Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Metric Complexity in Polyphonic Music: A Theoretical Framework and Quantitative Analysis of Hugo Distler's Motets

Lucas Hofmann | Julius-Maximilians-Universität Würzburg
Christoph Finkensiep | Universiteit van Amsterdam
Fabian C. Moss | Julius-Maximilians-Universität Würzburg

Third International Conference on Computational and Cognitive Musicology (ICCCM25)
Aalborg University | 8-10 October 2025

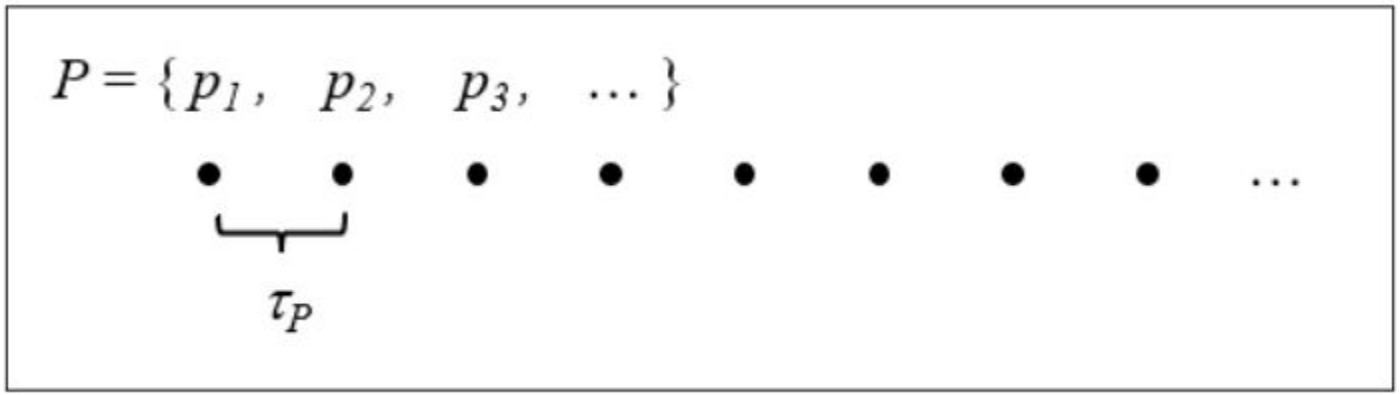
What is meter?

How to quantify meter?

How complex is Distler's music?

1. Pulse

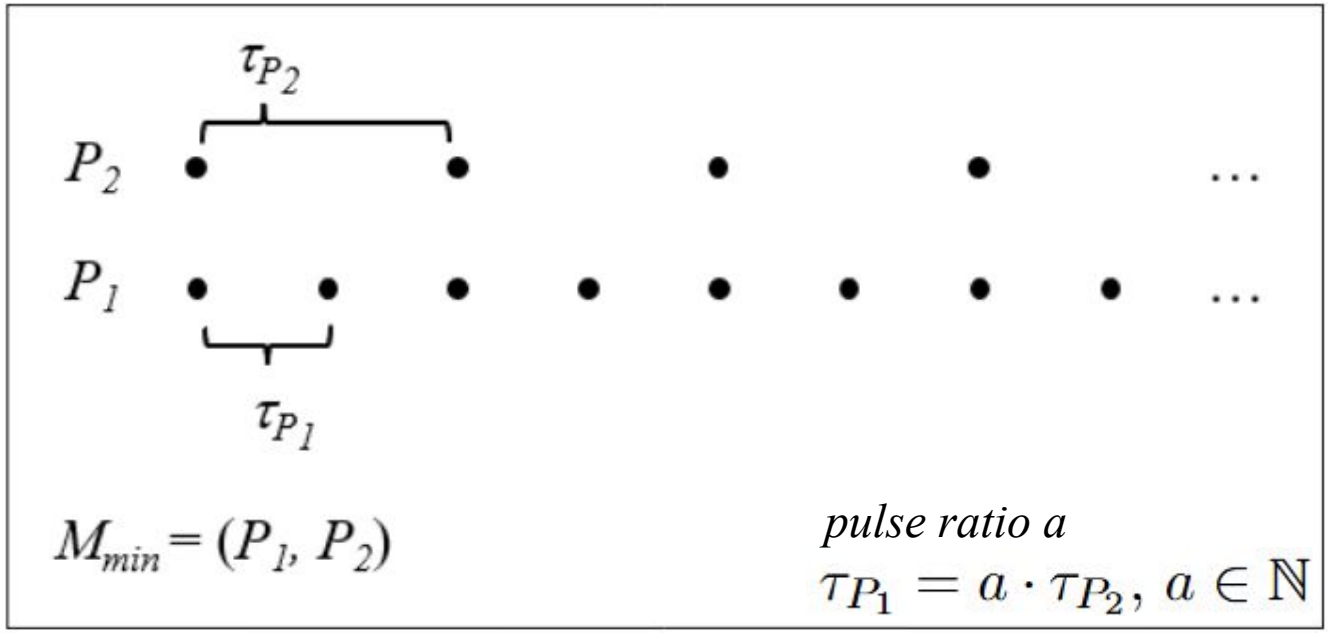
Definition 1. A *pulse* $P = \{p_i\}$ for $i \in \mathbb{N}$ is a finite ordered set of infinitesimal time points whose adjacent elements are separated by a constant value, the *pulse duration* $\tau_P = |p_{i+1} - p_i|, \forall i$.



cf. Cohn (2022), Hasty (1997)

2. Minimal meters

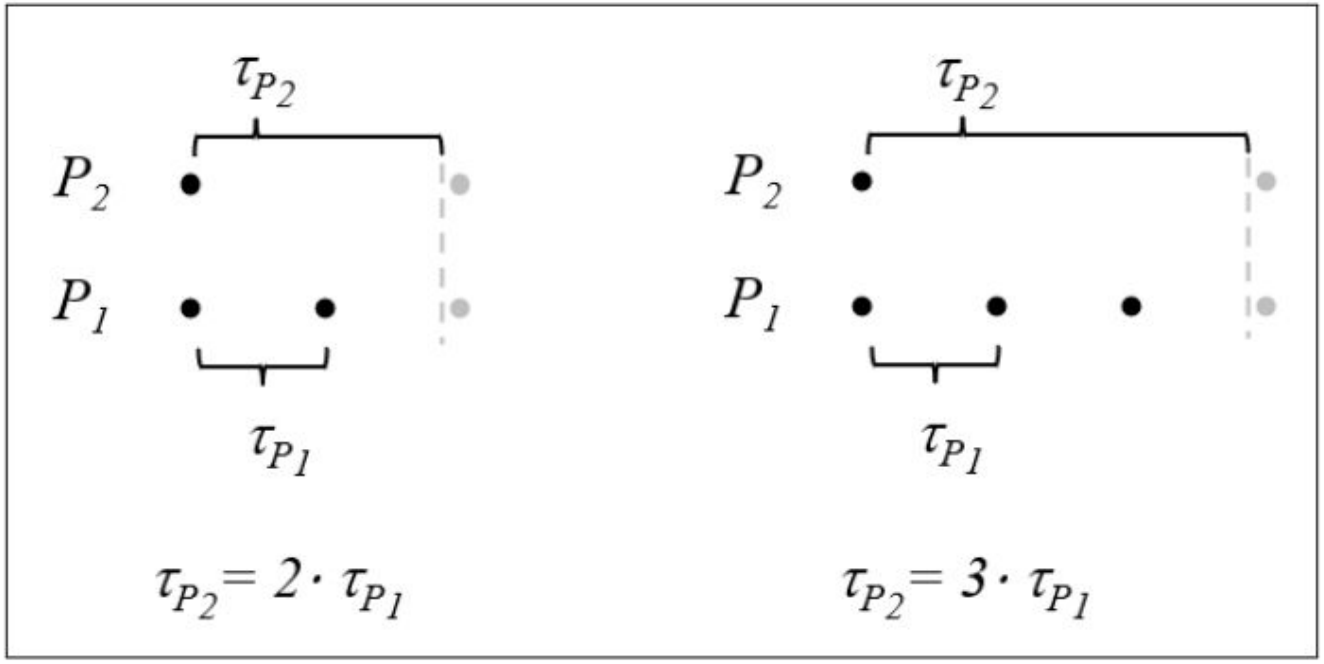
Definition 2. A *minimal meter* M_{min} is a pair of pulses (P_1, P_2) such that $P_2 \subset P_1$. The definition implies $\tau_{P_2} > \tau_{P_1}$, and thus that P_2 is slower and P_1 faster.



cf. Cohn (2022)

3. Simple meters

Definition 3. A *simple meter* M_s is a minimal meter M_{min} of cardinality $k = 2$. Simple meters fall into exactly two types: *duple meters* $M(2)$, where $\tau_{P_1} = 2 \cdot \tau_{P_2}$, and *triple meters* $M(3)$, where $\tau_{P_1} = 3 \cdot \tau_{P_2}$.



← equidistant „tatum“

duple triple

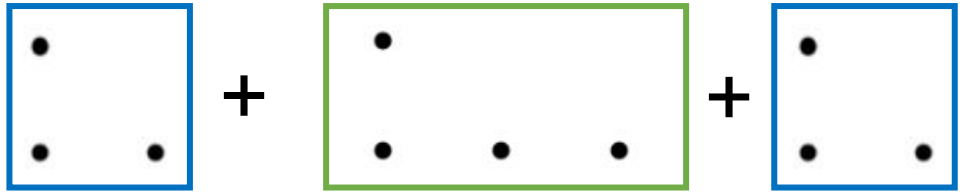
cf. Cohn (2019),
Cooper & Meyer (1963)

4. Compound meters

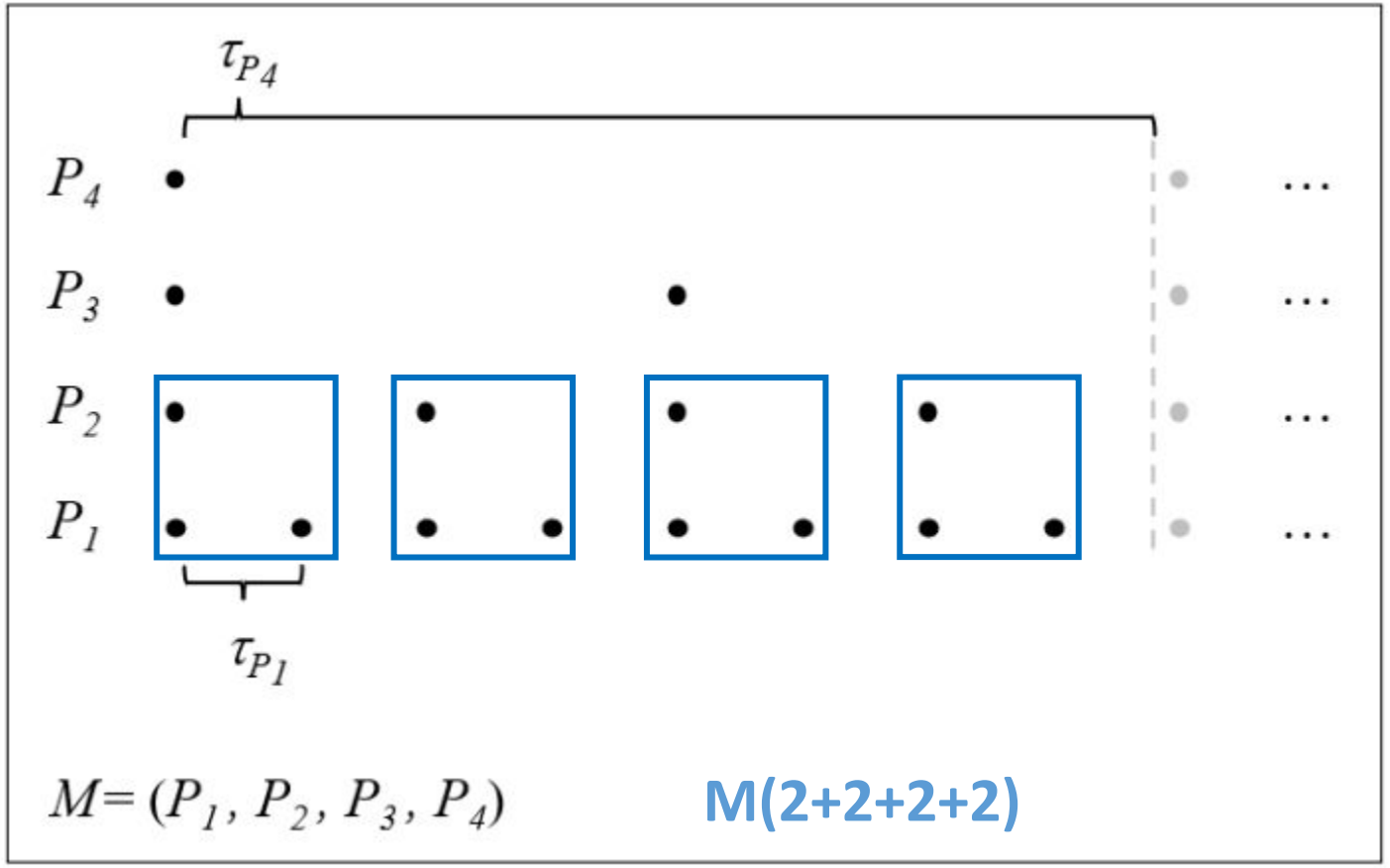
Definition 4. A *compound meter* M_c is defined as a concatenation of $S \in \mathbb{N}_{>1}$ simple meters $M_s^{(i)}$. This concatenation is represented as a symbolic sum of the form

$$M_c = M_s^{(1)} + M_s^{(2)} + \cdots + M_s^{(S)},$$

where the + sign denotes the linking of partitions, not numerical addition. For example, a compound meter built of a duple, a triple, and another duple meter is written as 2+3+2.



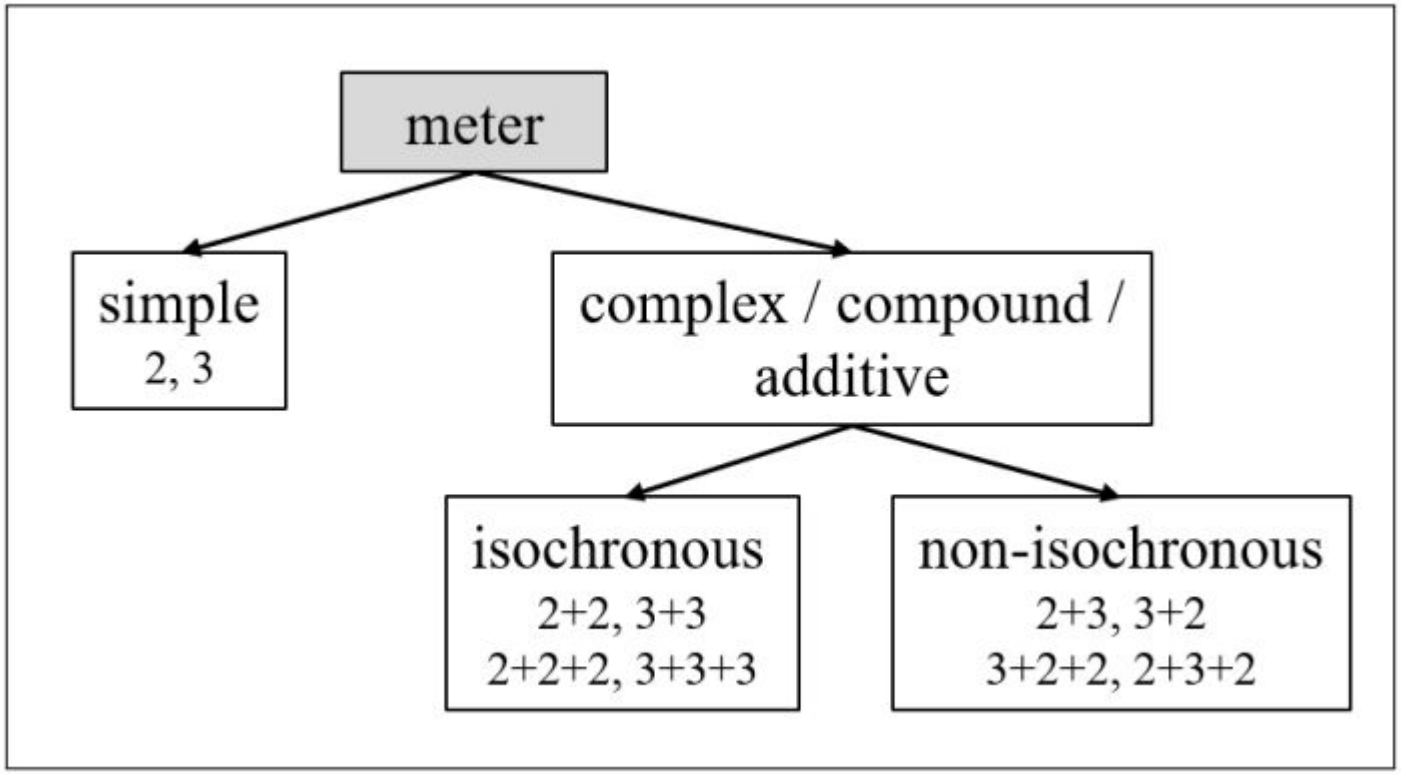
5. Deep meters



not necessarily equidistant

equidistant „tatum“

6. Taxonomy

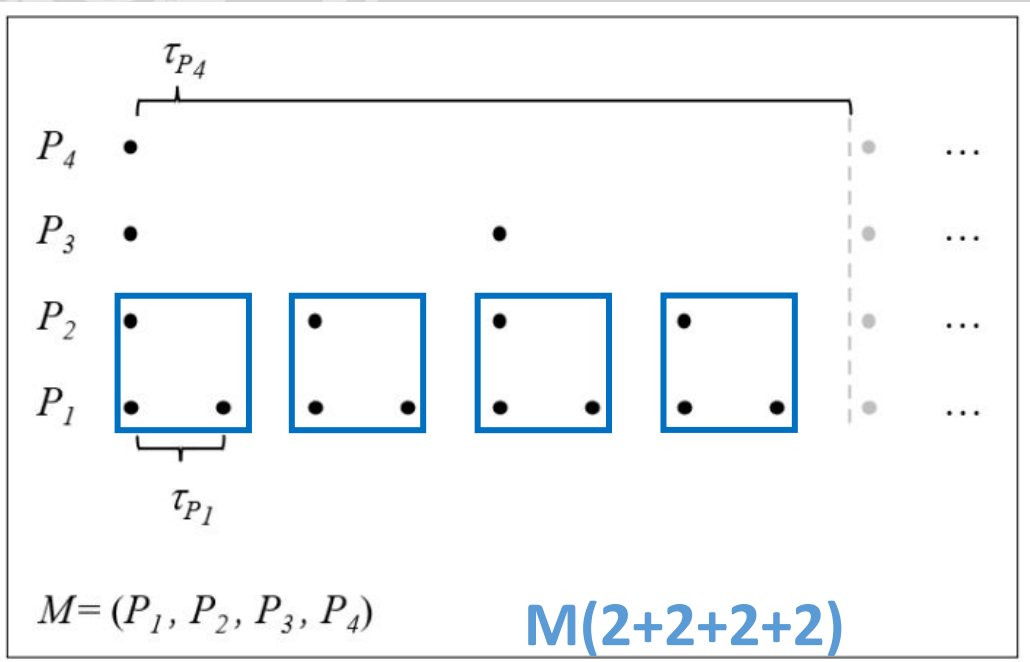

meter
simple
2, 3
complex / compound /
additive
isochronous
2+2, 3+3
2+2+2, 3+3+3
non-isochronous
2+3, 3+2
3+2+2, 2+3+2

What is meter?

How to quantify meter?

How complex is Distler's music?

1. Structural features of meter



- the cardinality k; (*k* = 4)
- the number m of different single meters (duple or triple meters) that constitute a meter; and (*m* = 1)
- the number of summands S that constitute a meter. (*S* = 4)

2. Metric complexity

$$C_M(n) = k + \quad m + S$$

cf. Cohn (1992), Rundall (2011)

2. Metric complexity

$$C_M(n) = k + \quad m + S$$

cf. Cohn (1992), Rundall (2011)

Conditions:

- $C_M(2) = C_M(3) = 1$
- $C_M(2 + 3) > C_M(2)$
- $C_M(2 + 3 + 3) > C_M(2 + 3)$
- $C_M(3 + 2 + 2) > C_M(3 + 3 + 3)$

2. Metric complexity

$$C_M(n) = k + \quad m + S - 4.$$

Conditions:

- $C_M(2) = C_M(3) = 1$ cf. Rundall (2011)
- $C_M(2 + 3) > C_M(2)$
- $C_M(2 + 3 + 3) > C_M(2 + 3)$
- $C_M(3 + 2 + 2) > C_M(3 + 3 + 3)$

2. Metric complexity

$$C_M(n) = k + 2 \cdot m + S - 4.$$

Temperley (2001), Cambouropoulos (1998)

Conditions:

- $C_M(2) = C_M(3) = 1$
- $C_M(2 + 3) > C_M(2)$
- $C_M(2 + 3 + 3) > C_M(2 + 3)$
- $C_M(3 + 2 + 2) > C_M(3 + 3 + 3)$

Desain & Honing (2003), Hannon & Trehub (2005), Yates et al. (2017)

2. Metric complexity

Definition 5 (Metric Complexity). Let $M_s \in \{M(2), M(3)\}$ denote a simple meter. Let M_c be a compound meter composed of $S \in \mathbb{N}$ simple meters. Let $M \in \{M_s, M_c\}$ be a meter of cardinality k. Let $m \in \{1, 2\}$ denote the number of distinct simple meter types present in M. n represents the partition of simple meters that constitute M.

Then the *metric complexity* C_M of the meter M is defined as:

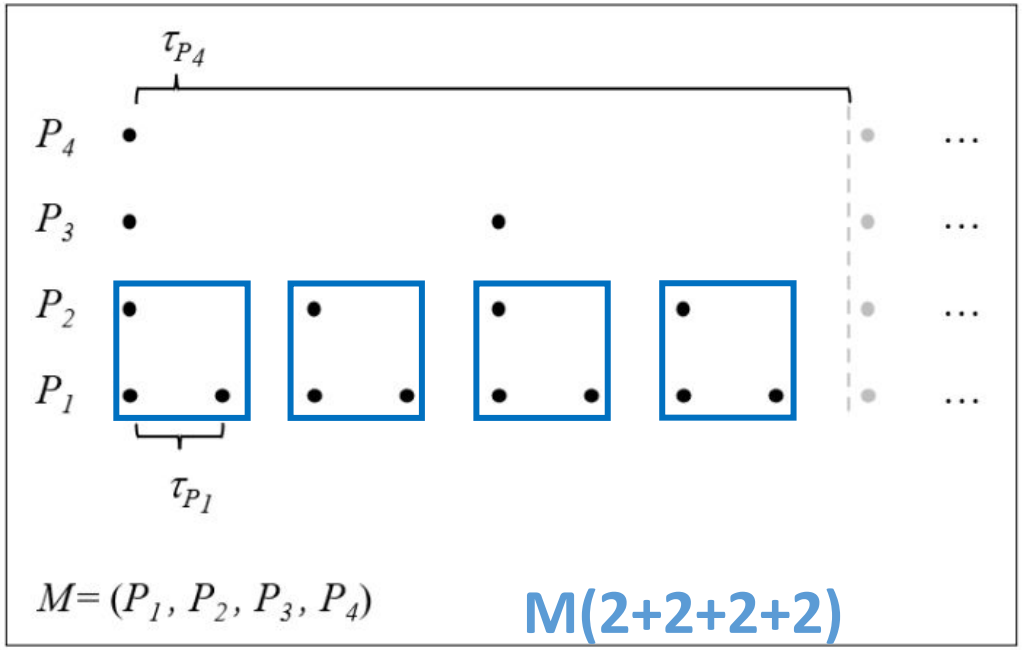
$$C_M(n) = k + 2 \cdot m + S - 4.$$

2. Metric complexity

M	time	k	m	S	C_M
2	2/8	2	1	1	1
3	3/8	2	1	1	1
2+2	2/4	3	1	2	3
3+3	6/8	3	1	2	3
2+3	5/8	3	2	2	5
3+2	5/8	3	2	2	5
2+2+2	3/4	3	1	3	4
3+3+3	9/8	3	1	3	4
3+2+3	8/8	3	2	3	6
3+2+2	7/8	4	2	3	7
2+2+2+2	4/4	4	1	4	6
3+2+2+3	10/8	4	2	4	8
2+2+2+2+2	5/4	4	1	5	7

2. Metric complexity

M	time	k	m	S	C_M
2	2/8	2			
3	3/8	2			
2+2	2/4	3			
3+3	6/8	3			
2+3	5/8	3			
3+2	5/8	3			
2+2+2	3/4	3			
3+3+3	9/8	3			
3+2+3	8/8	3			
3+2+2	7/8	4			
2+2+2+2	4/4	4	1	4	6
3+2+2+3	10/8	4	2	4	8
2+2+2+2+2	5/4	4	1	5	7



M(2+2+2+2)

What is meter?

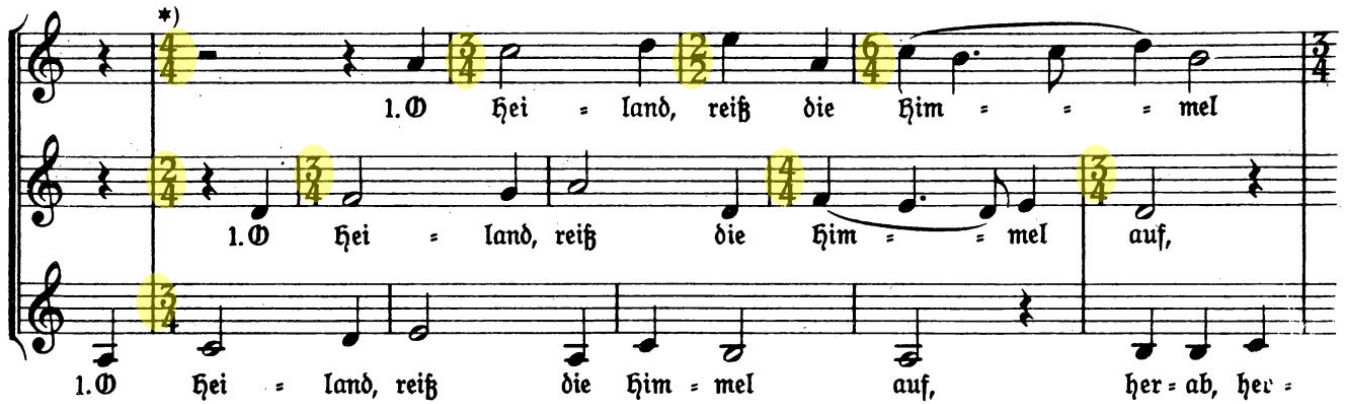
How to quantify meter?

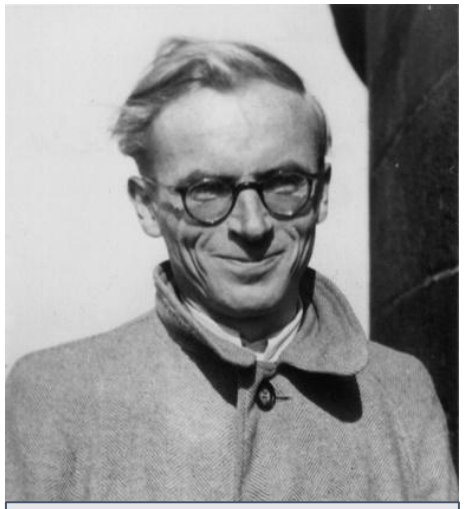
How complex is Distler's music?

Hugo Distler / Der Jahrkreis

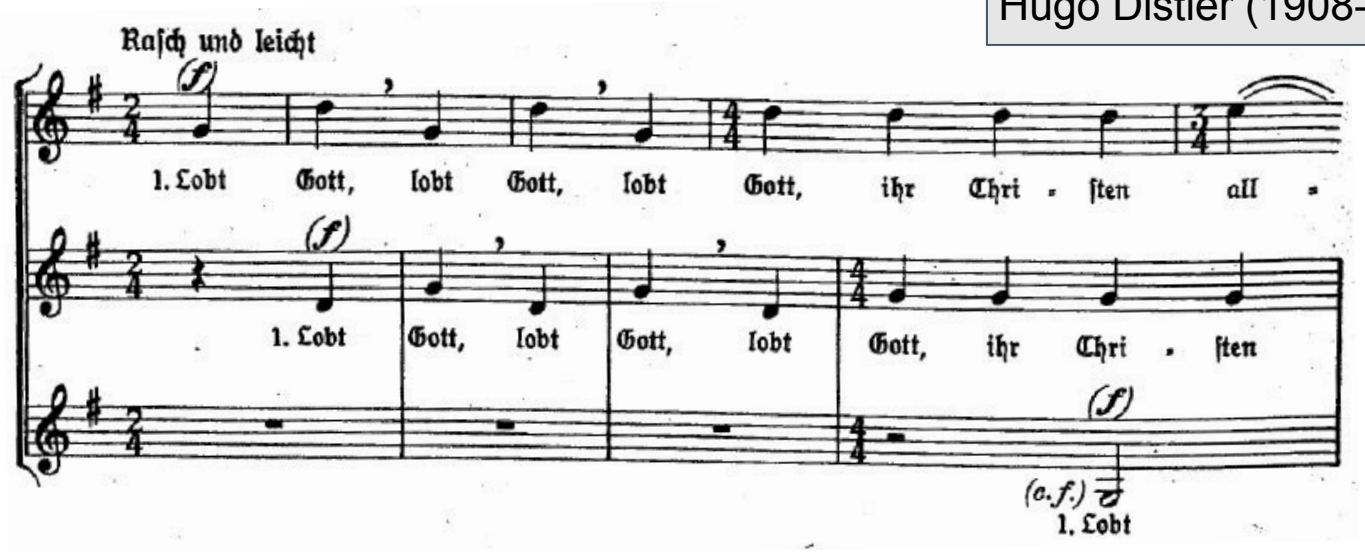
Eine Sammlung von 52 zwei- und dreistimmigen geistlichen Chormusiken zum Gebrauch in Kirchen-, Schul- und Laienchören

Opus 5





Hugo Distler (1908-42)

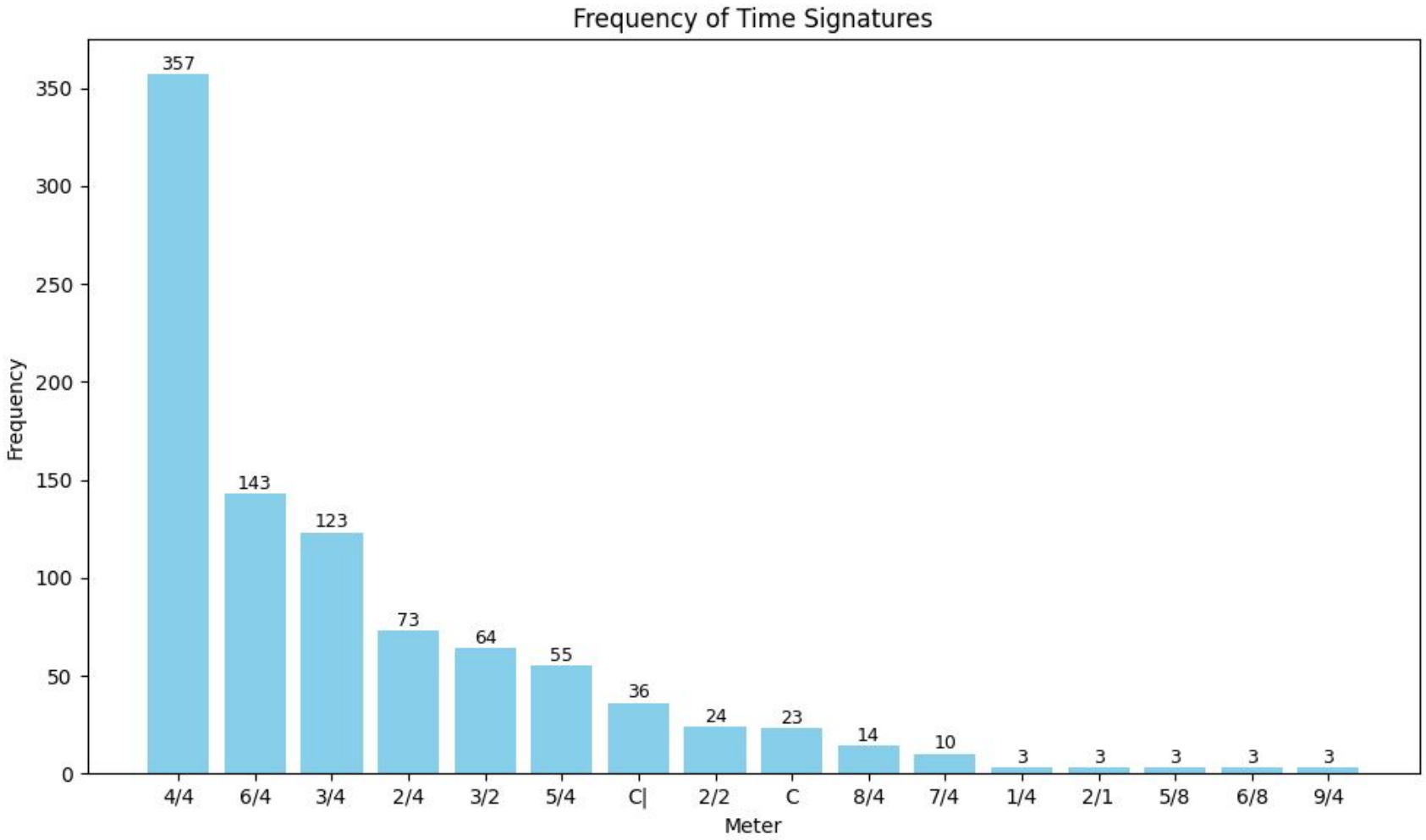


Distler (1933)
Strinning (2023)
Redden-Liotta (2020)

Corpus soon available on Verovio Humdrum Viewer!

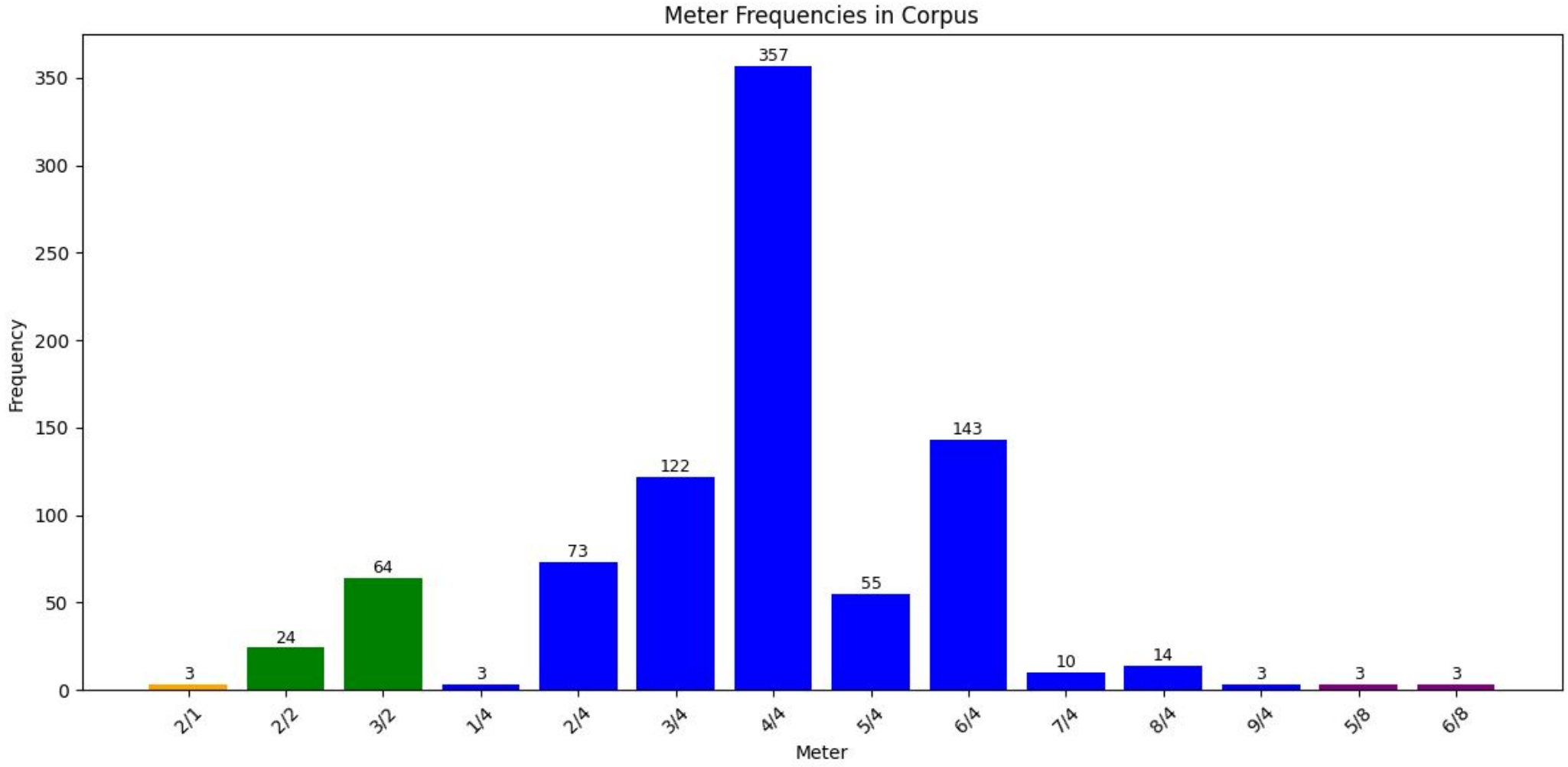
Jahrkreis corpus:

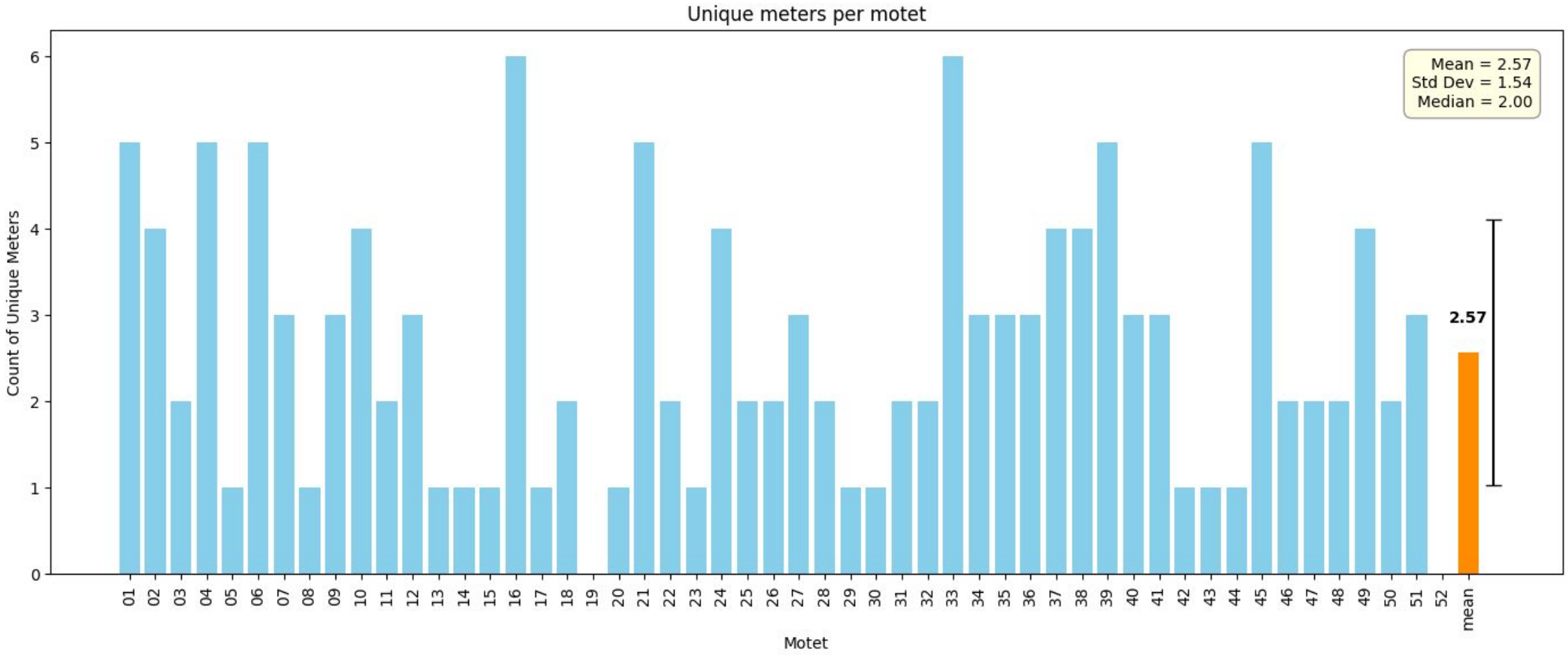
52 motets



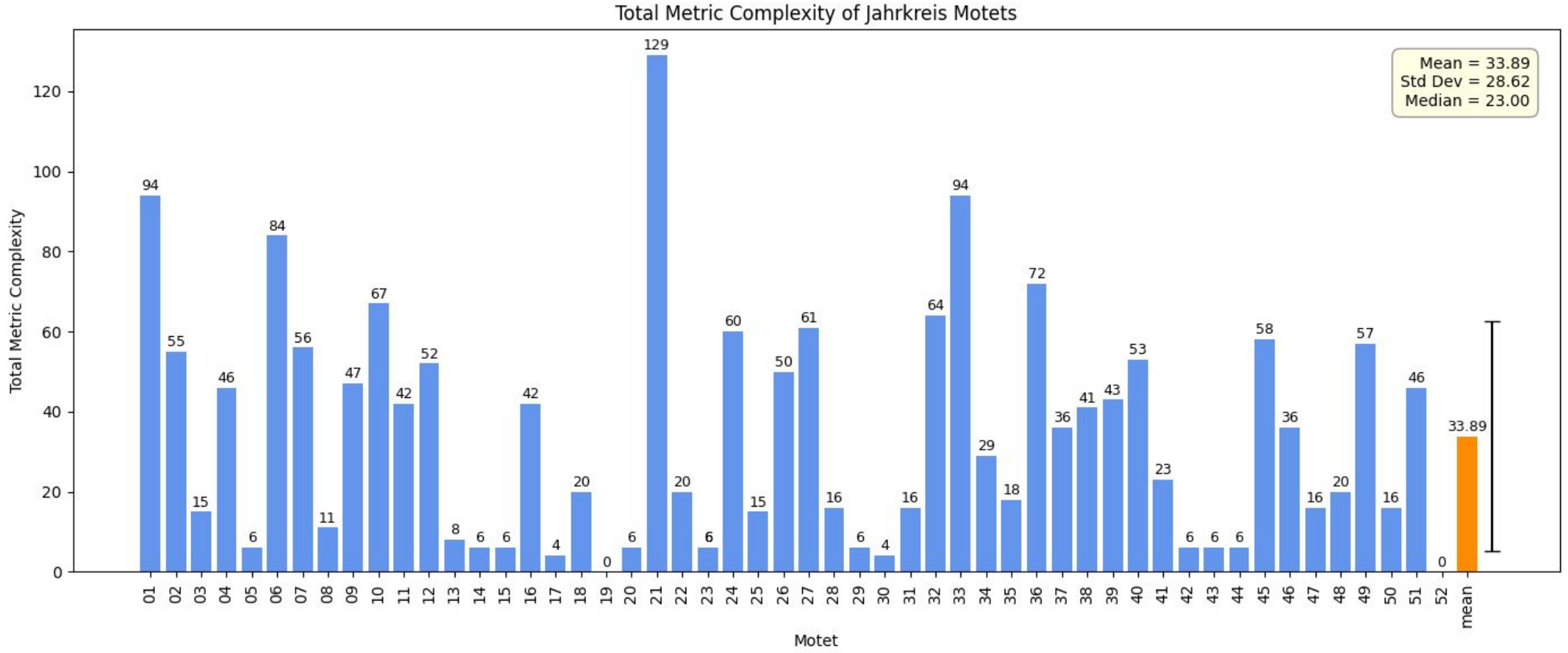
Jahrkreis corpus:

52 motets

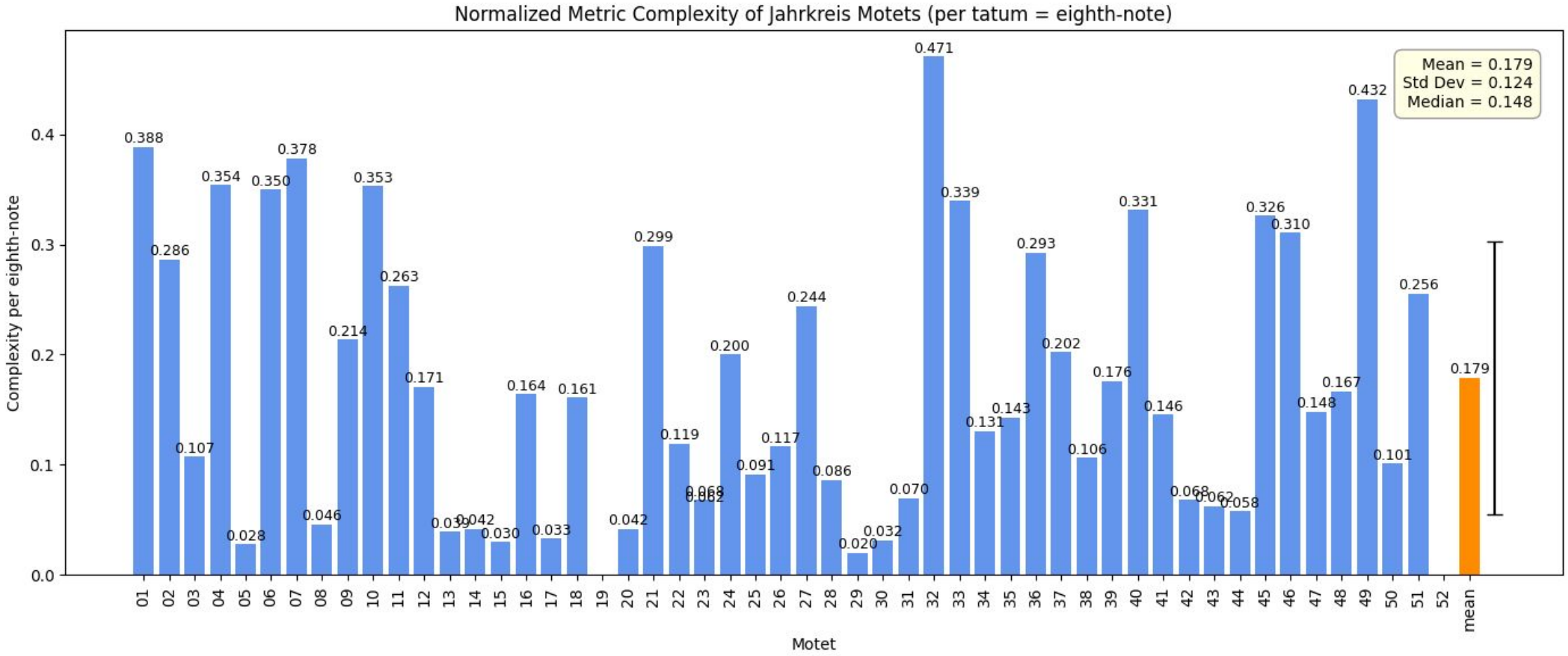




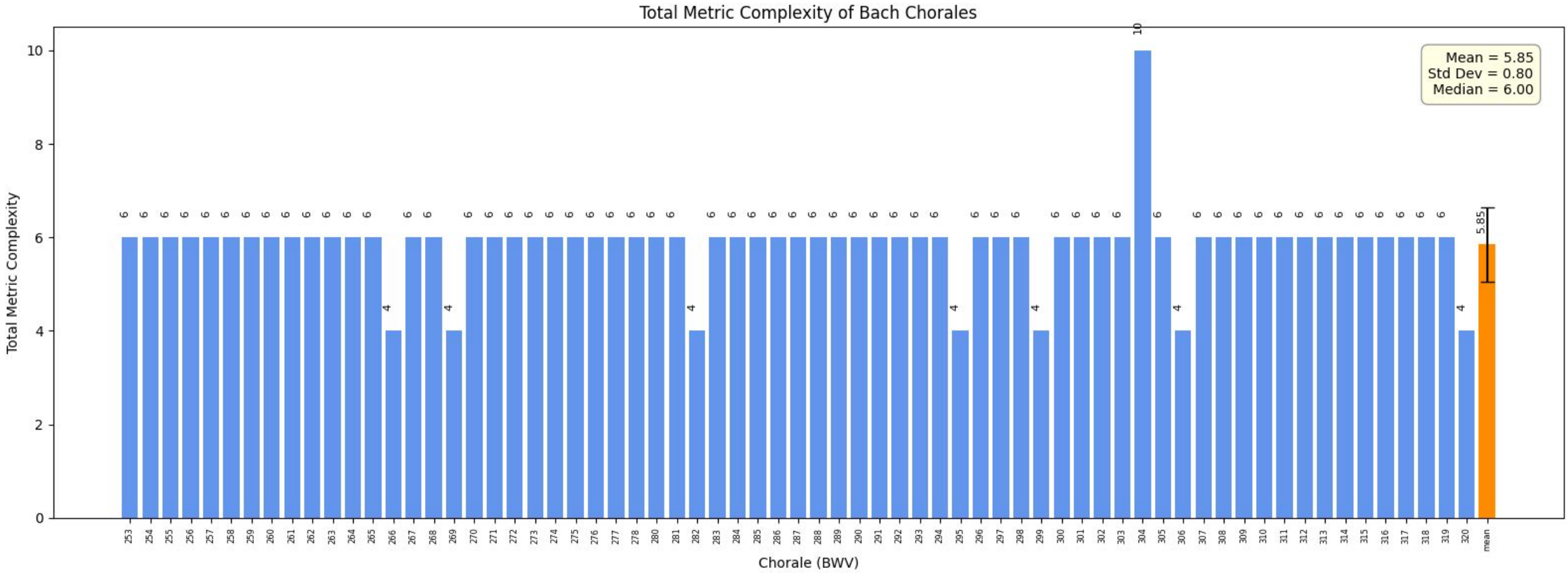
“How many different time signatures occur in the motet?”



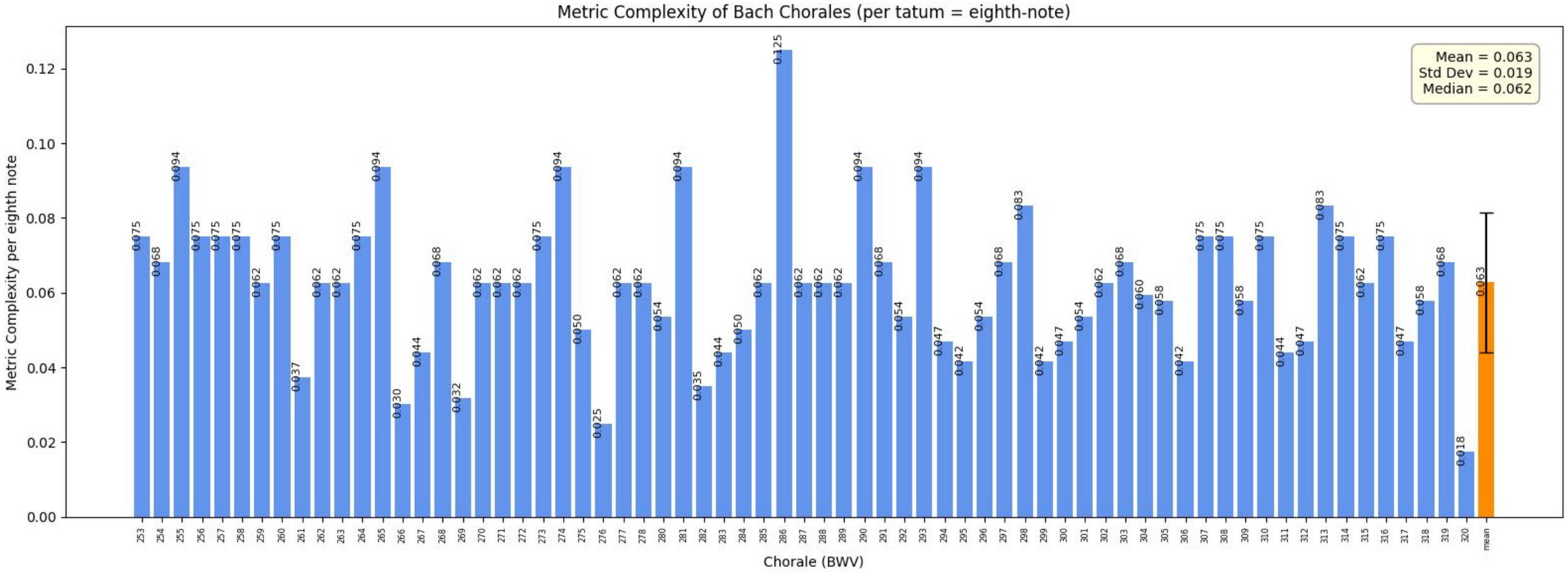
We calculate and add up the complexity values for these meters according to the table.



We normalize the complexity values by the number of tatum beats per motet.



Using the same initial conditions, we calculate the complexity values of a random selection of Bach chorales for comparison.



And we normalize these values, too.

Discussion

- Researcher has to define tatum
- Commutative formula ⇔ non-commutative perception (2+2+3 vs. 3+2+2)
- Normalization by N
- Validation through experiments

Conclusion

- Useful tool for comparing music meter-wise
- Applicability for other symbolic corpora needs to be researched
- Meter is more than time signatures

Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Metric Complexity in Polyphonic Music: A Theoretical Framework and Quantitative Analysis of Hugo Distler's Motets

Lucas Hofmann | Julius-Maximilians-Universität Würzburg
Christoph Finkensiep | Universiteit van Amsterdam
Fabian C. Moss | Julius-Maximilians-Universität Würzburg

References:

Thank you for your attention.