Report Blend Art And Data To Empower Habits Tracking

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***Abstract*—A sleep diary contains the registration of various sleep data. There are different kind of sleep diaries depending on the variables they contain and therefore on their final purpose. It is a reliable tool for tracking sleep habits like actual sleep duration, the interruption of it and many other parameters that could help the diagnosis of some pathologies. Another use of sleep diaries is to prepare patients for some specific studies: a sleep diary can increase the validity of the sleep test showing that a person's sleep is stable in the pre-study period.**

I. Introduction

As already mentioned, people often suffer from sleeping sickness without even knowing it, but always having disturbed and irregular sleep so this could have repercussions on everyday life. Being reliable and above all objective, a sleep diary can become the key to diagnose those diseases. After recording the necessary parameters, it is important to know how to interpret them and therefore to have an overall and intuitive view of the data. In fact, the purpose of this project is to improve the graphical interface of a sleep diary making the result easier to understand. I was provided with an excel dataset which contains all the values of 16 parameters with the respective date of registration and using the python language, I have implemented some graphics: in this way I obtained a better visualization making it easier to analyze the trend of sleep habits and thus be able to see the presence of any anomalies that could be consequence of sleep pathologies.

II. Implementation

A. Tools

For the implementation of the interface, I used python programming language. I had to install and import several libraries:

- Pandas: to import and process the excel file.
- Numpy: to handle arrays.
- Matplotlib: to plot the elaborated graphs.
- Datetime module: to calculate and to manipulate hours and dates.

B. Data processing

First, I asked the user for the name of the excel file so that the program could also be used for dataset with the same format: data placed in chronological order containing the values over a year of the following 17 parameters:

- Date
- Minutes of nap
- Time the patient went to bed
- Time the patient turned off the light
- How quickly the patient fell asleep since the light was turned off
- Expected waking time
- Actual waking time
- Time when the patient gets out of bed
- How many times did the patient wake up during the night
- How many minutes did the patient stay awake during the night
- Sleep disturbance level (from 1 to 10)
- Sleep quality level (from 1 to 10)
- Fatigue level (from 1 to 10)
- Level of sleepiness (from 1 to 10)
- Activity goal (registered by the polar device)
- Actual sleep (registered by the polar device)
- Sleep continuity (registered by the polar device)

Considering that there were different types of data in the 'Date' dataset column (in my case string and datetime), I made everything more homogeneous by converting all into datetime.dates.

To have a better visualization of data, I decided to calculate and make the bar plot of the monthly average instead of the daily values. In this way I obtained a cleaner and more understandable graphical interface for the parameter analysis. With this purpose, therefore, I constructed a vector that would contain the days of each month of the year under consideration so that for each dataset entered, any leap years would not have given problems. Furthermore, to get an overall idea of the patient's rhythms, I also graphed the annual averages of each parameter considered. As regards the polar indices, since some days the device may not have measured anything, there could be missing values in the dataset. To eliminate this problem, I decided to delete the rows corresponding to any of these missing values and make the graph with only the values measured: it shows the monthly averages and tells the user how many days the device has not detected anything and consequently how many samples has been deleted from the dataset.

C. Elaboration of the graphs

1) Hours of sleep or in bed: Sleep appears to be a vital element for general health and well-being. In fact, fundamental factor for sleep analysis is the amount of hours the patient sleeps. However, research states that each of us has a different need of sleeping hours; the number of hours varies according to age, lifestyle and health conditions of each person. Knowing this, we can understand that the well-being of the individual in a given period of life is important and that his sleeping

requirement is met throughout the year. If the analysis shows that the patient has often maintained his hours of sleep around a certain average, and that this trend favors his general well-being, it can be said that he maintains a regular sleep rhythm, consistent with his needs, which are absolutely personal. Furthermore, I estimated and put on the same graph the time spent in bed, so that could be seen the time spent in bed without sleeping: if this difference is too wide, it could be a symptom of insomnia or physical fatigue.

2) Minutes taken to fall asleep: According to some studies, the minutes it takes to fall asleep are extremely important: the normal time it takes most people to fall asleep at night is between 10 and 20 minutes. Of course, there are certain nights this time may be more or less, but for example if the patient falls asleep too quickly, there may be an underlying issue to consider like sleep deprivation. Also, if it often takes beyond a half hour, it has been proved that his sleep quality will decrease. To visualize this factor, I used the bar plot of the provided data 'Minutes taken to fall asleep', highlighting the right range of values.

3) Polar indices: Another important parameter is the number of times the subject wakes up during the night. In fact, I graphed it because it could be helpful to see any recurring discontinuity. Excessive sleep discontinuity can cause daytime sleepiness and be symptom of pathologies like obstructive sleep apnea or thyroid hyperactivity: research proved that high blood concentration of thyroid hormones interfere with the time it takes to fall asleep and the ability to stay asleep.

With the aim of analyzing this factor, the dataset also shows 'Actual sleep' and 'Sleep continuity' which are indices provided by the polar device: the first one is a percentage that compares the actual sleep with the sleep time. More specifically, the more time the patient spends awake after falling asleep, the lower his actual sleep percentage is. 'Sleep continuity' also describes how continuous the sleep is: it is assessed on a scale 1-5, where 5 reflects very continuous sleep while the lower the value the more fragmented the sleep is. Values between 3 and 5 are considered good, therefore I graphed this range so that can be seen immediately how much good the sleep was.

An adequate physical activity is fundamental for the patient's physical well-being. In fact, in the dataset format is also present the variable 'Activity goal': polar devices give the costumer an activity goal each day and guide him in reaching it. The activity goal in the polar device is shown as a bar that gradually fills to show how close the patient is to his goal, while in my graph I used percentage values so if the bar plot reaches the values 1, the patient has reached his goal.

4) Delay in waking up: I considered important to analyze how much the subject respected the expected waking time: it can be an indicator of excessive sleepiness and eventually a non-compliance with the sleep needs. I estimated and printed on the screen in a bar plot the difference between the expected awakening time and the time the subject actually woke up (negative values are displayed if he woke up before the expected time).

5) Patient's well-being: The patient's impressions of sleep quality, sleep disturbance, fatigue and level of sleepiness during the day are also important: disturbed sleep or excessive fatigue affect normal activities. Monitoring these factors using graphs, can therefore help the patient to improve his sleep habits and consequently his daily life.

D. Results and conclusions

I used the methods of analysis I described to observe the daily trends of a patient. In the dataset I was provided with, the year taken in consideration is 2020. Here are the graphs of all the parameters mentioned above.

In the bar plot of the patient's sleep hours (Fig. 1), it can be seen that on average he sleeps about 7 hours and that he tends to remain close to this value throughout the year. This is a sign that the person is maintaining a regular pace and most likely in accordance with his needs. Then we can notice in the same graph, how much he remained in bed without sleeping. Observing the data it is possible to say that he remains within normal values even if clearly irregular, probably due to various factors such as environmental, physical and mental conditions.

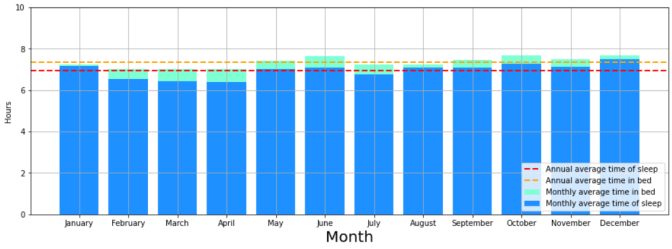

Fig. 1. Comparison of sleeping hours and hours spent in bed.

Observing now the minutes taken to fall asleep (Fig. 2), we can see that the subject always remains above the lower limit of the correct range and well below the upper limit. Also here we can see irregularities due to the patient's particular conditions in a certain period of the year.

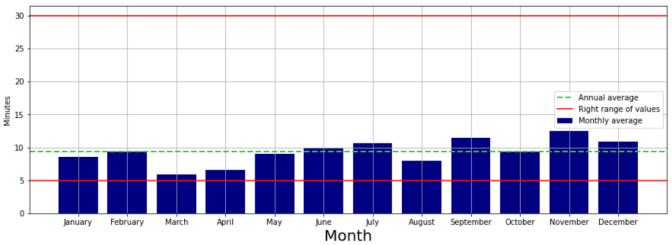

Fig. 2. Minutes taken to fall asleep.

Let's see then his sleep continuity. We can see that on average he tends not to wake up so many times during the night (Fig. 3). In confirmation of this, in fact, the percentage of actual sleep (Fig. 4), remains at about 90% throughout the year.

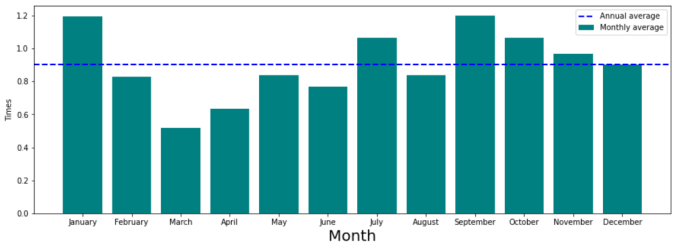

Fig. 3. How many times did the patient wake up.

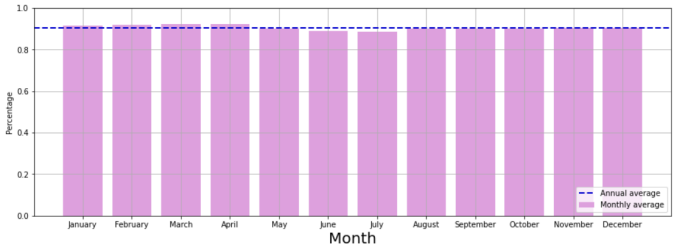

Fig. 4. Actual sleep.

However, the sleep continuity index signals a problem (Fig. 5) since I have obtained values that almost always remain below the lower limit. So, the patient does not have excellent sleep continuity.

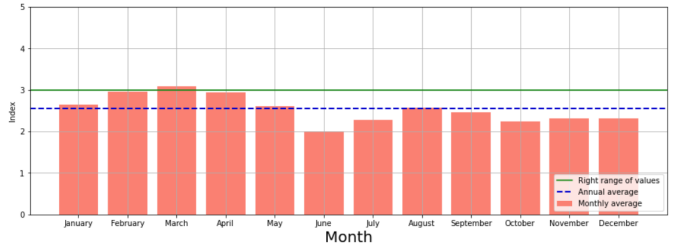

Fig. 5. Sleep continuity.

It is likely that the evaluation of the sleep quality (Fig. 6) provided by the patient is a consequence of these slight irregularities during the night: the sleep quality index remains high but not excessively. The same thing is true for the sleep disturbance level; it does not reach high values but on average it remains around 2, which indicates a situation that is not serious but, in any case, not perfect.

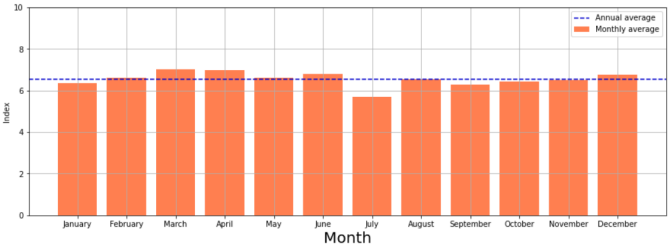

Fig. 6. Sleep quality.

Then if we analyze the delay in waking up, it can be seen low values but at the same time huge irregularities during the year (Fig. 7). However, looking at the other graphs, since they indicate a general well-being of the subject, I cannot conclude that he is not respecting his sleep needs. Probably this irregularity is due to environmental factors such as hours of light or even different workloads and therefore different mental conditions in different periods of the year.

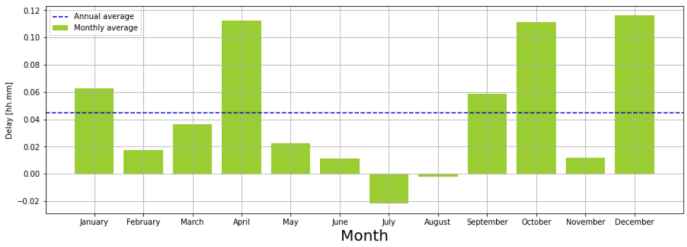

Fig. 7. Delay in waking up.

Eventually, for the patient's daily conditions, we need to look at the fatigue (Fig. 8) and sleepiness (Fig. 9) graphs. In addition, it is also important to evaluate his activity goal to see how sedentary he is and how much this affects his rhythms. In this case, I obtained normal levels, however also dictated by the patient's daily load, and if we focus on the activity goal graph, we can see that on average he has largely exceeded his daily goal.

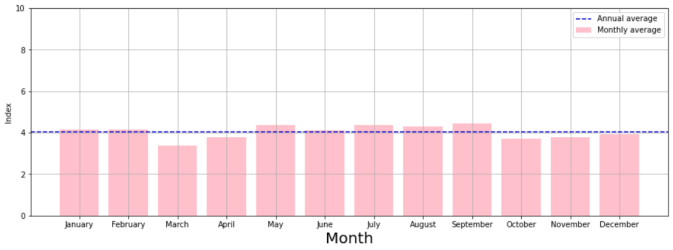

Fig. 8. Fatigue level.

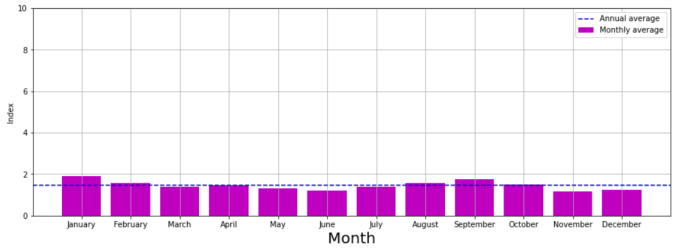

Fig. 9. Sleepiness level.

I can therefore conclude that the patient I have analyzed has an almost regular rhythm that is consistent with his physical and mental needs. The only factor that could be improved is the continuity of sleep: studies advise in the evening before falling asleep to limit exposure to blue light, not to take exciting drinks or alcohol and to optimize the environment in which you sleep.