Rhythm Sensing: Identifying Chronotypes and Sleep and Activity Rhythms from Passive Mobile Phone Data

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Every form of life on Earth is affected by the 24-hour cycle of day and night. Human physiology and behavior also follow near 24-hour routines called circadian rhythms [1]. One of the most important exhibitions of these rhythms is the sleep and wake cycles. Sleep and activity times are traditionally measured by means of questionnaires and personal logs. However, because of ubiquity of smartphones and the variety and number of tasks which are done using these devices, phone logs, which are biproduct of different tasks and processes completed on phones, can be used to infer various behavioral aspects of their users, for example their sleep and activity parameters [2]. In this study, we use data from the Sensible DTU dataset, which has collected data from around 1000 university students for over a year [3]. We use the timestamps of the times phone screens turn on and off. We find that 1) based on these logs we can see clear (and distinct) individual activity patterns throughout the days and in different days of the week, which remain consistent across many weeks for each individual. 2) Based on the activity of all users we can extract 4 main activity patterns from the data using non-negative matrix factorization (Fig. 1). Each individual's activity pattern has different weights for each of the 4 main activity patterns (components). 3) Based on the weights on different components we cluster individuals into different groups. Specifically, we are able to label each individual with their chronotype (chronotype is a categorization of individuals based on their propensity to sleep at different hours of the day). Our results make it clear that chronotypes should not be seen as clear-cut lines that divide people into groups, but there is a spectrum of activity patterns. Future research could further explore sub-categories of individuals based on rhythms of different activity types.

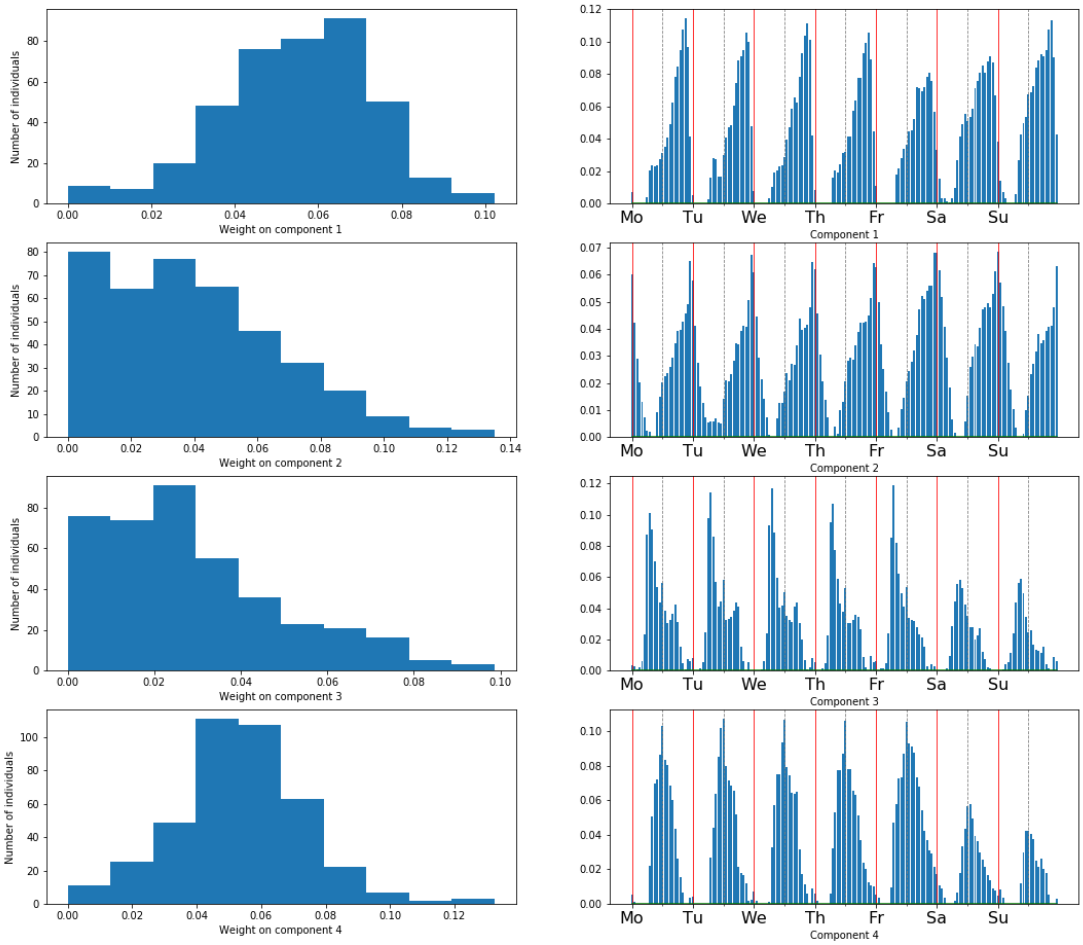

Figure 1: Right: The activity rhythm associated with each of the four components extracted by non-negative matrix factorization. The x-axis depicts a week divided into one-hour time bins. Left: Distribution of individuals activity rhythms' weights on each of the four components extracted by non-negative matrix factorization.

References

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