A NON-MELODIC CHARACTERISTIC TO COMPARE THE MUSIC OF MEDIEVAL CHANT TRADITIONS

Geert Maessen

Gregoriana Amsterdam, Amsterdam, The Netherlands
gmaessen@xs4all.nl

Peter van Kranenburg

Meertens Intstituut, Amsterdam, The Netherlands
Utrecht University, Utrecht The Netherlands
peter.van.kranenburg@
meertens.knaw.nl

1. INTRODUCTION

In the scholarly discourse on the origins of Gregorian chant (GRE) several medieval chant traditions play key roles, notably Old Roman (ROM), Milanese (MIL) and Beneventan chant (BEN). Although hardly anything is known with certainty about Gallican chant, which was in existence in Gaul before GRE, this chant also played an important role. The chant of the Mozarabic rite has long been considered of major importance as well. However, due to the lack of pitch-readable sources it was virtually absent in the discussion. (Levy, 1998)

At the end of the eleventh century the Mozarabic rite and its chant were officially replaced by the Roman rite with its chant (GRE). Over 5,000 chants, however, are preserved in neumatic notation dating from the ninth to thirteenth centuries. In this notation, precise intervals (apart from incidental primes) cannot be read (Randel, 1973). The most complete manuscript is the early tenth-century León antiphoner (LEO) with over 3,000 notated chants (for an example see Figure 1).

In Toledo, six parishes were allowed to continue the tradition. Oral descendants of this tradition, heavily mixed with a newly invented tradition, were finally written on the staff in the early sixteenth century (MOZ). Only a few dozen melodies agreeing with the early neumatic notation of the Mozarabic rite were ever found in pitch-readable notation. We know, however, that there must have been melodic relations between the lost tradition and traditions preserved in pitch-readable notations. Based on the chant texts and the number of notes per syllable Kenneth Levy (1998) has shown in detail that some LEO sacrificia must have been musically related to offertories on the same texts in GRE, ROM and MIL.

In a previous paper, we have shown that it is possible to produce melodies agreeing in all detail with our knowledge of the early neumes (Maessen & Van Kranenburg, 2017). In order to produce melodies with higher historical probability we compiled a data set of all GRE, ROM, MIL, BEN and MOZ offertories (Van Kranenburg & Maessen, 2017). For the current study, we additionally have encoded 25 out of all 102 LEO sacrificia (2 to 5 parts each); some from beginning, end and middle of the manuscript, and several pieces of specific interest, including Levy's sacrificia (20,000 notes in total). Based on the intervals between consecutive notes in the traditions of this data set we have shown that parts of the chants can be classified with very high accuracy. In order to extend this classification to include LEO we needed a pitch-independent feature that is shared by all six traditions. The number of notes on a syllable of chant text is such a feature. We defined 15 categories for the number of notes per syllable. All melisma lengths up to 10 we consider separate categories, and we added categories for 11-15, 16-20, 21-25, 26-50, and 50 or more notes. In this study, we perform a (zeroth-order) dimension reduction analysis, and we train (first-order) bigram language models.

2. CLASSIFICATION

For each tradition, we trained a bigram language model on the representation of the chants as sequences of melisma categories. We followed the same procedure as in Van Kranenburg & Maessen (2017): we computed for each chant part the perplexity for each tradition, and we assigned the chant part to the tradition with the lowest perplexity. In all cases the query chant was excluded from the language model of its own tradition. Although classification appeared to be less precise compared to
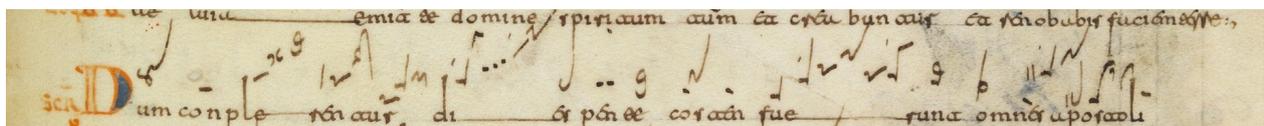

Figure 1. The first line of the sacrificium *Dum complerentur* in the León antiphoner (E-L 8; 210r14).

pitch-based models, most chant parts in each tradition, could be classified correctly. The fourth row in Table 1 shows that LEO chant parts are classified 65 % as LEO and never as MOZ. ROM has highest classification score (80 %), BEN lowest (54 %). When we drop LEO as a target class, 70 % of LEO chant parts are classified as GRE and again none as MOZ (see Table 2).

3. DIMENSION REDUCTION

For a better understanding of the relations between the six traditions we also performed a dimension reduction using the t-SNE algorithm (Van der Maaten & Hinton, 2008). We used the occurrence rates of the melisma categories as features. Here, the result was somewhat dependent on the way we categorized the number of notes per syllable. Nevertheless, there are clear trends observable which are consistent across different configurations and different runs of the algorithm. Figure 2 shows a typical 2D embedding of the chant parts. Here, again, it is observable that LEO is most close to GRE, and that ROM and MOZ are most alien to each other.

	MOZ	MIL	GRE	LEO	BEN	ROM	parts
MOZ	74,1	8,6	10,8	4,3	1,4	0,7	139
MIL	3,4	63,3	22,4	4,8	2,7	3,4	147
GRE	1,7	13,1	61,3	8,1	4,7	11,0	394
LEO	0,0	6,3	19,0	65,1	6,3	3,2	70
BEN	2,4	12,2	14,6	4,9	53,7	12,2	41
ROM	1,8	3,5	9,5	2,1	2,5	80,7	285

Table 1. Classification (in %) of parts in six traditions.

	MOZ	MIL	GRE	BEN	ROM	parts
MOZ	77,7	8,6	12,2	0,7	0,7	139
MIL	3,4	64,6	22,4	6,1	3,4	147
GRE	1,8	13,5	67,5	5,3	11,9	394
LEO	0,0	12,9	70,0	5,7	11,4	70
BEN	2,4	22,0	22,0	46,3	7,3	41
ROM	1,8	4,6	8,1	1,8	83,9	285

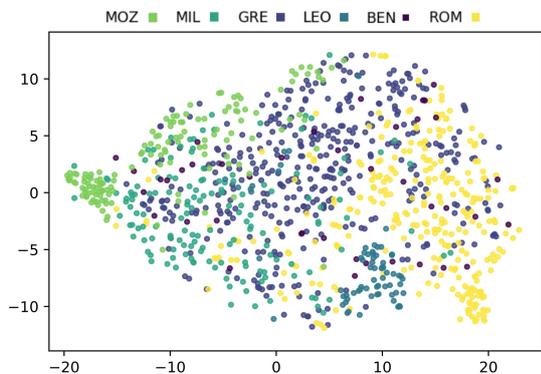**Table 2**. Classification without LEO as a target class.

Figure 2. Dimension reduction for six traditions.

4. CONCLUSION & FUTURE WORK

Some of the misclassifications and outliers of LEO found in Sections 2 and 3 are striking. LEO 053, *Erit hic vobis,* and 075, *Oravi Deum meum,* e.g. are two of only three extreme outliers (the other is 027, *Sicut cedrus*). These two chants are also two of only three Levy chants that are clearly related to their GRE counterparts (the third is 098, *Sanctificavit Moyses*). The GRE counterpart of LEO 075 also was the most extreme outlier in our interval-based analysis. Since this indicates that *Oravi* is alien to both LEO and GRE, Levy may have been right in stating "the most plausible origin" for *Oravi* and *Erit* as of "Gallican or mixed Mozarabic-Gallican usage" (Levy, 1998). Other traditions he excluded on other grounds. Apart from *Oravi* and *Erit,* now also *Sicut cedrus* and 099, *Congregavit David,* are qualified as candidates for Gallican chant. Another observation by Levy, the possible Gallican origin of five cognate GRE-MIL pairs, is confirmed for two of them by our analysis based on numbers of notes only: *Angelus Domini* and *Oratio mea.*

Our main conclusion: it is possible to make claims about relations of chant melodies in different traditions without reference to their texts and pitch content. This means that "a systematic exploration of the preserved Mozarabic repertory with a view to identifying any Gallican residue" (Levy, 1998) has become much easier. For the lost melodies of the Mozarabic rite it also means that, using our classification results, we are able to relate each chant to a specific tradition and take this tradition as the basis for the production of a melody.

In order to make our claims more precise we will continue our investigation in the way how to handle the different numbers of notes on chant syllables and in encoding the sacrificia of the León antiphoner.

5. REFERENCES

Levy, K. (1998). Toledo, Rome and the Legacy of Gaul. In *Gregorian Chant and the Carolingians*, 31-81.

Maessen, G. & Van Kranenburg, P. (2017). A Semi-Automatic Method to Produce Singable Melodies for the Lost Chant of the Mozarabic Rite. In *Proceedings of the 7th International Workshop on Folk Music Analysis 14-16 June 2017, Málaga, Spain,* (pp. 60-65).

Randel, D. (1973). An Index to the Chant of the Mozarabic Rite. New Jersey: Princeton University press.

Van der Maaten, L.J.P. & Hinton, G.E. (2008). Visualizing High-Dimensional Data Using t-SNE. *Journal of Machine Learning Research* 9:2579-2605.

Van Kranenburg, P. & Maessen, G. (2017). Comparing Offertory Melodies of Five Medieval Christian Chant Traditions. In *Proceedings of the 18th International Society for Music Information Retrieval Conference, Suzhou, China, October 23-27,* (pp. 204-210).