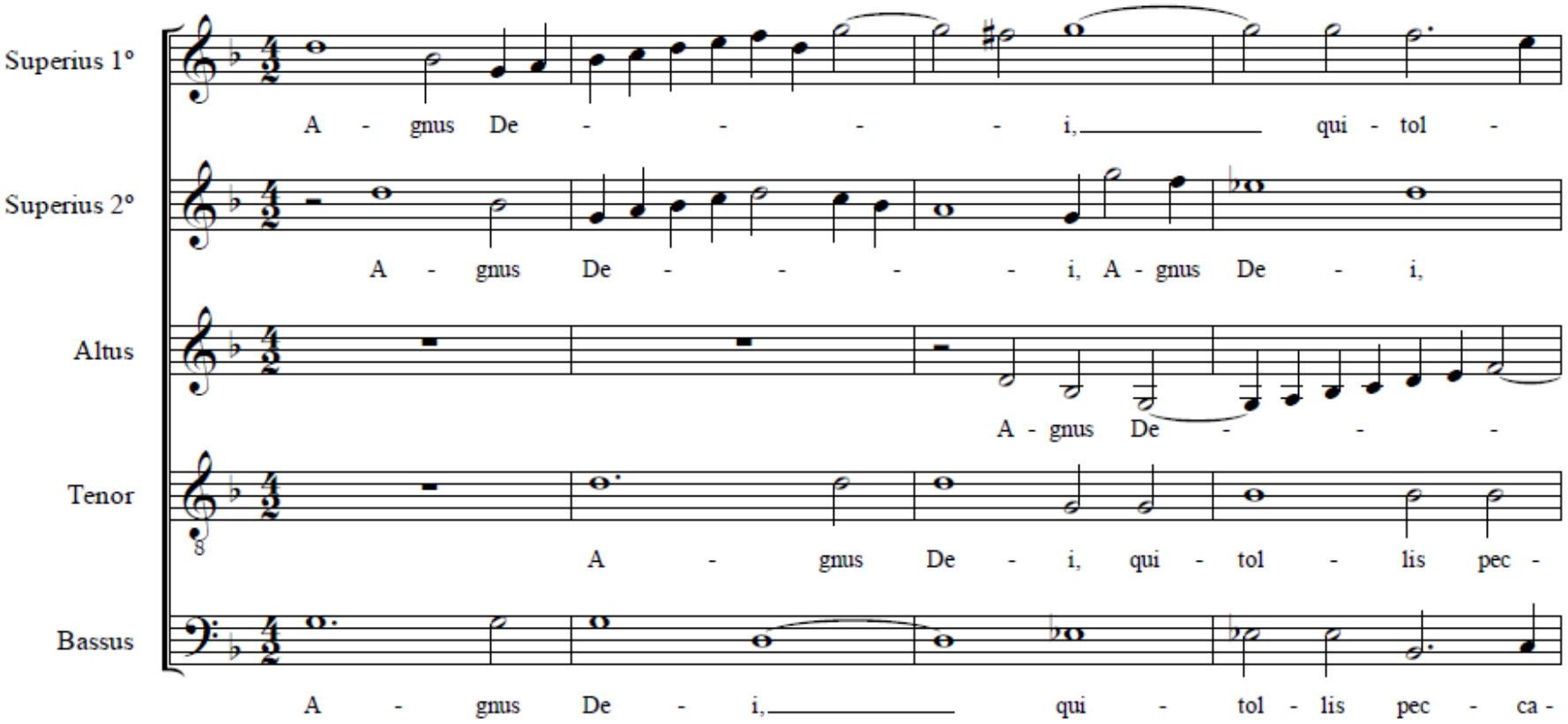
Imitative duo at the beginning of the Kyrie of the Fernández Buch's *Missa Gloriose confesor* (cc. 1-10)



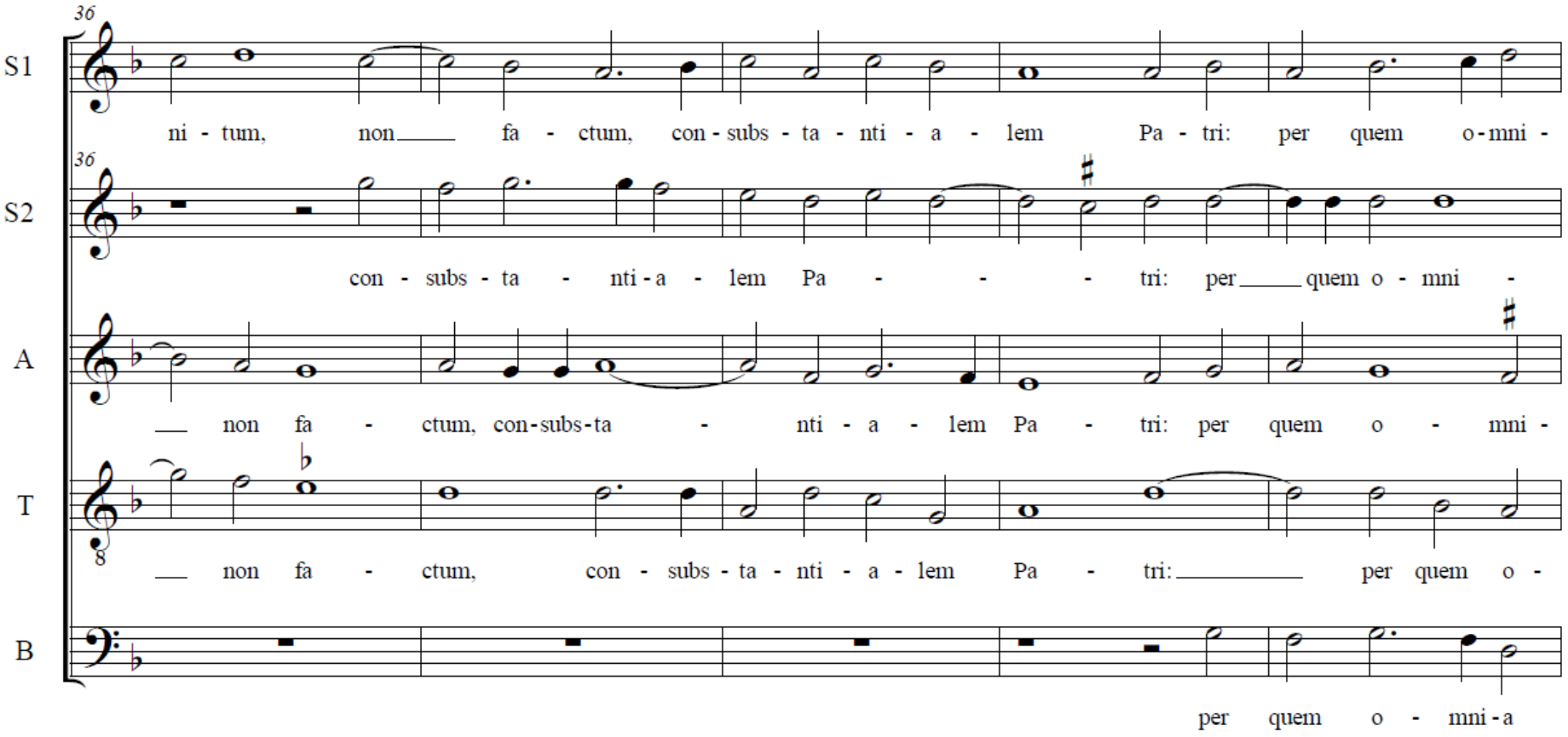
Percentages of flexed entries in Guerrero's motets and Buch's masses



Beginning of Agnus Dei of Fernández Buch's *Missa Tota pulchra* (cc. 1-4)



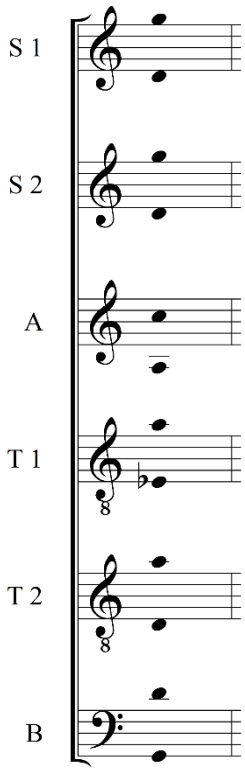
Credo of Fernández Buch's *Missa Tota pulchra* (cc. 36-40)



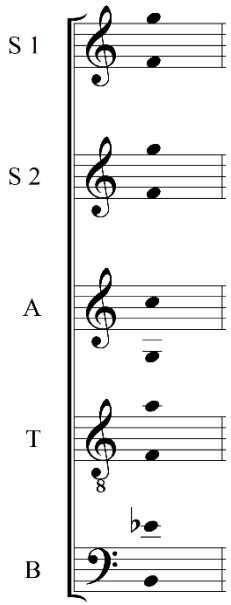
Modality in Guerrero's motets and Buch's homonymous masses

Pitch with high clefs	*Tota pulchra*	*Sancta Maria*	*Gloriose confesor*	*Virgines prudentes*
Original tune	Mode 1-2 en G (B flat)	Mode 1-2 en G (B flat)	Mode 11 in F (B flat)	Mode 7-8 (B natural)
Transposed down by fourth	Mode 1-2 in D (B natural)	Mode 1-2 in D (B natural)	Mode 11 in C (B natural)	

Guerrero's *Tota pulchra*



Buch's *Missa Tota pulchra*



Guerrero's *Sancta Maria*

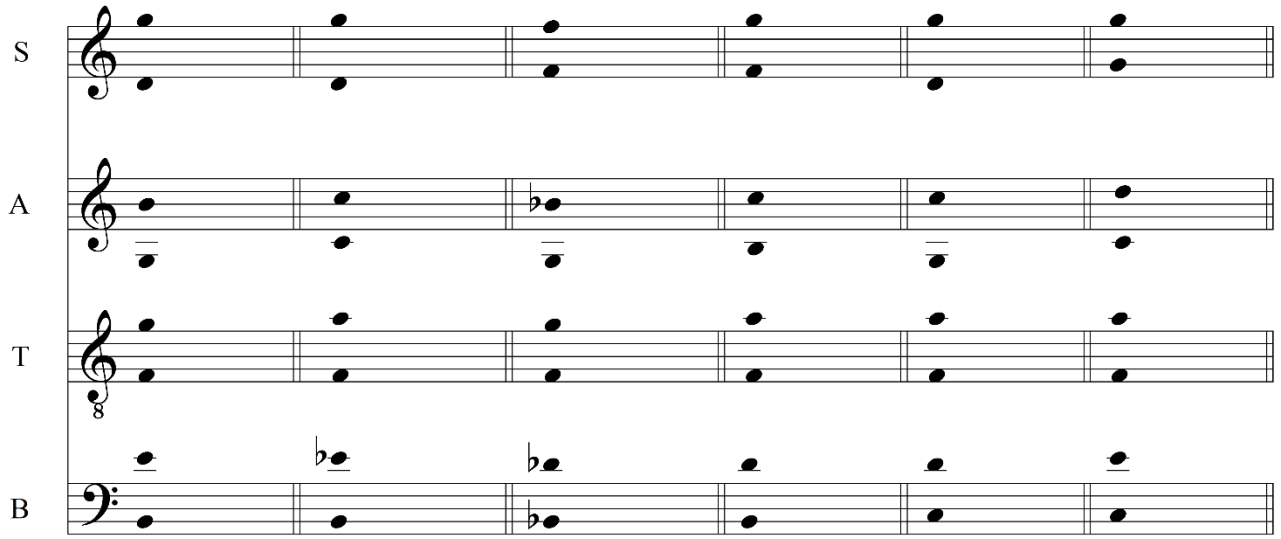
Buch's *Missa Sancta Maria*

Guerrero's *Gloriose confesor*

Buch's *Missa Gloriose confesor*

Guerrero's *Virgines prudentes*

Buch's *Missa Virgines prudentes*



Quantitative experiments

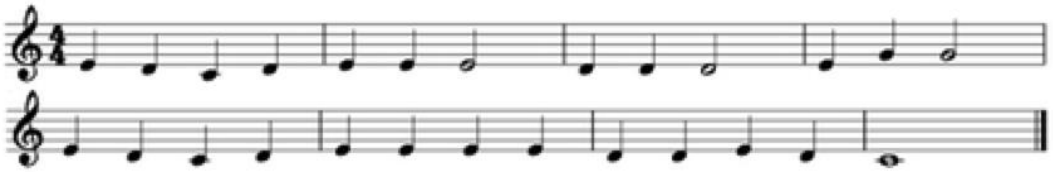
- We performed a series of quantitative musicological experiments using features, statistical analysis and machine learning

What is a “feature”?

- A piece of information that measures a single characteristic of a musical item in a consistent and precisely-defined way
- Represented using a number
  - Can be a single value, or can be a set of related values (e.g. a histogram)
- Provides a summary description of the characteristic being measured
  - Typically examines macro (musical item as a whole) rather than local characteristics

A basic sample feature: *Range*

- Range: Difference in semitones between the highest and lowest pitches in a musical item



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

- In practice, of course, one will wish to compare many features, not just one

jSymbolic

- The jSymbolic software (McKay et al. 2018) can be used to automatically extract features from digital scores

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

jSymbolic

- Extracts 1497 separate feature values
- Only 552 of these 1497 feature values were used in this particular study
  - Excluded features not relevant to this corpus
    - e.g. dynamics
  - Excluded features vulnerable to encoding bias
    - A problem when music is assembled from sources where the music was encoded using different editorial practices or workflows

Previous jSymbolic MedRen talks

- Composer attribution
  - McKay et al. 2017
- Origins of the madrigal
  - Cumming & McKay 2018
- Database search and annotation
  - McKay et al. 2019
- Coimbra manuscripts
  - Cuenca & McKay 2019
- N-gram features
  - McKay et al. 2020
- Ave festiva ferculis
  - Rodriguez-Garcia & McKay 2021
- Morales and Guerrero
  - McKay & Cuenca 2021

Our corpus: 1,366 MIDI files

Composers	Mass Movements	Motets
Pedro Fernández Buch	26	0
Francisco Guerrero	104	104
Cristóbal de Morales	122	74
Tomás Luis de Victoria	115	115
Jacobus Clemens	5	43
Nicolas Gombert	13	42
Orlando di Lasso	93	132
Giovanni P. da Palestrina	120	258

- Divided into 3 groups:
  - Spanish (black)
  - Earlier Franco-Flemish (red)
  - Later Franco-Flemish and Italian (blue)

Masses vs. motets

- In the case of Buch, we are only studying masses
- We could (and did) conduct experiments comparing Buch's masses only to masses by other composers
  - This helps control for mass-specific musical characteristics
- We also conducted experiments comparing Buch's masses to both masses and motets by other composers
  - More data generally provides better results when using machine learning
  - Conducting cross-genre experiments can also help make a composer's general stylistic characteristics more apparent
- The results of both types of experiments (mass only and masses/motets combined) are reported separately

Experiment 1: Spanish composers

- Research questions:
  - Is Buch's style markedly distinct from the styles of Guerrero, Morales and Victoria?
  - How relatively similar is Buch's music to that of Guerrero, Morales and Victoria?
  - What musical characteristics (jSymbolic features) best distinguish Buch statistically from Guerrero, Morales and Victoria?

Experiment 1 Part A:
Cross-validation methodology

- Used machine learning to train support vector machine (SVM) classifiers to distinguish between the music of these four composers based on features extracted by jSymbolic from their music
  - Each MIDI file is only assigned one composer label
- A process called cross-validation was used to classify each MIDI file using a model that had not been trained on it
  - If a composer's works are often (incorrectly) labeled as being by another particular composer, this suggests that the two are stylistically similar

Experiment 1 Part A:
Confusion matrix analysis

- A confusion matrix shows how the MIDI files by each composer were classified during the cross-validation experiment
  - Rows indicate true composer
  - Columns indicate output labels
  - Numbers indicate the number of MIDI files belonging to the given true composer (row) classified with the given label (column)

Experiment 1 Part A:
Results and conclusions

MASSES	Buch	Guerrero	Morales	Victoria
Buch	**26**	0	0	0
Guerrero	0	**98**	5	1
Morales	0	4	**113**	5
Victoria	0	0	7	**108**

MAS + MOT	Buch	Guerrero	Morales	Victoria
Buch	**25**	0	0	1
Guerrero	1	**187**	15	5
Morales	1	17	**172**	6
Victoria	0	10	8	**212**

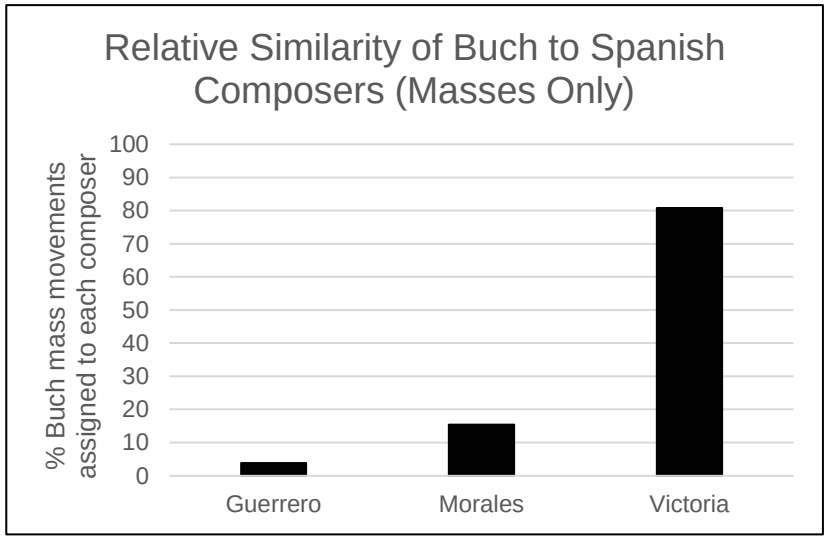
- CONCLUSION: Buch is quite distinct from the other three composers
  - 0 pieces by Buch were misclassified in the masses-only group, and only 1 Buch piece in the combined group
  - 0 pieces in the masses-only group were misclassified as by Buch, and only 2 in the combined group
  - Buch was actually the most distinct composer of the four (100% and 96% successful classification, versus runners up of 94% and 92%, respectively)

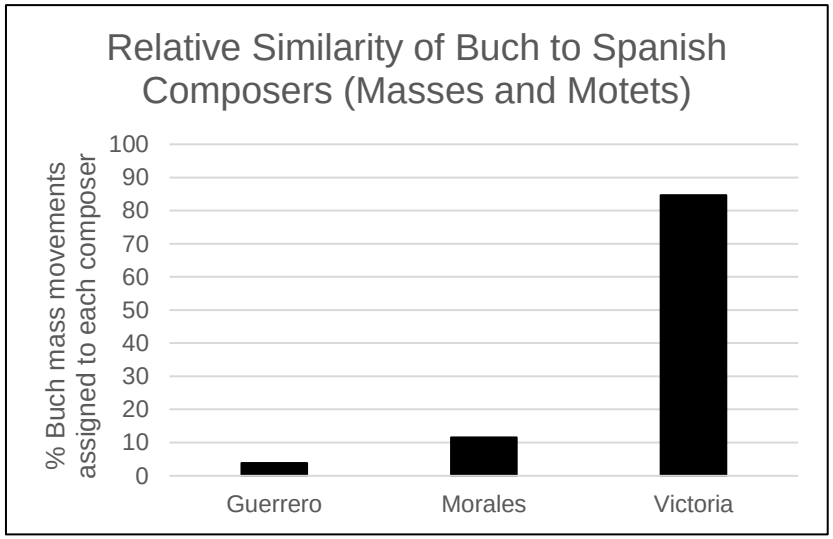
Experiment 1 Part B:

Classification-based similarity

- Used machine learning to train an SVM classifier to distinguish between Guerrero, Morales and Victoria
  - Not trained on the music of Buch
- Used this this trained classifier to label each of Buch's mass movements
  - i.e. forced the classifier to label each of Buch's mass movements with the name of one of these three composers, even though the music was known to be by Buch
  - The fraction of Buch's mass movements classified as each of the other three composers provides an indicator of similarity to that composer, relative to the other two

Experiment 1 Part B:
Results and conclusions





- Buch's music is most similar to Victoria, then Morales and then Guerrero

Experiment 1 Part C:
Information gain

- Information gain is a commonly used entropy-based metric for identifying discriminative features
  - Measures how much a given feature contributes individually to the ability to statistically distinguish between categories (e.g. Buch vs. Victoria)
- Calculated information gain values for each jSymbolic feature in three pair-wise analyses
  - Buch vs. Guerrero
  - Buch vs. Morales
  - Buch vs. Victoria
- Only considered mass movements

Experiment 1 Part C:

Results and conclusions

- Aggregated across the three sub-experiments, the following features best statistically separate Buch's style from that of Guerrero, Morales and Victoria:
  - Importance of High Register
  - Vertical Interval Histogram 17 (P11)
  - Mean Pitch
- There are many other discriminative features as well
  - Also, how features vary together can be very meaningful, but is not captured by these information gain analyses

Remaining experiments

- The same three types of analysis were applied to each of the two remaining composer groups:
  - Cross-validation to evaluate how well Buch's music is stylistically separated from the other composers
  - Classification to evaluate Buch's relative stylistic similarity to each other composer
  - Information gain to identify which features most separate Buch's style from that of the other composers
- These two remaining groups are:
  - Earlier Franco-Flemish composers
  - Later Franco-Flemish and Italian composers
- Also conducted a final analysis comparing Buch with the three overall groups of composers

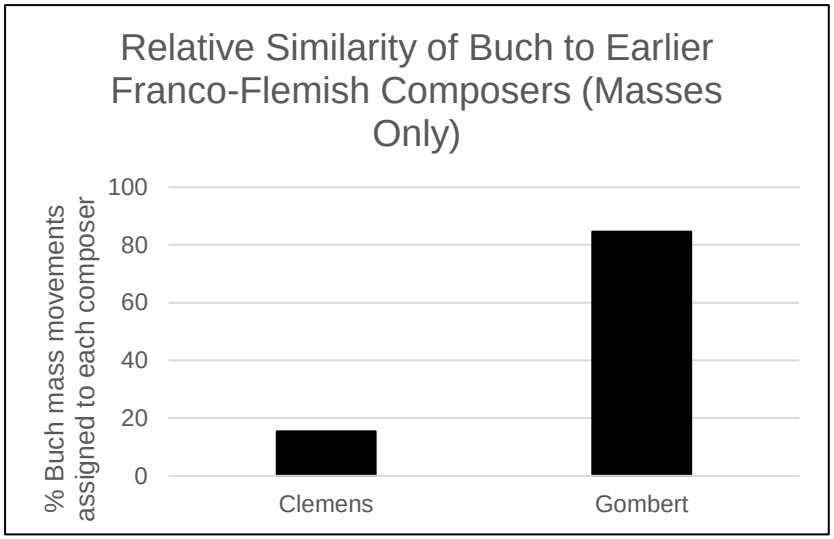
Experiment 2 Part A: Earlier Franco-Flemish confusion matrices

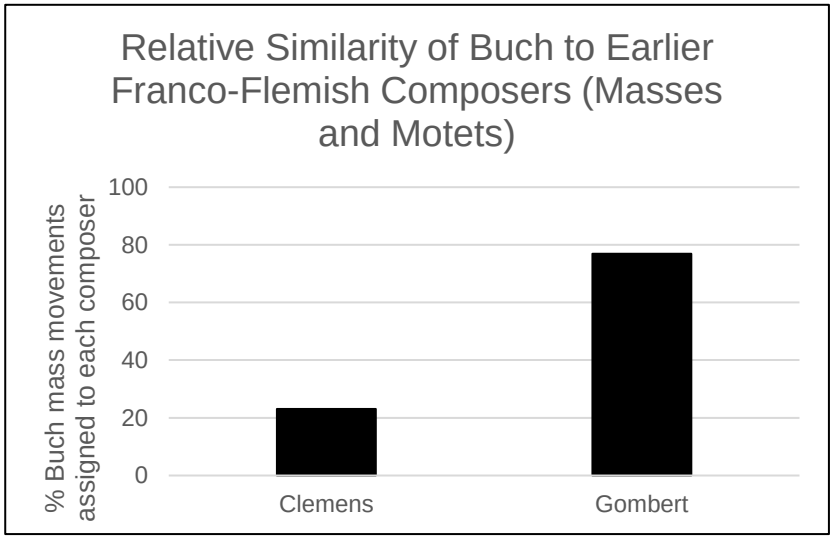
MASSES	Buch	Clemens	Gombert
Buch	**26**	0	0
Clemens	0	**5**	0
Gombert	0	0	**13**

MAS + MOT	Buch	Clemens	Gombert
Buch	**26**	0	0
Clemens	0	**39**	9
Gombert	0	10	**45**

- CONCLUSION: Buch is very distinct from the other two composers
  - 0 pieces by Buch were misclassified in either group
  - 0 pieces were misclassified as by Buch in either group

Experiment 2 Part B:
Classification-based similarity





- Buch's music is more similar to Gombert than to Clemens

Experiment 2 Part C:

Information gain

- Aggregated across the two masses-only sub-experiments, the following features best statistically separated Buch's style from that of Clemens and Gombert:
  - Mean Pitch
  - Importance of High Register
  - Melodic Pitch Variety
  - Mean Melodic Interval
  - Vertical Perfect Fifths
- Once again, there are many other discriminative features as well

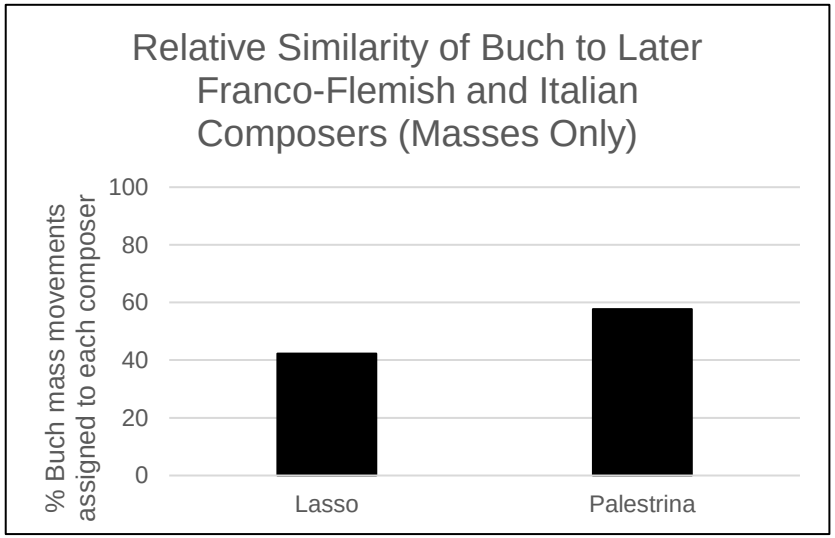
Experiment 3 Part A: Later Franco-Flemish/Italian confusion matrices

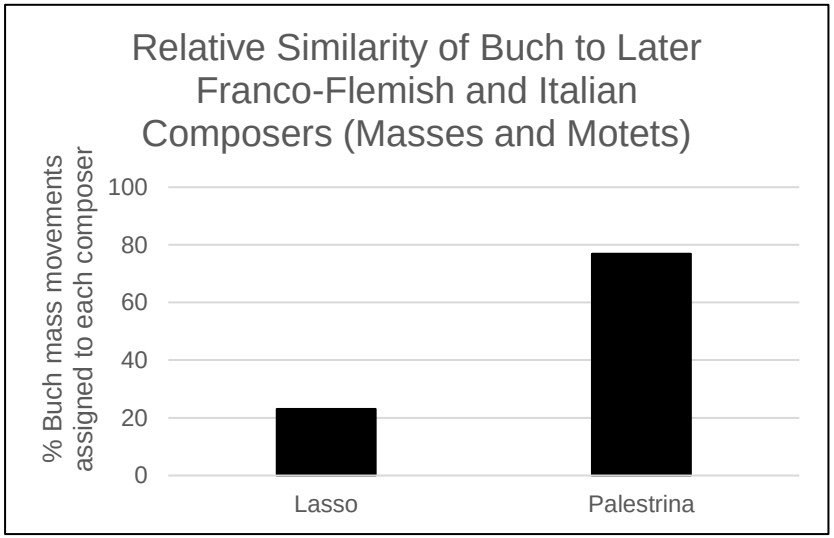
MASSES	Buch	Lasso	Palestrina
Buch	**26**	0	0
Lasso	1	**87**	5
Palestrina	1	2	**117**

MAS + MOT	Buch	Lasso	Palestrina
Buch	**26**	0	0
Lasso	1	**203**	21
Palestrina	4	15	**359**

- CONCLUSION: Buch is very distinct from the other two composers
  - 0 pieces by Buch were misclassified in either group
  - 2 and 5 pieces were misclassified as by Buch, for the masses and the masses & motets combined groups, respectively)

Experiment 3 Part B:
Classification-based similarity





- Buch's music is more similar to Palestrina than to Lasso
  - However, Buch's style is less strongly relatively similar to Palestrina's in the masses-only group than in the combined group (58% / 42% vs. 77% / 23%, respectively)

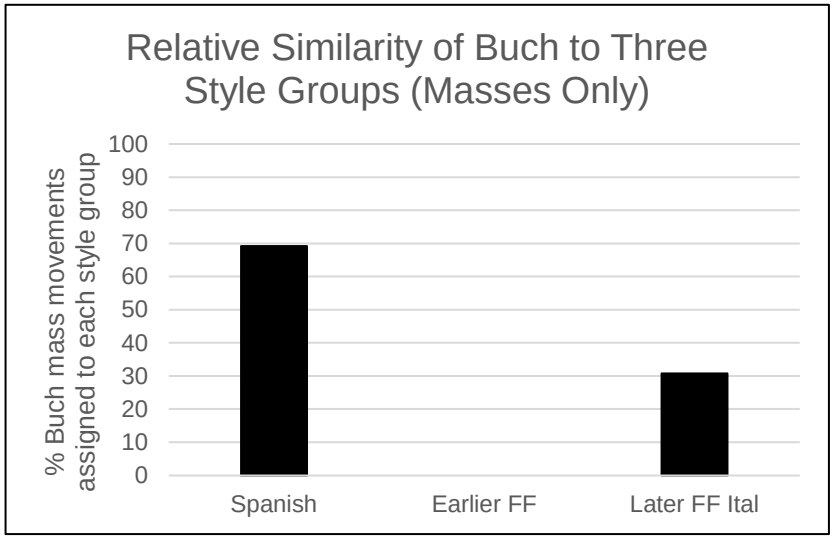
Experiment 3 Part C:
Information gain

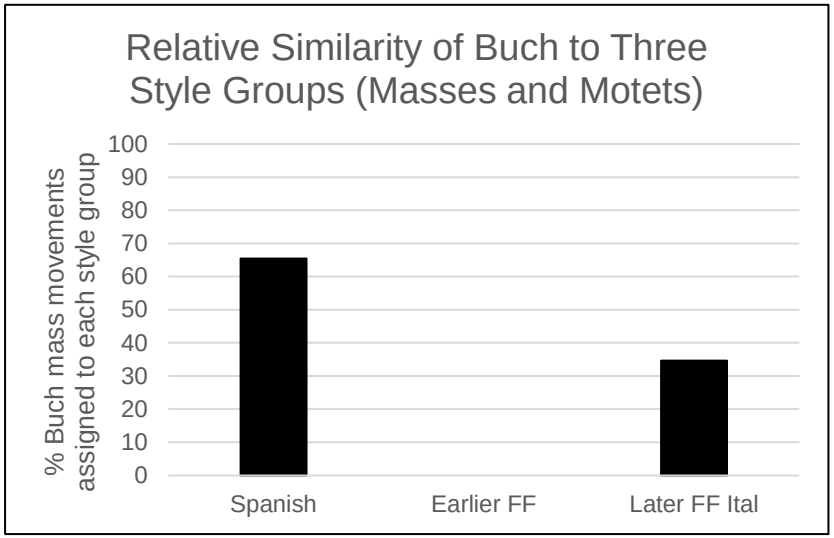
- Aggregated across the two sub-experiments, the following features best statistically separate Buch's style from that of Lasso and Palestrina:
  - Importance of High Register
  - Vertical Interval Histogram 17 (P11)
- Once again, there are many other discriminative features as well

Experiment 4: Aggregated classification-based similarity

- Performed a final classification-based relative similarity experiment where each Buch mass movement was classified into one of three aggregated groups:
  - Spanish composers: Guerrero + Morales + Victoria
    - Buch was excluded from training
  - Earlier Franco-Flemish composers: Clemens + Gombert
  - Later Franco-Flemish and Italian composers: Lasso + Palestrina

Experiment 4:
Results and conclusions





- Buch's music is quite distinct from the earlier Franco-Flemish group (0 classifications)
- Buch's music is roughly twice as similar to the Spanish group as to the later Franco-Flemish and Italian group

Overall conclusions from feature-based experiments (1/2)

- Buch's style is clearly easily differentiable from that of any of the other composers studied
  - His music has its own distinct character
- Within each of the three groups examined individually, Buch's music is most stylistically similar to:
  - Victoria
  - Gombert
  - Palestrina
- Buch's music has a strong (relative) similarity to the Spanish style
  - With some (relative) similarity to the later Franco-Flemish and Italian style, and little (relative) similarity to the earlier Franco-Flemish style

Overall conclusions from feature-based experiments (2/2)

- Certain musical elements of Buch's style stand out statistically:
  - Importance of High Register
    - Buch (mass) average: 0.16
    - Others (mass) average: 0.05
  - Vertical Interval Histogram 17 (P11)
  - Mean Pitch
  - Melodic Pitch Variety
  - Mean Melodic Interval
  - Vertical Perfect Fifths

General overall observations

- Buch's music may have fallen out of favor because he was unable to publish his work
  - The study of his masses reveals his mastery of counterpoint as a scholastic composer
- We have found Buch tends towards a less expressive development of the melodies linked to the prosody of the text
  - This separates him from Guerrero
- Buch focuses on a more vertical and harmonic conception of counterpoint
  - He uses homophony as an expressive resource in the manner of Victoria, Gombert or Palestrina

Future research

- Dive into the information gain results
  - How specifically do each of the highlighted features differentiate Buch's style?
  - How do the features vary together?
- Add more composers to each of the groups
  - Ideally with a focus on more masses in particular
- Study the stylistic transmission between Buch and his disciples
  - e.g. Gabriel Fernández and Juan de Madrid
  - They may have composed some of the anonymous works preserved in the manuscript of the Collegiate Church of Pastrana

Thanks for your attention

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