Suicidal Tendency Among Schizophrenia-Diagnosed Patients

Haim Lavi, 038712105

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Abstract

In this paper, I shall analyze a dataset from Turkey, containing different features on people who are either diagnosed or not diagnosed as having Schizophrenia. Although there is much to study from this dataset about the disease itself, I shall concentrate in Schizophrenia-diagnosed people, and their tendency to attempt to commit suicide. I shall use unsupervised learning methods to find general patterns in the data, and by these patterns I will be able to identify this particular feature (suicide attempt), and I will try to check if it has any statistical relation to other features, or it stands by itself.

1 Introduction

1.1 General Explanation

Schizophrenia is a serious mental illness that affects the patient and disables him or her from performing as a fully capable valid person. The question of why someone has Schizophrenia does not always have a decisive answer, because there are many factors that can cause this situation, genetic and environmental. Research in this field can help find helpful ways to tackle this harsh situation, because, if we find several factors which are statistically observed as common among people who have Schizophrenia, especially if we find the most common ones, then neutralizing some of these factors can help in preventing the abruption of this mental condition. Another major question, which I shall concentrate in, is, when we have a patient diagnosed with Schizophrenia, what must we consider regarding his or her own personal safety and well-being, and specifically the danger of the patient taking his or her own life, and preventing it.

1.2 This Paper Research

I have found in Kaggle a dataset containing data collected among people in Turkey. The dataset contains several data features that I would like to divide to three categories:

1. Features that are basic to any research on human beings, such as age and gender.
2. Features that directly correspond to the subject of Schizophrenia, above all is the diagnosis itself (diagnosed / not diagnosed as Schizophrenic), as well as mental and behavioral tests.
3. Physical / Behavioral / Environmental features, that are suspected or known as factors for Schizophrenia, whether their influence is positive (having more of) or negative (having less of).

By finding patterns and ties between these features, we may extract important information regarding Schizophrenia, its origins and ways of treatment, and also awaken new and interesting questions, such as the one I hereby present.

1.3 Question of Study

One major question, regarding people diagnosed as Schizophrenic, is whether they are suicidal or not. The danger of having a person committing suicide can dictate the use of extreme safety measures, such as using heavy drugs or straitjackets. But if we can identify features that distinguish between different people who have Schizophrenia, we can avoid using those measures, and keep them only for people

who share features that are highly related to being suicidal. For instance, since committing suicide is an act of self-violence, we would expect this to be less common in females than in males, or we would expect this more in younger people rather than the matured population. Also, we can expect this to be more common in people who are addicted to drugs, which usually increase the violent tendencies of the person consuming them. This question arose directly from the unsupervised data analysis, as shall be explained later.

2 Methods

2.1 Dimensionality Reduction

I used three methods for the reduction of dimensionality.

1. PCA
2. t-SNE
3. UMAP

2.2 Clustering

I used three methods for clustering.

1. K-Means
2. DBSCAN
3. Gaussian Mixture

For methods that are given the expected number of clusters, I have iterated over a range of possible numbers, calculating the silhouette score on each iteration, and updating a stored value of the maximum score. While the minimum number of clusters is naturally 2, the maximum number is a matter of guessing.

For the DBSCAN algorithm, which is not based on calculating centroids, I have used the same parameter for calculating the epsilon parameter, by a heuristic function which divides the total area of the set of data points by this increasing factor, yielding a decreasing set of distances, which are used as the epsilon input parameter.

2.3 Statistical Tests

For the categorical variables I used the χ^2 test, while for the quantitative variables I used t-test, as shall be explained in the results part and the following remarks.

2.4 Remarks

1. Default Parameters

   Basically, I avoided altering the default parameters in all the algorithms that I used, because I assume that the defaults given by the package developers are usually the optimal. Indeed, the results that I got, both visually and by the Silhouette scoring, appear to be quite sufficient for this study. Moreover, for each dimensionality reduction method, I got very similar, if not almost identical, results for the different clustering methods, and this forms a sort of indication that the clustering achieved, at least by using standard methods, is optimal.

2. Columns to Drop

   Many datasets, including the dataset I was working with, have columns that do not carry any real measurable data, specifically the numeric identifier of the data points, usually it will be the first column. Such columns are not only irrelevant for our analysis, they also add noise, and in order to avoid using them in the process of learning, I added an optional input parameter to the process, telling it to drop specific columns.

3. Pivot Columns

   As mentioned earlier, our dataset contains features that are directly related to the subject of our study, meaning the diagnosis and the behavioral tests that support it. Thus, it would be useful to identify a particular column, in our case the diagnosis, and use it as the pivot of our research, since, for this particular question we are studying, we want to find ties (or strict differences) between the features that are common among people who are diagnosed as Schizophrenic. For this purpose, I also added an optional input parameter. As a side effect of this, there is the next remark.

4. Cluster Visualization

   Looking at different examples, there seems to be a tendency to visualize the different clusters using different colors. However, I found that it would be useful for my analysis to visualize the index (cluster label) of each cluster, next to the middle point of the cluster, while using different colors to visualize the value of the pivot column, as mentioned in the previous remark.

5. Statistical Tests

   In this paper, and the accompanying code, I use the t-test for quantitative variables, since my choice of optimal clustering goes with the method that yields only two distinguished clusters for the population diagnosed with schizophrenia. However, while preparing this paper and code, I made some statistical tests on a higher number of clusters, using the One-way ANOVA test, and therefore the code basically supports both tests (simply by checking if the number of clusters is 2 or more).

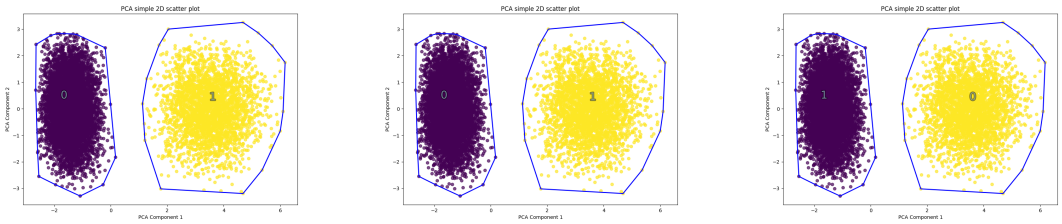
6. Language Barrier

   As specified above, the dataset was collected among people in Turkey. This means that the names of the columns are in Turkish. I have added a small mechanism to tackle this (after trying to add a dynamic call to Google Translate API, with no success), simply by preparing a .csv translation file, and have the code read it and substitute the Turkish names with the English names.

3 Results

3.1 PCA

I ran the PCA algorithm, as a classic method for reduction of dimensionality from the high dimension to 2 dimensions. Clustering, in this case, was quite immediate, since the data is divided in two distinguished bulks, separated along the x-axis (the highest significant dimension), where each bulk of the two assumes the general shape of an ellipse, having the y-radius measure longer than the x-radius. For the case of PCA, all the clustering methods that I used yield the same amount of clusters (2), which is the minimum, with relatively high silhouette scores. The advantage of using PCA for this dataset, even though it does not expose a rich structure of the data, is that it shows the general division of the data. Using the Diagnosis column as a pivot, we obtain a clear image of the separation between the two groups of people who are, or are not, diagnosed with Schizophrenia.

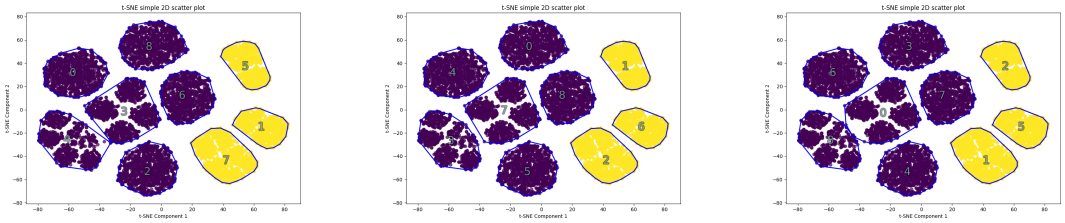


(a) PCA K-Means (b) PCA DBSCAN (c) PCA Gaussian Mixture

Figure 1: PCA

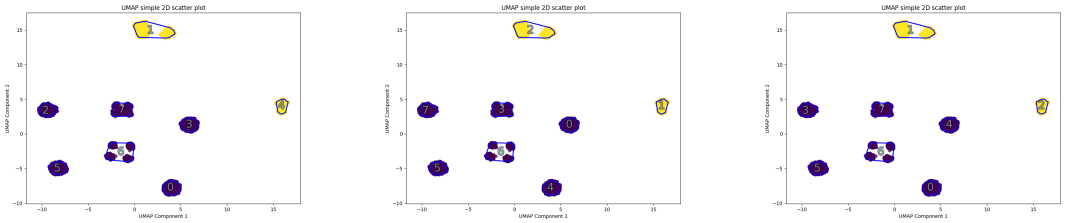
3.2 t-SNE and UMAP

Due to the nature of t-SNE and UMAP, and their significant difference from the PCA algorithm, I managed to get a finer clustering of the data by using them. By using the Diagnosis as a pivot column, we observe that both populations, the people who are diagnosed with and without Schizophrenia, have inner divisions of their data to separate clusters. Even though the Silhouette scores of the t-SNE clusters are quite lower than those of the clusters that are generated by the UMAP algorithm, they look to the eye as preserving a somewhat similar formation of clusters and neighboring ties (though we have some warping in space between the two sets of clusters obtained by these two algorithms, and some of the t-SNE and UMAP clusters are clearly divided to smaller inner clusters which we do not identify through the clustering algorithms that we use).



(a) t-SNE K-Means (b) t-SNE DBSCAN (c) t-SNE Gaussian Mixture

Figure 2: t-SNE



(a) UMAP K-Means (b) UMAP DBSCAN (c) UMAP Gaussian Mixture

Figure 3: UMAP

The best results achieved by these algorithms are presented in the following table.

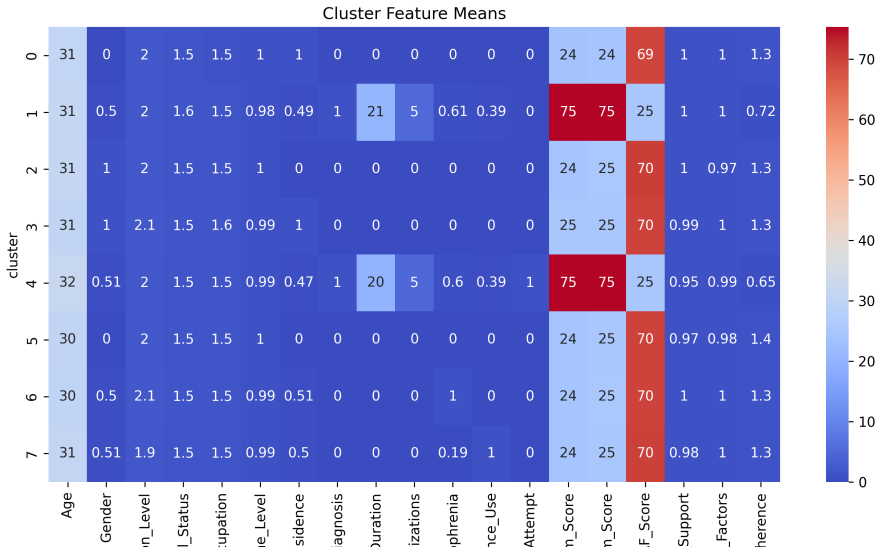
Reducer	Clustering Method	Optimal K	Highest Score
PCA	KMeans	2	0.7203
PCA	DBSCAN	2	0.7203
PCA	GaussianMixture	2	0.7203
t-SNE	KMeans	9	0.5343
t-SNE	DBSCAN	9	0.5343
t-SNE	GaussianMixture	9	0.5338
UMAP	KMeans	8	0.8477
UMAP	DBSCAN	8	0.8477
UMAP	GaussianMixture	8	0.8477

Table 1: Comparison of Dimensionality Reduction and Clustering Methods

3.3 Optimal Results

As can be seen in the results table, the optimal method, according to the Silhouette score, is UMAP, with either of the three used clustering methods, while it may seem to the eye that we get slightly

better results by using the t-SNE method, as can be seen in the table and from the figures above. This emphasizes the fact that unsupervised learning can be analyzed in different ways, and different patterns and ties can be found with each of them. For this paper, I prefer to stick with the division to clusters which is considered the optimal by the Silhouette score. For an easier analysis of the data, we can display the best results in a heatmap, where we display the means of all the features, for each cluster, and observe the similarities and differences between the clusters.



(a) heatmap for UMAP

We can clearly observe from the heatmap that the subject-oriented columns (Diagnosis and the three behavioral scores) form a strong distinction between the two populations, the diagnosed people, and the people who are not diagnosed. This can lead us to working on different questions. What got my eye was the difference between the two clusters of diagnosed people, namely 1 and 4 (since the scores for all the clusters of the UMAP algorithm are the same, we randomly pick the K-Means clustering, so we can see the indexed clusters in the UMAP K-Means image above). As it appears, the only significant difference between these two clusters is in the suicide attempt column, which says, if we can prove it statistically, that **other features, existing in this dataset, do not influence the suicidal tendency of the diagnosed person**, which can lead to the harsh conclusion, that Schizophrenic people may attempt to commit suicide, or avoid this, regardless of other parameters, such as the group in population they belong to (male/female, young/old etc.), or their environmental and genetic factors (family history, stress factors, social support etc.), thus being a substantial challenge for the mental health teams taking care of them. Using the χ^2 for categorical variables (which are the majority of the variables in this dataset) and t-test for variables such as gender, duration of disease etc., we do establish the above observation through statistical tests, as shown in the following table.

Variable	p-value
Age	0.3404
Gender	0.6780
Education Level	0.1944
Marital Status	0.3908
Occupation	0.1858
Income Level	0.7828
Place of Residence	0.3524
Substance Use	0.8901
Social Support	0.1099
Stress Factors	0.7110
Family History of Schizophrenia	0.8858
Number of Hospitalizations	0.6519
Disease Duration	0.0761

Table 2: p-values for each variable comparing between clusters.

Taking 0.05 as the magic value for p in statistical tests, we can see that none of our columns p-values has managed to pass the test, that is to say, if H_0 is that $\mu_0[\text{column}] = \mu_1[\text{column}]$, where $\mu_0[\text{column}]$ is the mean of the particular column among patients who did not make an attempt to commit suicide, and $\mu_1[\text{column}]$ is the mean among patients who did make an attempt, and H_a is that $\mu_0[\text{column}] \neq \mu_1[\text{column}]$, then it is safe to say that H_0 holds for all cases. However, it would be wise to pay attention to relatively small values, particularly values that are rather close to 0.05, such as the Disease Duration column.

3.4 Answer to Question

As already stated in the previous paragraph, this unsupervised learning analysis is showing that statistically, there is no obvious relation between any of the features that were collected in this study and the suicidal tendency of a Schizophrenia-diagnosed individual.

4 Discussion

I have shown that the suicidal tendency among the Schizophrenia-diagnosed people in this dataset seems to stand by itself, and is not significantly affected by most other features of the patients. While the wide subject of Schizophrenia, and mental diseases in general, has almost no limit to the amount of data that can be collected and studied, I would like to concentrate, for this part as well, in the specific subject of suicidal tendency, and suggest a few more features and tests that can be made, in order to both predict, and to avoid, the possible attempt of a Schizophrenic person to commit suicide.

1. Religion

   I would suggest any research team in this field to ask also about the level of religious tendency among people who participate in this research (Atheist/Secular/Traditional/Religious/Ultra-Religious etc.), because religion gives a meaning and purpose in life to its believers, and also because most known religions consider suicide a sin. Thus, if we prove that religion is a statistically-proven factor that influences suicidal tendency, we may encourage the help of the religious institutions in offering Schizophrenia patients comfort and help.

2. Environmental Stimulations

   I could recommend also asking about the patients reactions to different sounds (silence/sounds of the nature/soft music/loud music/comedy skits/news broadcasts etc.), or sights, smells etc., because this can also serve as a positive or negative factor in the way a schizophrenic person feels and behaves. We may encourage the exposure of patients to external inputs of this nature which are found to be soothing and enjoyable, and prevent them from being exposed to negative inputs, such as irritating noises or disturbing images.

3. Nutrition and Sports

   Another feature that should be documented is the nutrition habits of the people who are diagnosed, or not diagnosed, as Schizophrenic, since it may have influence both on the disease itself, and on the tendency of someone to commit suicide. A proper diet, along with sport activities, are known to improve the life of an individual, and they cal also positively influence Schizophrenia patients, and help them avoid any negative and suicidal thoughts. This would lead also to including nutrition and sport habits as informative features for this study.

There are many other factors that can influence this condition, and all should be studied, for the benefit of the population, but I only stated a few of them which I find particularly influencing.

5 Links

git repository: https://github.com/HaimL76/unsupervised.git
overleaf project: https://www.overleaf.com/read/dyrnjnxdkbkf#908474
executable file: https://drive.google.com/file/d/1J-hOjCndZ0Q3PCy5jHOU1jL5xxLNBAiU/view?usp=sharing

References

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[4] https://www.geeksforgeeks.org/gaussian-mixture-model/

[5] https://keydifferences.com/difference-between-t-test-and-anova.html