



MASTERS OF PCA

The Evolution of Metallica Through the Years with Exploratory Data Analysis. An Invitation of Teaching PCA in a Different Way

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WHY?

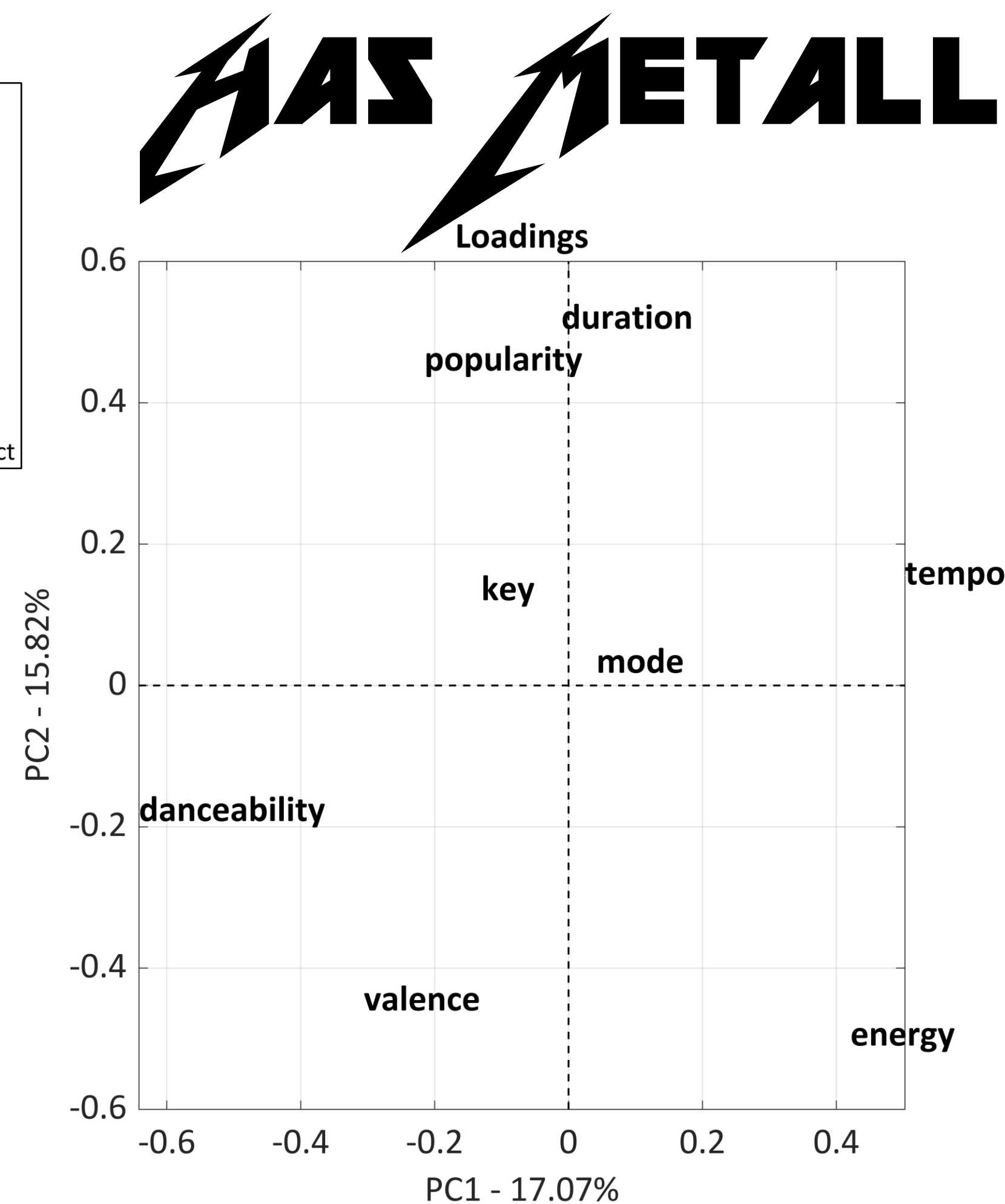
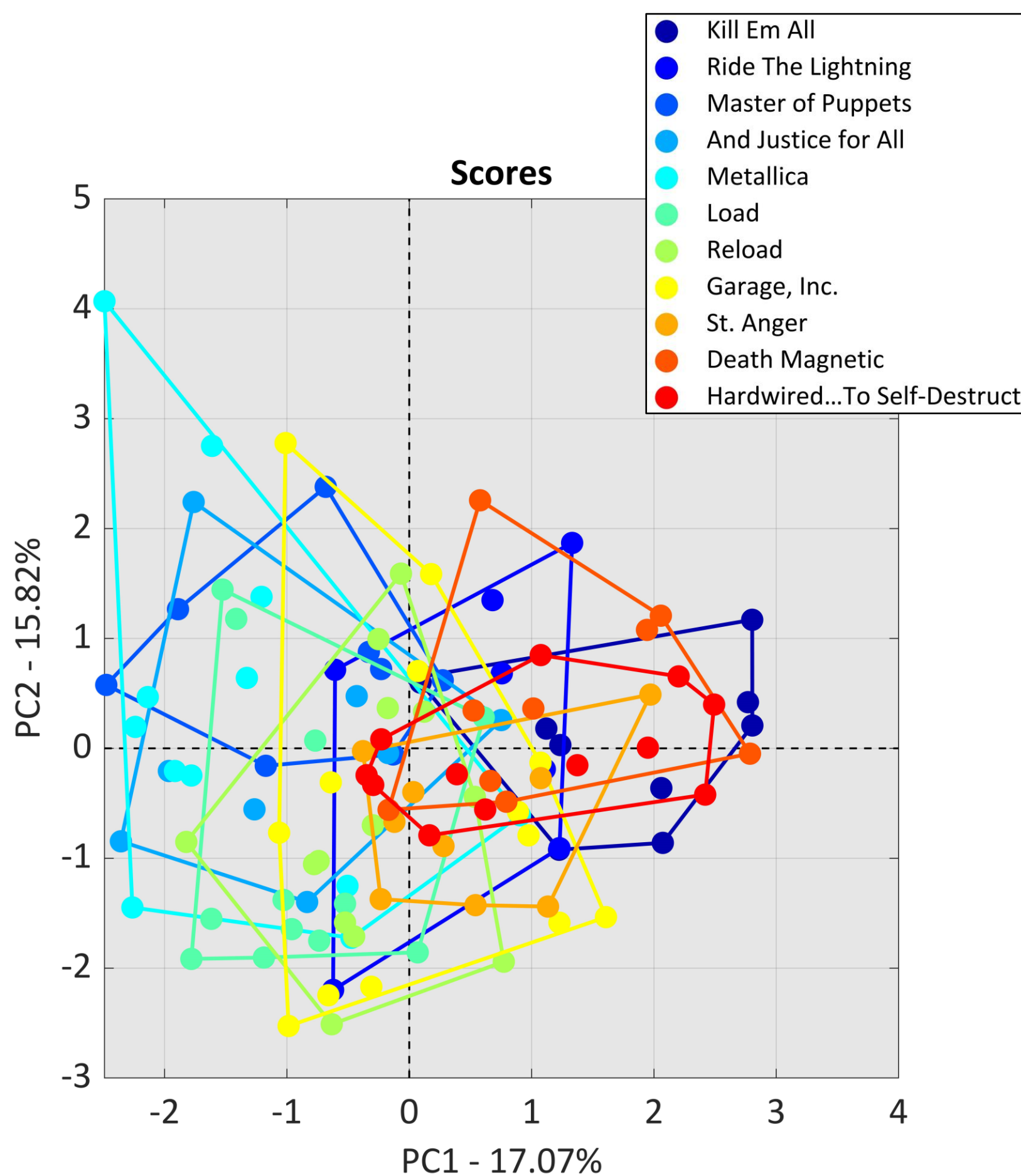
Why...not? We love Music and Chemometrics, and being both users and teachers we strive to find different ways of explaining the latter to the students!

So, we want to take a more "relatable" approach at explaining PCA, by trying to answer a real-world question which kept many metal fans awake at night:

Has Metallica come back to metal in their last albums?

To do so, we used the Music4All dataset [1], and modelled the following parameters: Popularity, Danceability, Energy, Key, Mode, Valence, Tempo, Duration.

[1] I. A. P. Santana, F. Pinhelli, J. Donini, L. Catharin, R. B. Mangolin, Y. Maldonado, G. da Costa, V. D. Feltrim, M. A. Domingues. Music4All: A New Music Database and its Applications. In: 27th International Conference on Systems, Signals and Image Processing (IWSSIP 2020), 2020, Niterói, Brazil. p. 1-6.



In this PCA we are looking at Metallica's production along the years.

The scores plot on the left contains all Metallica's songs, and the colored groups correspond to the different albums, ordered in time (year or release).

To answer question #1: it is very clear that Metallica has come back to their roots, with the first (*Kill Em All*) and last (*Hardwired...To Self-Destruct*) album.

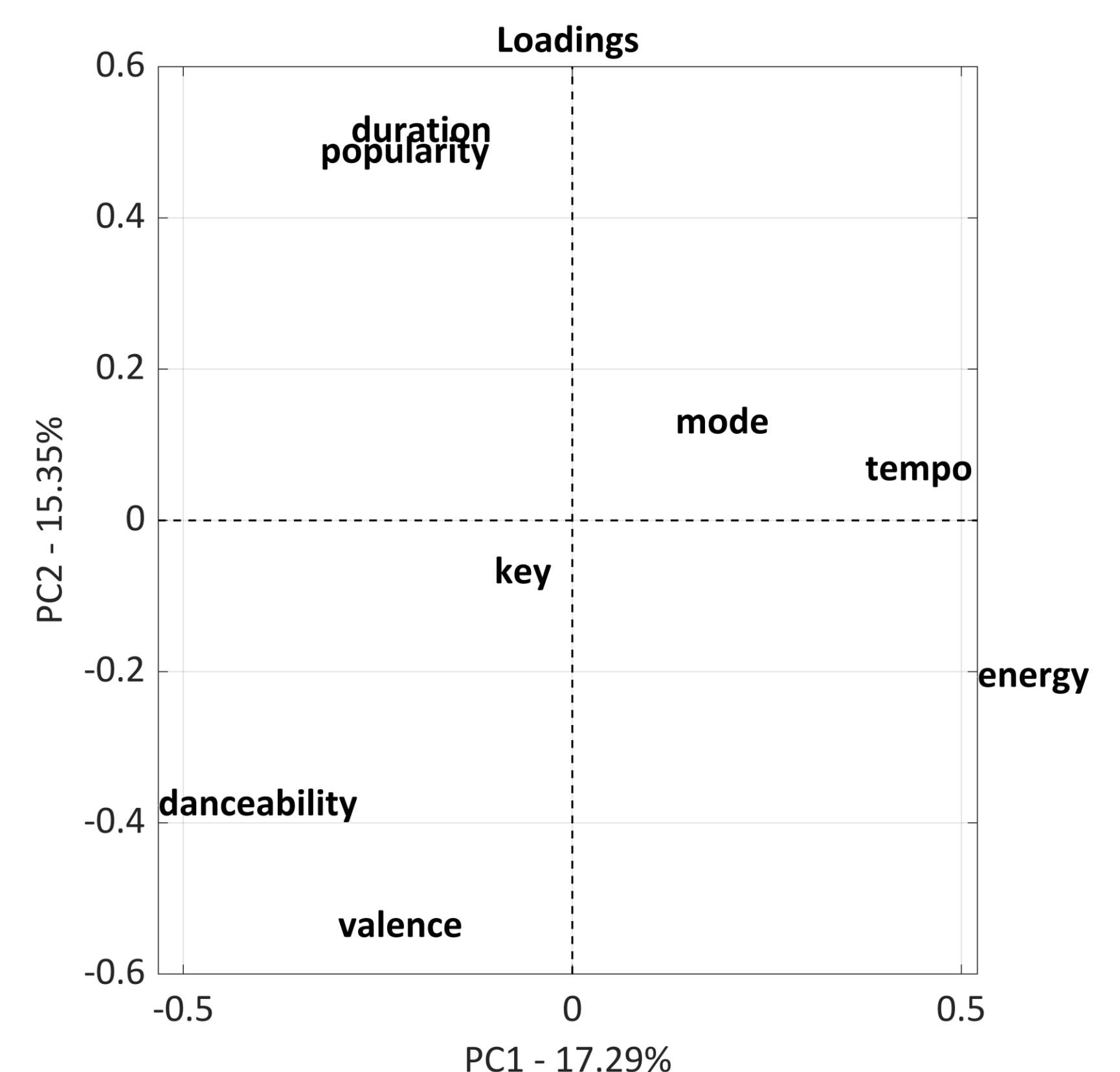
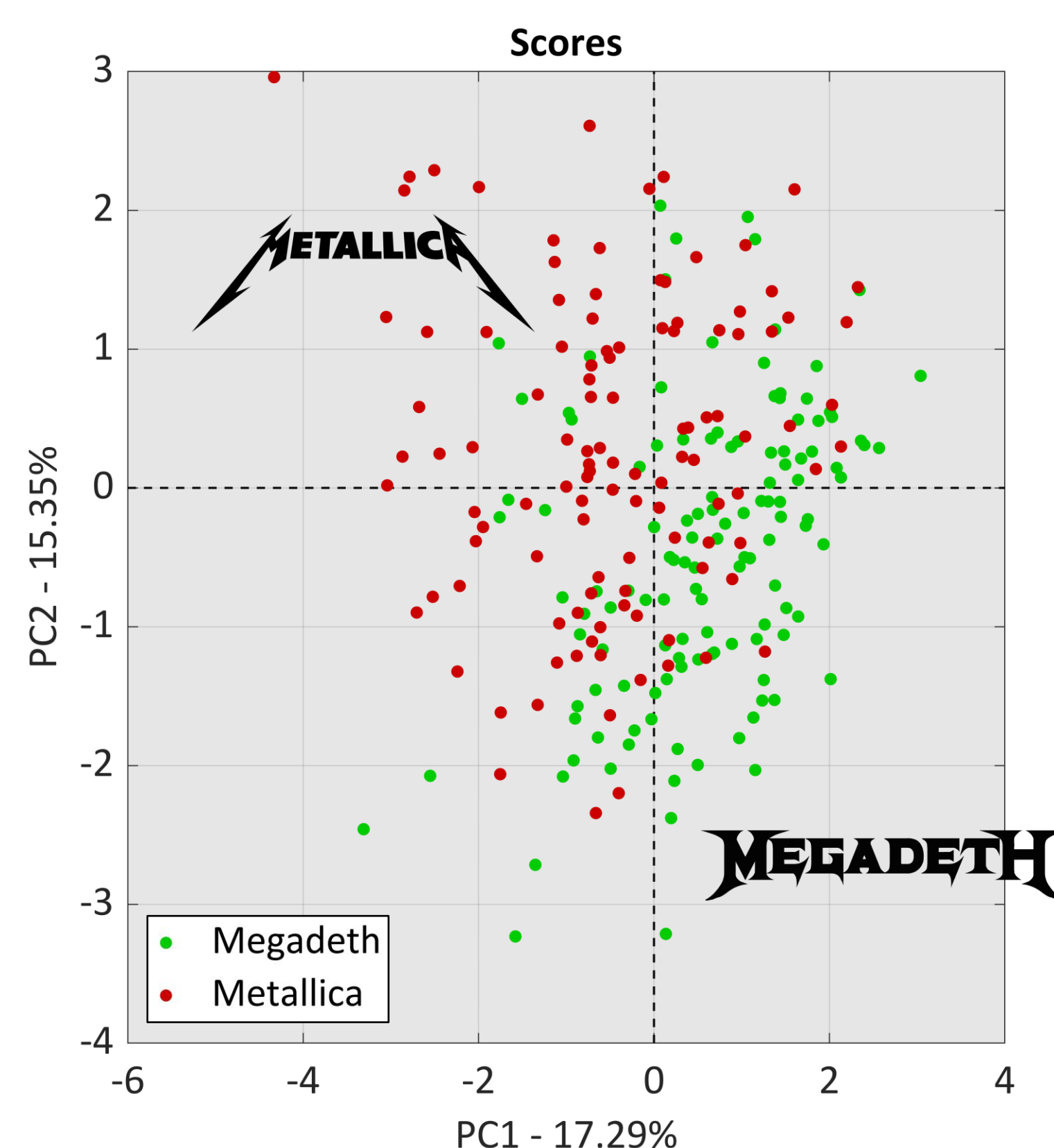
PC1 and PC2 provide this information: the first albums had faster tempo and energy. Then Metallica moved to more "danceable" (mainstream?) songs but with the last two albums came back to **METAL!!!**

METALLICA VS MEGADETH

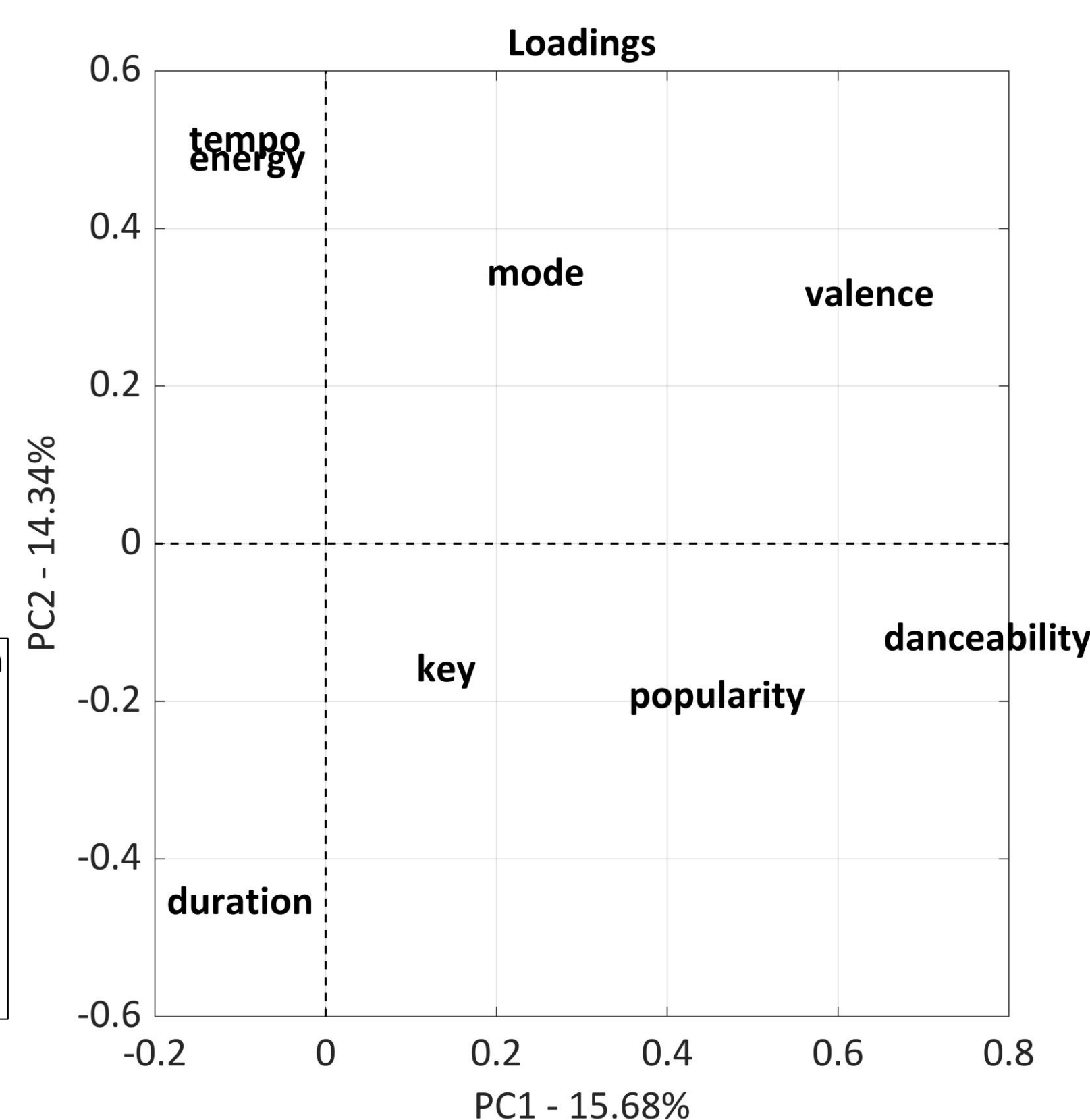
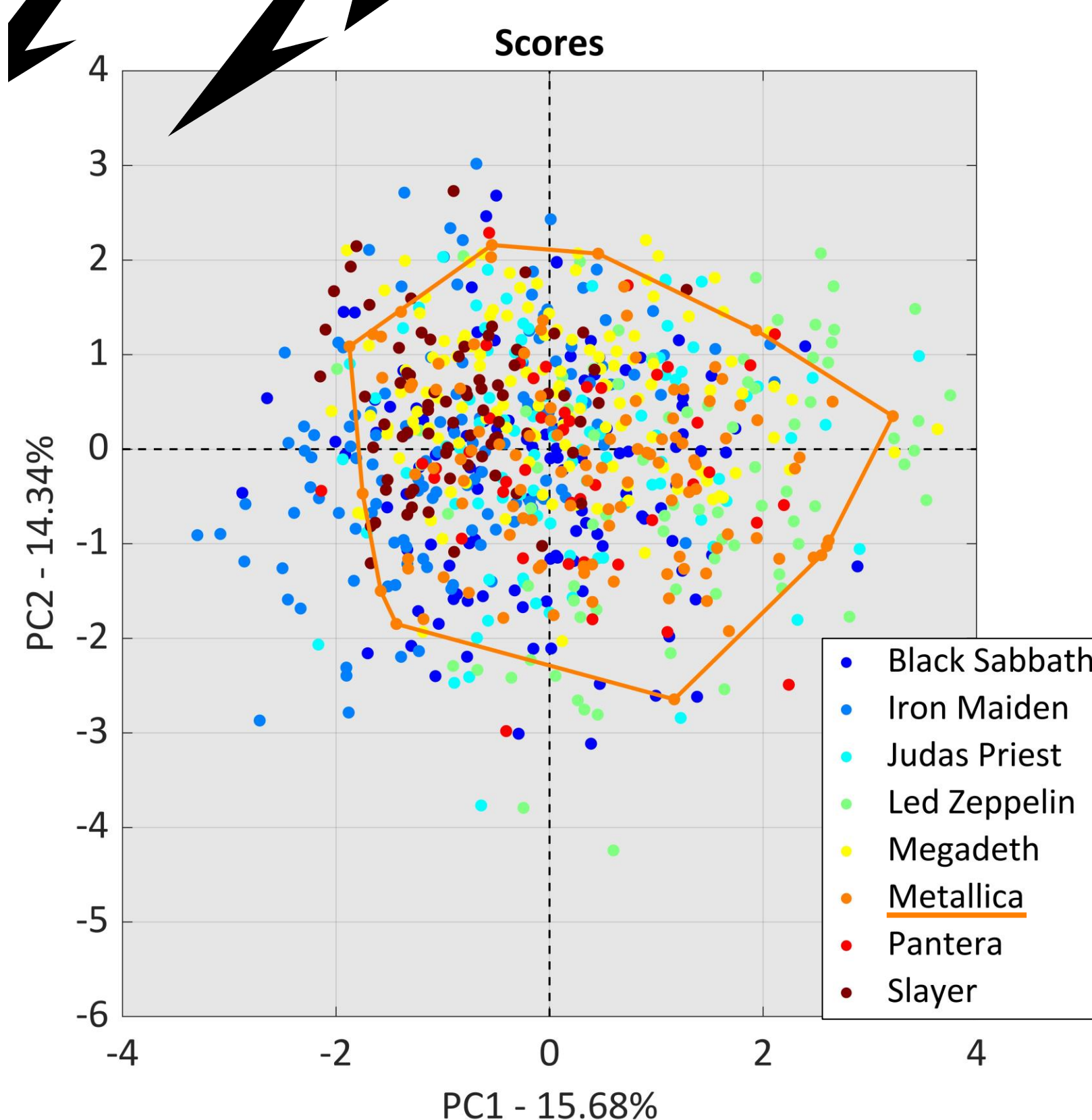
Always a war to find who was the fastest and strongest between Metallica and Megadeth! Here the answer: a PCA comparing them!

A clear diagonal trend appears, with Metallica in the top-left part of the scores and Megadeth opposite to that. This distribution is determined by variables such as "duration", "popularity" opposed to "tempo", "energy" (and, to some extent "valence").

Metallica appears to be more popular than Megadeth, and they also write longer songs, on average. Megadeth, on the other hand appear to write more positive songs ("valence") with stronger energy and faster tempos.



METALLICA THE BEST HARD-ROCK BAND?



What about a comparison among the 8 most important metal bands (according to ChatGPT, at least)?

All bands appear rather overlapped, with Metallica spanning the whole "metal space". We know that Metallica has tried producing music spanning different directions, also because of its period of activity, musical influences, success and willingness to do something new, every now and then.

It is not unexpected then to find them in a central position, with a slight imbalance towards the variables of "danceability" (which we can interpret as "chance of doing a headbanging"), "popularity" and "valence", thus evoking positive strong emotions in the listeners.

Conclusions: PCA rocks! What to say? In a world flooded with intelligent models, PCA is still the one to start with! Simple, straightforward and fast. Like metal! Teaching PCA must be a MUST! And here with music, but maybe with other data, you can teach new students what really matters!