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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGIES - BITOLA
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Introduction

The International conference on Applied Internet and Information Technologies is a traditional meeting held every year, that sprouts out of collaboration between the University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin, Serbia and the University "St. Kliment Ohridski", Faculty of Information and Communication Technologies - Bitola, Republic of North Macedonia. The XIII AIIT2023 was held in Bitola, Macedonia on which besides the participants from Serbia and Macedonia there were researchers from Croatia, Bosnia and Herzegovina, Hungary, Finland, Russia, Turkey, Egypt, India and Australia whose contribution was either as authors or as reviewers of the papers.

At the Conference were presented innovative findings in the field of information systems, communications and computer networks, software engineering and applications, data science and big data technologies, artificial intelligence, intelligent systems, business intelligence and IT support to decision-making, data and system security, distributed systems, Internet of Things and smart systems, embedded systems, computer graphics, IT management, e-commerce, e-government, e-education, Internet marketing, and IT practice and experience.

The Conference chairs would like to express gratitude to the authors for their contributions and to express special gratitude to the reviewers for their tremendous work done for selecting the papers with their valuable comments and suggestions that contributed to improve the quality of the papers. Out of more than 60 submitted papers, 51 were selected, presented at the Conference and are published in this proceedings.

The work during the conference was organized in nine sessions: plenary session, five in-person oral sessions, one video session and two poster sessions. During the conference, a round table with participants from academic organizations and IT industry was successfully organized. The theme of the discussions at the round table was "Strengthening the capacities of Faculty of ICT for the realization of strategic cooperation with companies from the IT industry".

AIIT 2023 was very successful conference with fruitful exchange of experiences among the participants reviving the hope of further strengthening a friendly environment after the pandemic crisis. We hope that we will continue with the contribution to the further deepening the development of Internet and information technologies research.

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Kostandina Veljanovska, Ph.D. finished BSc in Computer Science at the University "Sts. Kiril i Metodi", Skopje. Her first MASc in Applied Engineering she received at the University of Toronto, Toronto, Canada. Her second MSc and also her PhD in Technical Sciences she received at the University “St. Kliment Ohridski” - Bitola, R. Macedonia. Her postdoctoral studies in Artificial Intelligence she attended at the Laboratory of Informatics, Robotics and Microelectronics at the University of Montpellier, Montpellier, France. She worked as a Research assistant at the Faculty of Applied Science, University of Toronto, Canada. She also, worked as a researcher in research team for Constraints, Learning and Agents at LIRMM, University of Montpellier. Since 2008, she works as a Full Professor in Information Systems and Networks, Artificial Intelligence and Systems and Data Processing at the Faculty of Information and Communication Technologies, University “St. Kliment Ohridski” - Bitola, Rebublic of North Macedonia. Her research work is focused on artificial intelligence, machine learning techniques and intelligent systems. She has published numerous scientific papers in the area of interest, as well as several monographic items. She is a reviewing referee for well-known publishing house, journals with significant impact factor in science and also, member of editorial board of several international conferences.

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Data Mining and Big Data Analytics Using Accelerate Data

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Abstract:
The use of smart phones has become increasingly prevalent, with nearly every individual carrying either in their hand or pocket, making it an integral part of their daily lives. Furthermore, the quantity of sensors integrated within the smart phone is constantly expanding. Through this integration within the Smartphone, it is presented the opportunity to utilize the Smartphone for more than just communication purposes presented. One of the sensors incorporated within the Smartphone is also an accelerometer sensor, which has found significant application in various industries, greatly enhancing the quality of life. In this paper, we will present an implementation of a mobile application for collecting data utilizing using accelerometer sensor. Here is an overview of the architecture and technology used in the development of this application. Subsequently, it presents the delve into the data analysis process and utilizes the R programming language for the collected data that was collected. Diverse functions and algorithms have been employed in the data analysis such as dbScan, Extrascan, and other custom functions for step counting of walking, running, counting floors while going upstairs/downstairs.

Keywords:
Accelerometer sensor, MongoDB, dbScan, kNN, clustering algorithms

1. Introduction

The number of Smartphone users is increasingly prevalent. In the previous year, there were 6.4 billion worldwide Smartphone users' number of Smartphone users was 6.4 billion, and it is predicted that the number of Smartphone users is going to be increased to 7.7 billion which is an increase of 21 percent from 2022 [1].
In addition to various features already integrated into smart phones, sensors such as the GPS sensor, audio sensor, light sensors, directions sensor and accelerometer sensor and commonly found in these devices.

Our primary focus in this paper will revolve around the utilization of the accelerometer sensor. We will collect data from this sensor and conduct an in-depth analysis of the collected data. The application of this sensor has made significant contributions across various industries, greatly facilitating and improving the quality of life. This sensor can play a vital role in identifying the issue with roads, poetically reducing the cost of maintaining the service, while simultaneously enhancing the pedestrian and passengers' safety [2]. In relation to other research, collecting data from this sensor employed to promote health and well-being by generating various reports on activities such as daily, monthly, and weekly walking, running and upstairs and stairs activities [3]. Data generated from accelerometer sensor has been utility to analyses the characteristic of young individuals' alcohol consumption behavior [4]. As technology continues to advance, it reshapes the way it works, and this transformation in work patterns has given rise to modern challenges, including stress. To detect and measure the level of stress in the work environments, is employed an accelerometer sensor from a smart phone [5]. During the aging process, individuals may start to exhibit specific illnesses. Data generated from accelerometer sensors has been utilized to address issues related to failed detections in the elderly population. [6].

The data presented in this paper was collected from the accelerometer sensors of two distinct Android smart phones. Users generated this data while engaging in their daily activities within the living room. They created an Android application using Xamarin Forms which generate data and then send data in real-time. To enable communication in real time, it is build an API application using NodeJS, which received information through web socket from mobile app, and then saved data in MongoDB. Then, for saving this generated data is created a NoSQL database using MongoDB. For more details about this process it will be shown in next section below.

Following the data collected and its storage in MongoDB database, the next phase involves the analysis of this data. Data analysis has been done using R programming languages, by importing them from excel. In this process, various algorithms and custom functions are employed for analyzing the collected data. Initially, we will introduce the six basic functions. Subsequently, we utility algorithms such as: dbScan, ExtraScan, HDScan, knn, hullPlot and fuzzy logic. Additionally, other functions are applied to analyze count walking steps, running, going up/downstairs.

This work is presented in section such as: In section 2 it is presented Related work which utilized the acceleration smartphone sensor in different industry. In section 3 it is presented an application implementation to track accelerometer data from Mobile App in which is presented also the technology and minor for collection data. In section 4 it is presented the part of analyzing data using different function and algorithms with R programming language.

2. Related works

The author in [7], has presented the monitoring of structural integrity and safety under extreme and normal loads using big data products generated by sensors. The building structure and bridge health is presented while earthquakes happen. The seismic scale for frequency of amplitude is measured. There is a sinusoidal wave monitor table for smartphone testing. Also, there is a test comparing the accuracy of three different smartphones compared with reference data. For the test, there were used low- and high-vibration scales.

The objective of this research [2] is to detect the quality of asphalt and cobblestone while driving the vehicle without extra effort. The problem identification is separated into three levels, such as the level of identification of pavements, the level of classification of pavement is cobalt street or dirty road and the last is to detect if classification if pavement is speed bumps, vertical patches or raised markers and other types of asphalt-obstacles. The data has been collected from two different smartphone acceleration sensors, which were installed inside the vehicle using a flexible suction holder near the dashboard. The smartphone generates data with three axes and GPS while using an application called ‘Asfoult’.

The data was classified into two classes, such as: Regular and Deteriorate. The next classification is Asphalt pavement type: Cobblestone Street the Dirt Road. And the last one is to detect different types of obstacles in the street: (i) speed bump, (ii) vertical patch, (iii) raised pavement markers, and (iv) raised crosswalk. For classification is used 1NN algorithms and for measuring distance is used DTW, LCSS, DDDTW and DTDDTW.

In this research [3], the author has presented activity recognition using cell phone acceleration. The objective of this research is to detect six daily activities from users such as: walking, sitting, standing, ruing, upper stairs, and downstairs within a specific period. The data has been collected from 29 users from smartphone acceleration sensors, which carry cell phones in their pockets. By analyzing this data collection, the duty is to send weekly mail to users, to inform them their health could be a good basin on performance.

Here are some features such as: Average, Standard Deviation, Average Absolute Difference, Average Resultant Acceleration, Time Between Peaks and Binned Distribution. In order to analyze data mining there are three techniques: decision trees, logistic regression and multilayer neural networks to predict daily activities. Based on the results that are generated, the Multilayer Perceptron shows more correct data than other techniques. Based on errors that were generated, the more difficult daily activities to predict are the ones going upstairs and downstairs.

Accelerometer sensor data generation has many applications in different fields. Accelerometer data collected can help alcohol consumption to classify the drinking behavior of young adults in an urban and ecologically valid nightlife setting, as the author described in this [4] research.

In this research [5], the author has used accelerometer data to automate stress level detection in working environments from smartphones.

In this research [6], the author has proposed a system to support physicians determining an accurate elderly frail diagnosis, by collecting accelerometer data from physical activity.

3. Application Implementation to track accelerometer data from Mobile app

In this section, we will demonstrate the real-time implementation of accelerometer data from a mobile device to web charts. The architecture of the implementation of managing data accelerometers from mobile apps to web charts is presented in Fig. 1.

The mobile application is built using Xamarin forms, the back end is built using NodeJS and Database management system is built in NoSQL with MongoDB. Each part of this architecture is described in the following sessions.

3.1. NoSQL with MongoDB Database

It is used by a NoSQL database to save accelerated data. MongoDB, as NoSQL, is used to create a collection. The name of the collection for save data is called 'magnetomererdatas', as shown in Figure 1.


```
{  "_id": {    "$oid": "646ff1091a3fa33fb5edd97c"  },
   "x": -5.45649004,
   "y": 5.38566017,
   "z": -6.12025023,
   "did": "2f985c765f344777",
   "dt": "2023-05-25T23:36:40.959993Z"
}
```


Figure 1. Example of acceleration document data in MongoDB

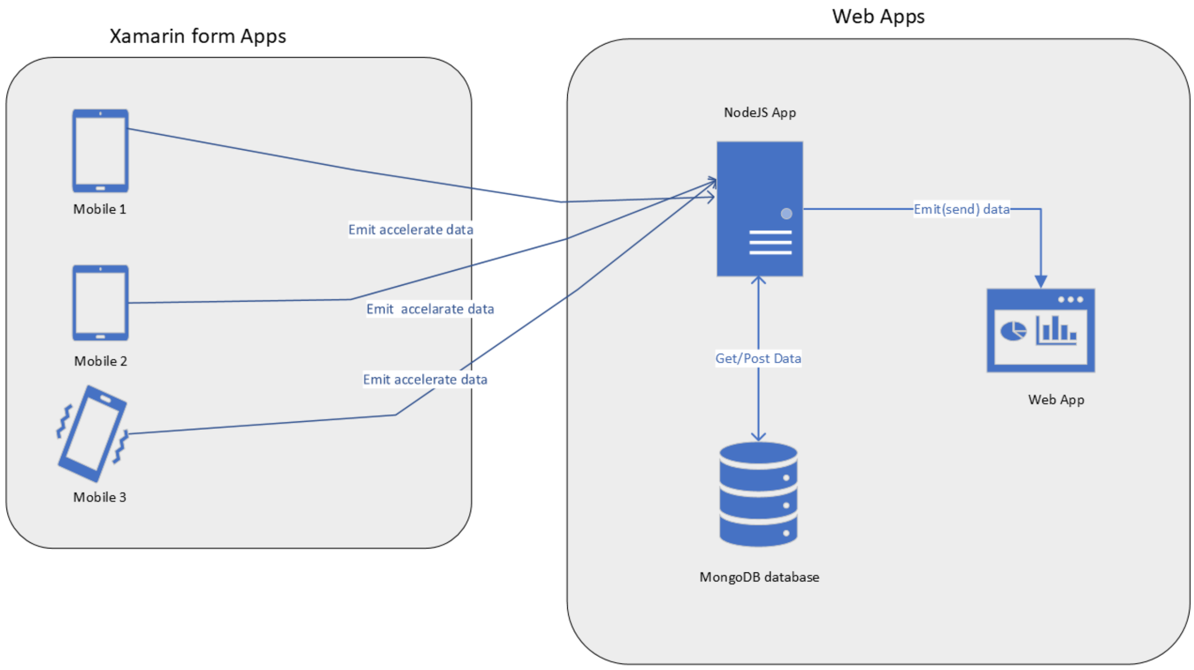


Figure 2. Mobile app and web app communication architecture

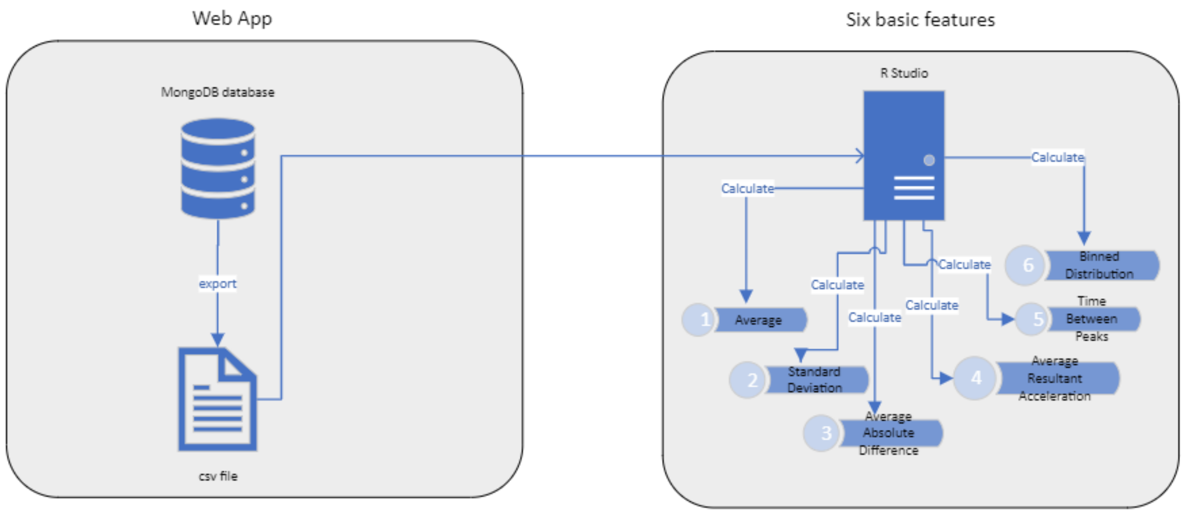


Figure 3. Web app communication and R application for generate six features

In Figure 1, there is an example document with data. The column "_id" represents a unique key within the collection, while column "x", "y" and "z" presents the values of the accelerometer sensor data that could be generated by mobile. The column "did" represents the id of the mobile device from which accelerated data was generated, and "dt" column represents the datetime in which data was generated.

Figure 2 displays the architecture of communication between MongoDB applications and R applications. The data from the MongoDB database was exported to a .csv file with data. The csv file contains the same columns that were defined in the MongoDB database schema. Then, the csv file was read late before the execution of each part of code, while analyzing data.

4. Analyses and results using R Programming

Here we have used different algorithms and function in order to analyze acceleration data and plot the results. Here is presented six basic features(Figure 3), which is mentioned below, dbScan, extraScan, HDBScan, knn, hullPlot, fuzy logic c-means, k-means and it uses a custom function to count steps that was displayed in table 1.

- The dbScan is a popular algorithm for clustering density-based clustering, which could be used from different tools such as ELKIT, scikit-learn, R, Weka and many others. dbScan is used to measures minimum density based on predefined minimum number of point known as minPts, within specific radius ε (which is fixed distance). A point which couldn't be achieved the minPts object numbers are considered as Noise point [8].
- The Knn (K-nears Neighbors) is part of lazy algorithms. knn uses the Euclidean distance to connect 2 points. Knn algorithm is non-parametric function for classification [9].
- The k-means algorithm is considered the most popular algorithm for clustering data with k groups (with similar attributes) [10].
- The fuzzy c-means, which is showing in Figure 7, is a soft clustering algorithm with each data in a not defined clustering group, each data could be part of more than two groups by percentage (0-1) [11].

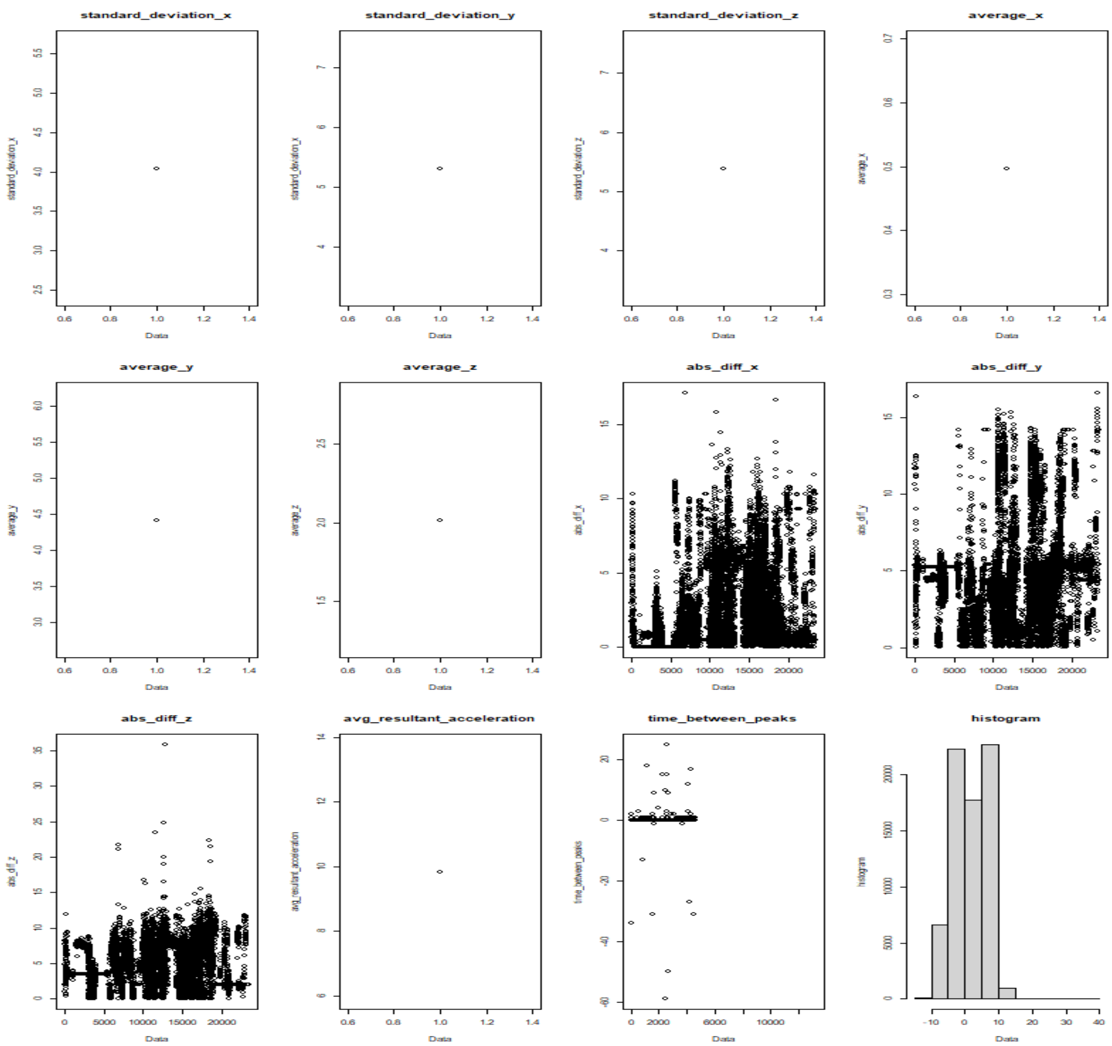


Figure 4. Shows the result of plotting six basic features (1.Average, 2.Standard Deviation, 3.Average Absolute Difference, 4.Average Resultant Acceleration, 5.Time Between Peaks, 6.Binned Distribution).

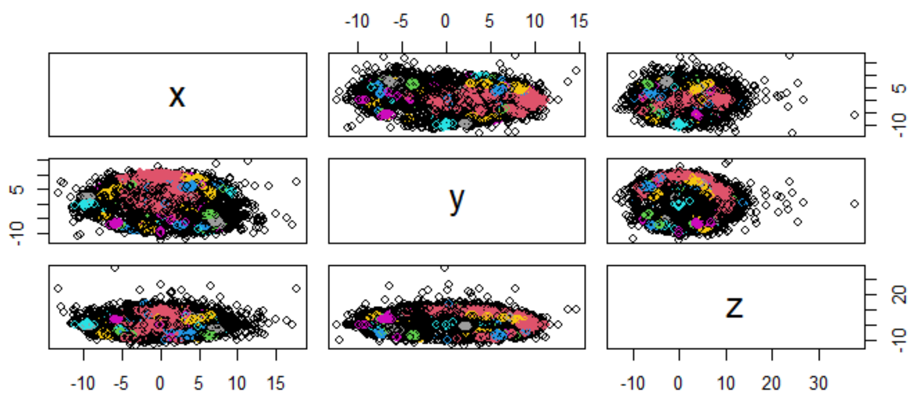


Figure 5 Result of clustering with dbScan

Figure 4 shows six basic features, such as Average, Standard Deviation, Average Absolute Difference, Average Resultant Acceleration, Time Between Peaks, and Binned Distribution.

The dbScan is shown in Figure 4. By acronym the dbScan means **D**ensity-**b**ased **S**patial **C**lustering of **A**pplication with **N**oise.

The algorithm dbscan find the clustering within data through density-base expression points [12]. This Figure 5 is displayed by execution the code below:

```
R >rdbscan_model<- dbscan(accel_features, eps = 0.5, minPts = 5)
R >rpairs(accel_features, col = dbscan_model$cluster+ 1L)
```

In Figure 6 is displayed the ExtrectdbScan, hdbscan, knn with k=5, kNNdistplot, fpccluster , by reading accelerometer data as was described above.

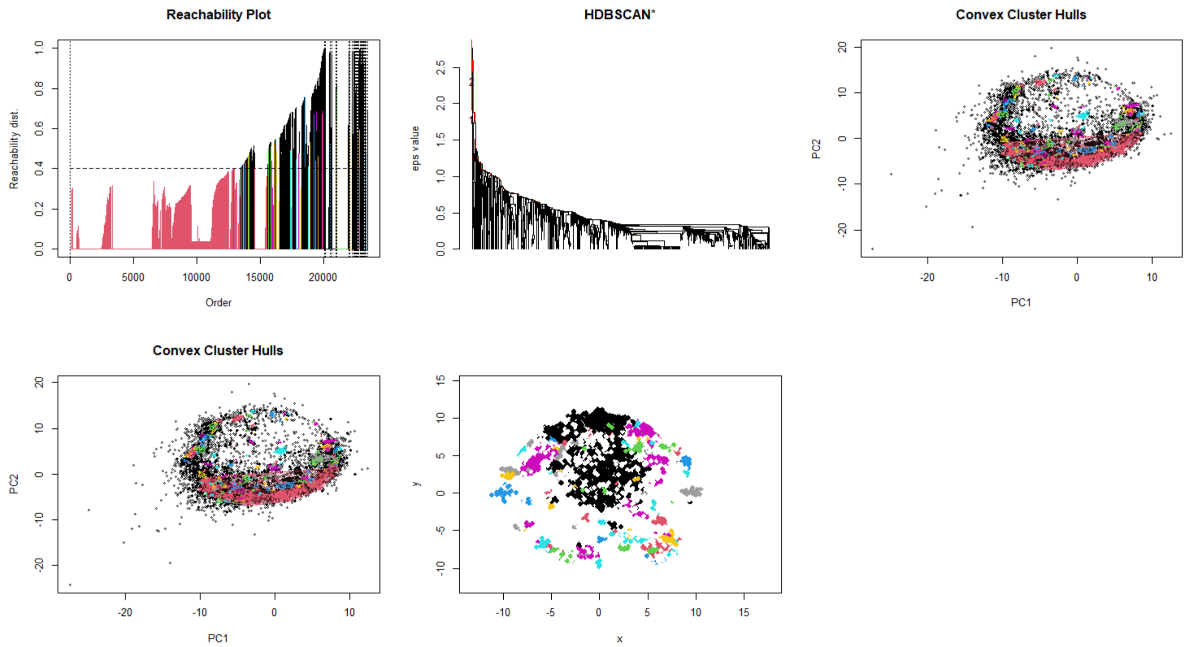
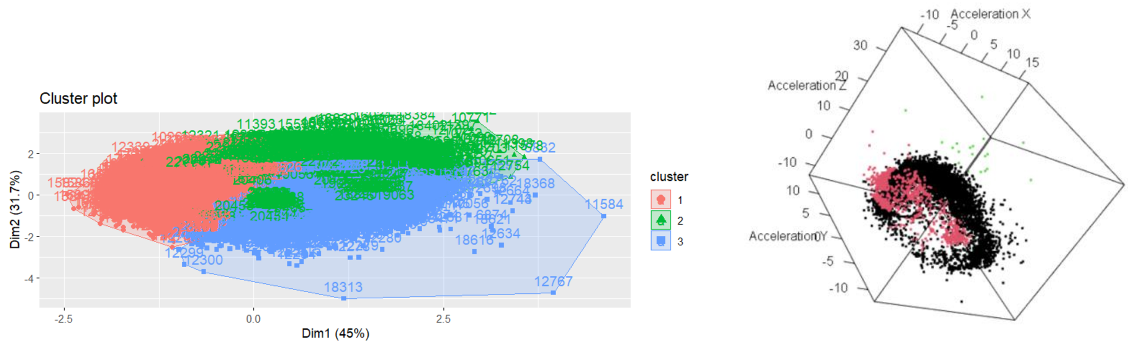


Figure 6 Result of plot: extractDBSCAN, HDBSCAN, knn k=5, hullplot.

Figure 5 shows some algorithms from the package 'dbscan' family. The extract DBSCAN Algorithms extract the cluster like DBSCAN, the letter difference is that this algorithm generates litter noise [13]. The hdbscan, which is seen in Figure 6, is a hierarchical dbscan, which is an improved algorithm of dbscanner[14]. The hullplot algorithms classify the data into two convex hull groups [15]. In order to display the result in Figure 5 and Figure 6, it is needed to access the part of code from [16] using R application:



a) b)

Figure 7. Result of fuzzy logic c-means algorithm with silhouette coefficient(a) and Visualize the clusters in a 3D scatter plot (b).

Table 1

Result of calculating daily activity

Walking steps	Running steps	Stairs steps
607	230	0

In order to count the walking steps, running steps and stairs steps, as could be seen in Table 1, there are shown the two functions below, which use accelerometer data from daily activity. The walking and running steps use some function with different threshold parameters. The code for calculate daily activities is:

```
R > countSteps < - function(pthreshold){
R > step_count < - 0 #init value
R > previous_state < - “below” #init value
R > current_state < - ““ #init value
R > for (i in 2:length(acceleration_magnitude)) {
if (acceleration_magnitude[i] > pthreshold) { current_state < - “above” }
else { current_state < - “below” }
if (previous_state == “below” && current_state == “above”){step_count < - step_count + 1 }
previous_state < - current_state
return(step_count)
}
R > walkedsteps< -countSteps(threshold)
R > runsteps< -countSteps(threshold_run)
R > step_count <- 0
R > for (i in 2:length(acceleration_magnitude)) {
if (acceleration_magnitude[i] > threshold) { current_state < - “above” }
else { current_state <- “below”}
if (previous_state == “below” && current_state == “above”) {
if (acceleration_magnitude[i-1] - acceleration_magnitude[i] > threshold)
{step_count step_count + 1}
}
previous_state <- current_state
}
R > c <- c(walkedspaps,runspaps,step_count)
R > df <- data.frame(work=c[1],run=c[2],stairs=c[3])
```

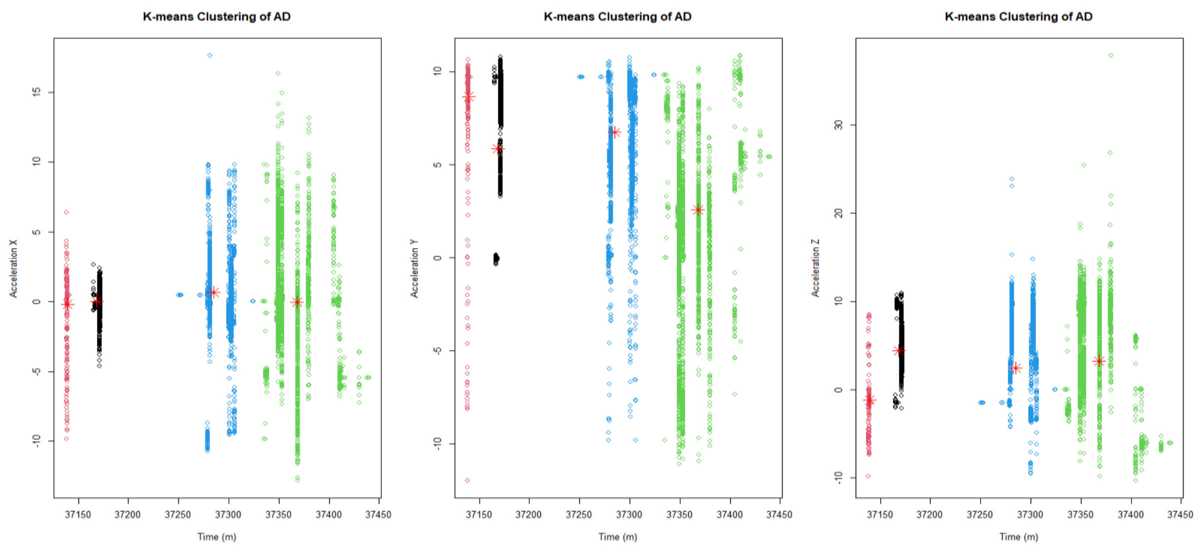


Figure 8 Result of displaying k-means using acceleration data with three axes.

In order to display the k-means (Figure 8) in three axes using acceleration data by executing the code below: the sign with red color is presented by the clusters.

5. Conclusion and future work

The extensive uses of smartphones and integration of numerous sensors within smartphones that generate valuable data, have opened up vast opportunities for researchers in the field of data mining and many industries.

In this presentation is shown the related work that involves the utilization of accelerator sensor data. It is a demonstration of a wide range of implementation across various industries, continuing to the enhancement, assisting and facilitating of various aspects of human life.

This presentation highlights a smartphone application for the collection of data using accelerometer sensor in the smartphone. It illustrates the process of saving and processing this collection data. The creation of this application involves the careful selection of appropriate technology efficient process and storing the collected data. Then, to analyze efficiently data collected, were employed a various of information and functions. These tools aid in data visualization, clarification, and extraction valuable insight.

In this presentation, the analysis primarily focused on accelerometer sensor data in isolation. However, it’s worth noting that there are significant potential benefits in combining this data with information from other sensors for comprehensive understanding and broader applications.

The combination of accelerometer sensor data could involve various aspects, such as:

- The combination of this data with high-quality air data can be instrumental in extracting valuable insights. For instance, it can provide a deeper understanding of activities like walking and running and their associated health benefits.
- Integration of this data sensor with heart rate monitoring holds significant potential for health and fitness tracking. This correlation between physical activity and heart rate changes can serve as a preventive measure against various heart diseases.
- Combining smartphone sensor data with other acceleration sensor data can be valuable for various purposes, including combining data from large objects with multiple floors to aid in orientation and navigation.
- Information reports could be automated by dependent based on configurations derived from other predefined sensors. Such automation has the potential to safeguard human lives and assets, save valuable time and resources, and enhance service efficiency.

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