Prediction of Human Activity Using Machine Learning

Supervised By:

Dr. Amitabha Chakrabarty, Associate Professor, BRAC University

Prepared By:

Sadia Nasrin Tisha; ID: 16101101

Benjir Islam Alvee; ID:16101112

Abstract: Involving machine learning in recognizing human activities is a widely discussed topic of this era. It has a noticeable growth of interest in implementing a wide range of applications such as health monitoring, indoor movements, navigation, and location-based services. The process is implemented gradually through several methods obtaining better accuracies than before. The data of human activities can be collected by wifi module, bio harness or wearable device which can be waist, wrist or thighs mounted. The purpose of our research is predicting human activities by classifying sequences of remotely recorded data of well-defined human movements using responsive sensors. The data are collected by a waist-mounted device that contains mobile phone sensors (e.g. accelerometer and gyroscope) for observing human activities of different aged people. The observed data are modeled using machine learning and neural network. Here we have used machine learning algorithms which are Support Vector Machine (SVM), K Nearest Neighbour (KNN), Linear Regression, Logistic Regression, Decision Tree, Naive Bayes Classifier and Random Forest Classifier. Moreover, we have also used artificial recurrent neural network (RNN) architecture- Long Short-Term Memory algorithm and Multi-Layer Perceptron (MLP) algorithm. Involving the data into various algorithms and obtaining results accurately is not convenient, because human motions recorded through wearable sensors have variations and complexity. For overcoming these problems we have used four dataset reduction techniques e.g. Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Linear Discriminant Analysis (LDA) and Independent Component Analysis (ICA) for achieving more accurate activity prediction performance with less complex and fast computation.

Introduction: Human activity recognition identifies human activities analyzing a set of observations retrieved from environment or sensors. For Human Activity Prediction, smartphone is a globally available key tool for approaching data collection of different human activities. The reason behind this is several; such as smartphone is a portable device which is easy to operate having different embedded sensors (e.g. accelerometer and gyroscope), it has computational features and also the ability to communicate. Smartphone is a convenient option for extracting human motions' data from various types of real-world environments. It is a budget-friendly programmable embedded device which has brought together hardware and software sensors. These sensors can sense different human activities such as: laying, sitting, standing, walking, walking downstairs and walking upstairs irrespective of age of the participant and his/her surroundings. We have developed a device for our research using smartphone sensors for collecting data , memory card module for storing data and clock module for recording definite seconds for each person.Human activity prediction identifies human activities analyzing a set of observations retrieved from environment or sensors. Sensors can be body worn used in different body parts such as the waist, wrist, chest, thighs etc. Though these sensors are uncomfortable to use but they provide noticeable performance. Dataset being used in our research consists of data collected through a wearable device in human waist. The device containing smartphone sensors extracts a large set of observations of human activities from the environment. These smartphone sensors are very responsive in terms of recording data. Smartphone is a flexible sensing tool with built-in sensors such as accelerometers, gyroscopes, dual cameras and microphones. All of these provide flexibility while monitoring Activities of Daily Living (ADL). Activities of daily living are routine activities people do every day without assistance. There are six basic ADLs: eating, bathing, getting dressed, toileting, transferring and continence. The performance of these ADLs is important in determining what type of long-term care and health coverage, such as Medicare, Medicaid or long-term care insurance, a person will need as he or she ages. The body worn device takes data of six human activities such as: Laying, Sitting, Standing, Walking, Walking Downstairs and Walking Upstairs. These wide range of data are analyzed using dataset reduction techniques which are Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Linear Discriminant Analysis (LDA) and Independent Component Analysis (ICA) whether they have related features or not and then modeled using machine learning classifiers such as: SVM, KNN, Linear Regression, Logistic Regression, Random Forest, Decision tree, Naive Bayes and neural network algorithms which are LSTM and MLP.. Apart from the existing dataset, we have developed another dataset with a smaller set of observations. We have developed a waist-mounted device using a gyroscope and accelerometer for recording data of human movements. Memory card does the task of storing and retrieving data from our device and clock module records the designated amount of time taken in taking data of each individual. We do not have so many features in our dataset except the three axes of accelerometer and gyroscope. That's why we did not need to apply reduction techniques in our dataset rather we have modeled those data using the same machine learning classifiers and neural network algorithms.

Literature Review:

From the paper ,the research team introduced a new publicly dataset For Human Activity Recognition using smartphones and acknowledged some results using a multiclass Support Vector Machine approach. They also improved the classification performance of the learned model using the dataset[1].

In this paper, performance of classification is observed using three machine learning algorithms which are SVM, HMM and ANN. Body activity recognition are obtained using numerical data collected from wearable sensors as well as the classification algorithms. Apart from activity motions other features like age, weight, acceleration statistics, physiological measurements are also taken into consideration. In future, they intend to make SVM approach for finding optimal parameters more efficient, decreasing the consumed time and computational complexity. They also plan to make HMM approach more convenient in producing accurate results. Lastly, they will try to recognize body activities from the perspective of sparse representation and random projections[2].

In this paper, human activities are recognised using LSTM network by evaluating four fusion methods for combining convolutional neural network outputs. Performance improvement is obtained by adding a third LSTM layer. Final illustrated results represents an attention mechanism to direct the LSTM through the noticeable fields of convolutional feature sequence[3].

In the paper , the research group introduced a comprehensive survey of the recent advances in activity recognition with smartphone sensors. They review the core data mining techniques behind the mainstream activity recognition algorithms, analyse their major challenges and introduced a variety of real application enabled by the activity recognition[4].

In the paper, it is analyzed that activities can be detected using a single triaxial accelerometer providing high accuracy. Meta-classifier usage is feasible to detect activities related to hands or mouth which are hard to detect using single accelerometer. They found that plurality voting classifier is the best classifier for activity recognition. They would like to extend their research recognizing short activities such as opening door using swipe card from accelerometer data. Also there motto is to study the effect of ontology of activities in terms of classifying activities which are hard to recognize[5].

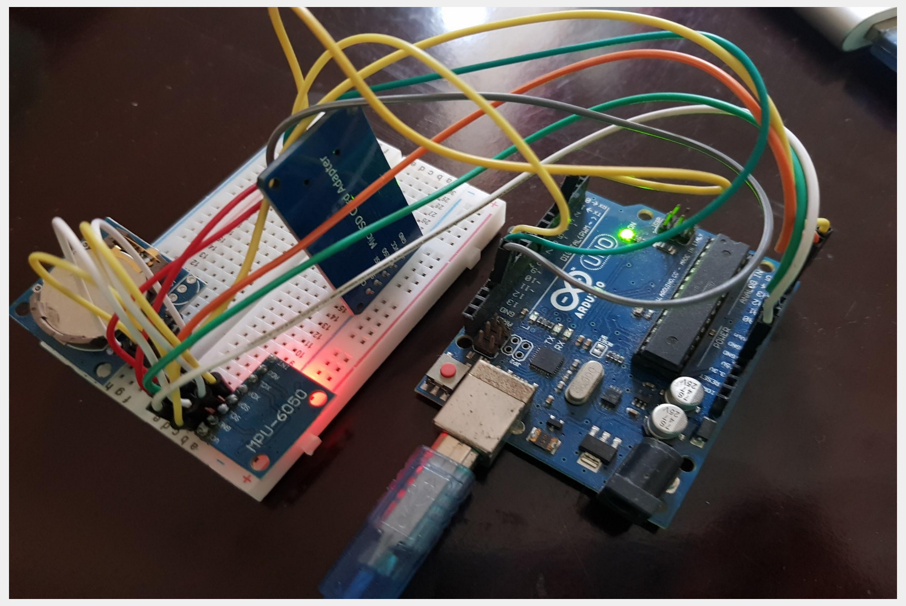

Figure 1 : waist mounted device

References:

[1]Anguita, D., Ghio, A., Oneto, L., Parra, X., & Reyes-Ortiz, J. L. (2013, April). A public domain dataset for human activity recognition using smartphones. In Esann."

[2]Cheng, L., Guan, Y., Zhu, K., & Li, Y. (2017, January). Recognition of human activities using machine learning methods with wearable sensors. In 2017 IEEE 7th annual computing and communication workshop and conference (CCWC) (pp. 1-7). IEEE.

[3]Gammulle, H., Denman, S., Sridharan, S., & Fookes, C. (2017, March). Two stream lstm: A deep fusion framework for human action recognition. In 2017 IEEE Winter Conference on Applications of Computer Vision (WACV) (pp. 177-186). IEEE.

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[5]Ravi, N., Dandekar, N., Mysore, P., & Littman, M. L. (2005, July). Activity recognition from accelerometer data. In Aaai(Vol. 5, No. 2005, pp. 1541-1546).

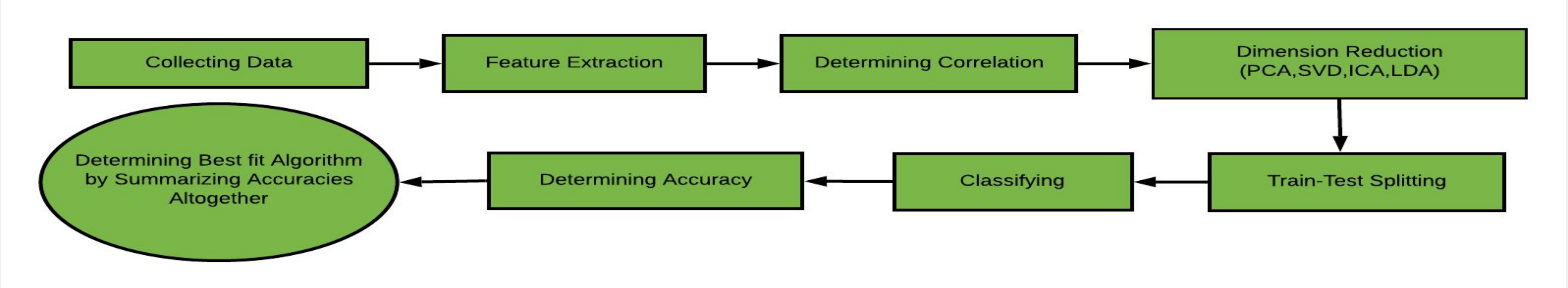

Figure 2 : Workflow for existing dataset

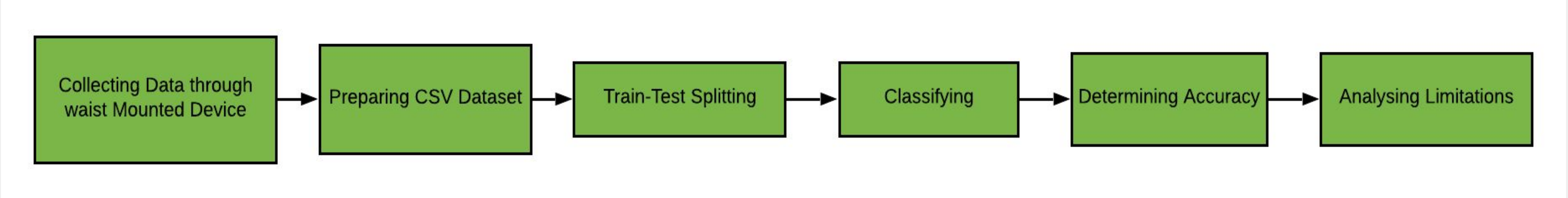

Figure 3 : Workflow for new dataset

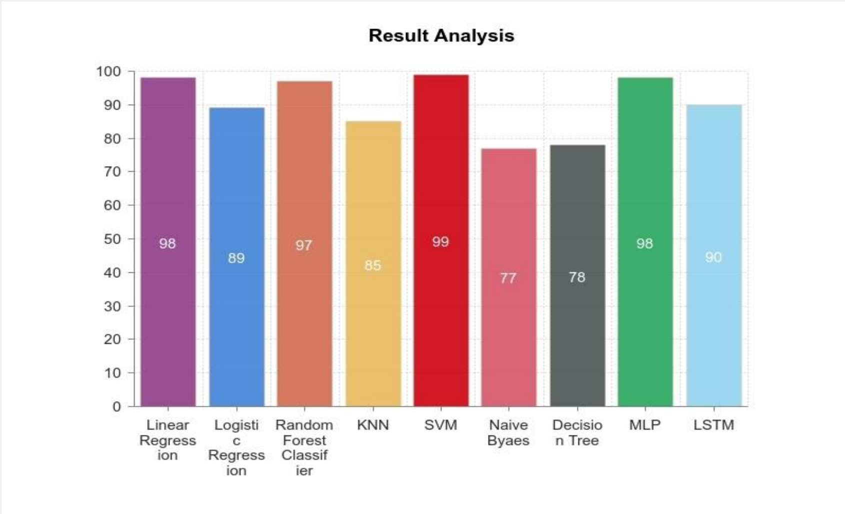

Figure 4 : Result analysis graph for existing dataset

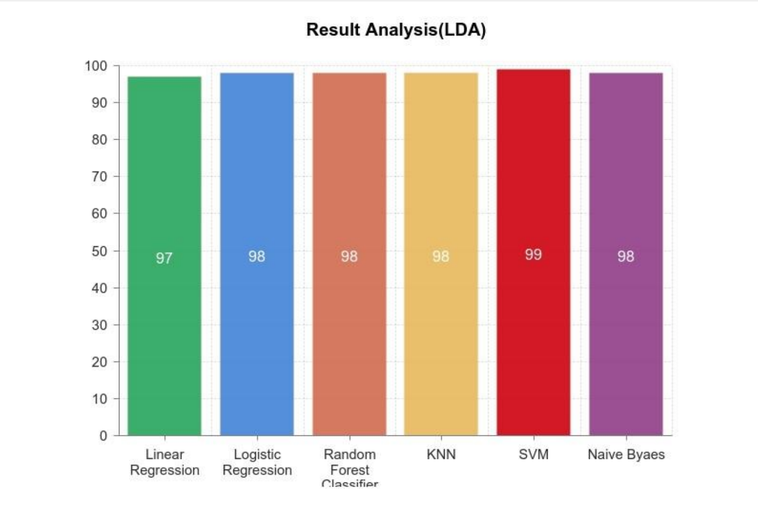

Figure 7 : Result analysis graph of existing dataset using LDA

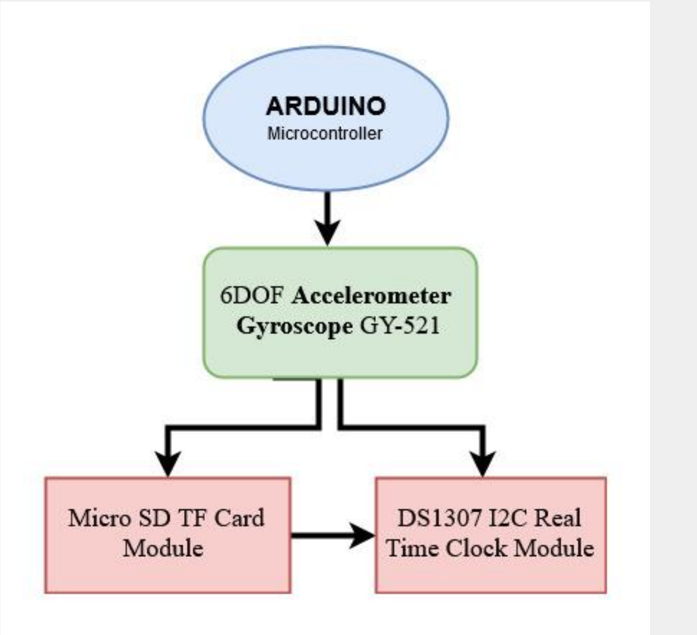

Figure 10 : Waist mounted device setup

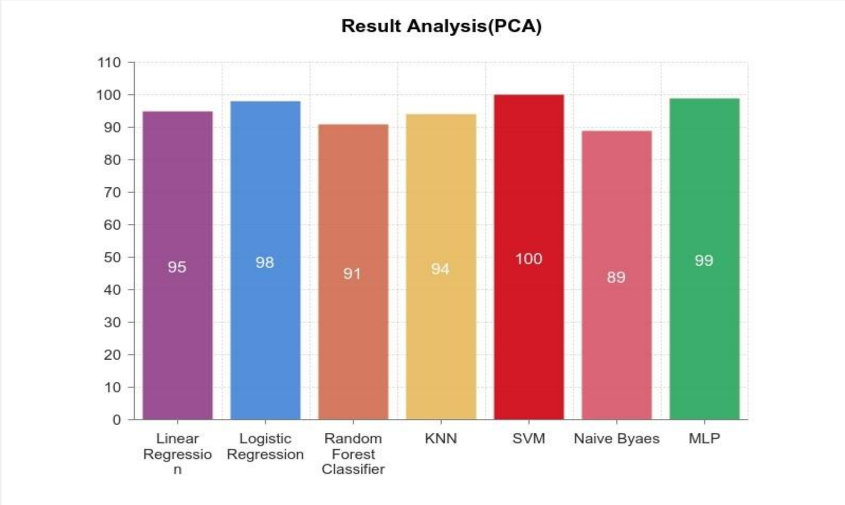

Figure 5 : Result analysis graph of existing dataset using PCA

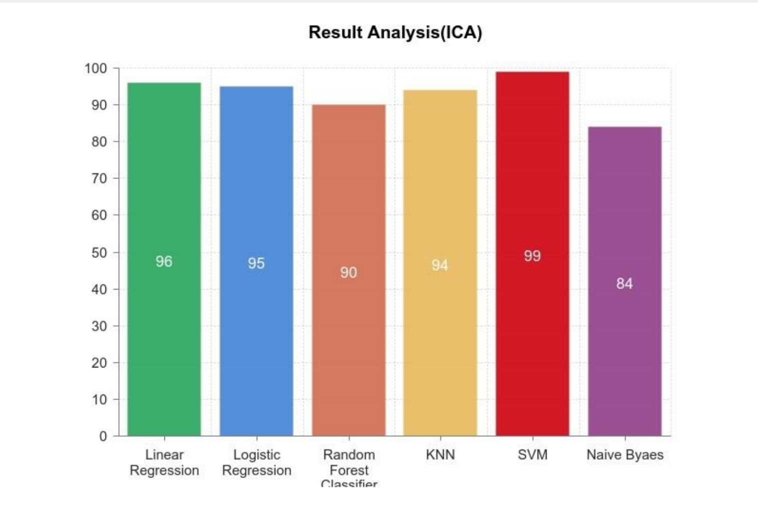

Figure 8 : Result analysis graph of existing dataset using ICA

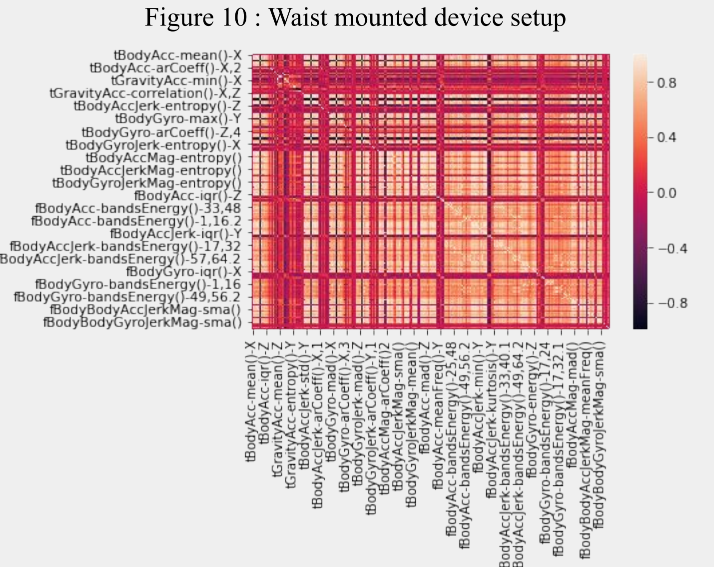

Figure 11 : Heatmap for existing dataset

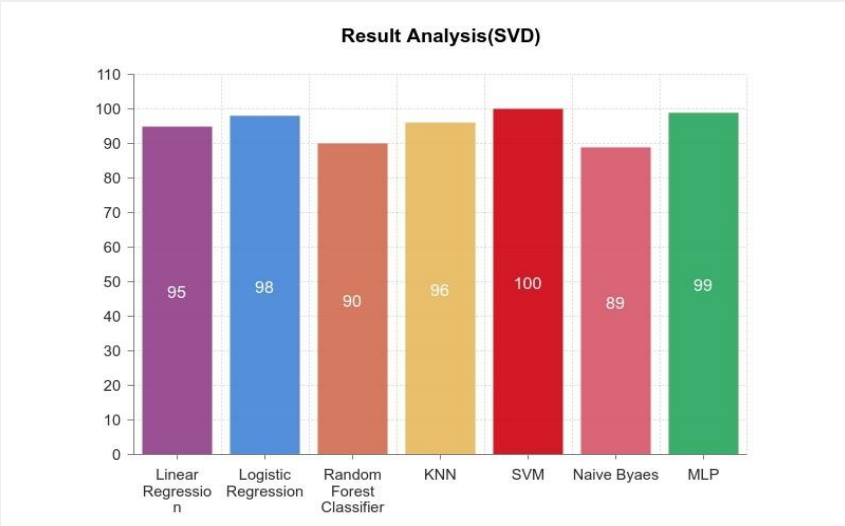

Figure 6 : Result analysis graph of existing dataset using SVD

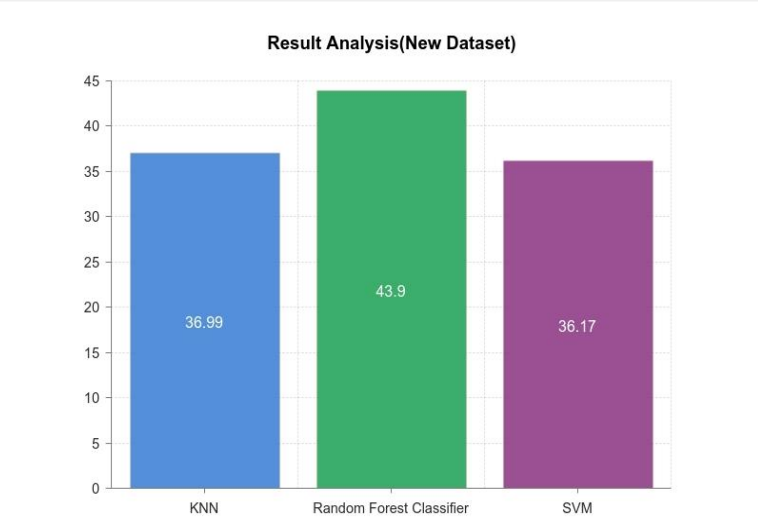

Figure 9 : Result analysis graph of new dataset

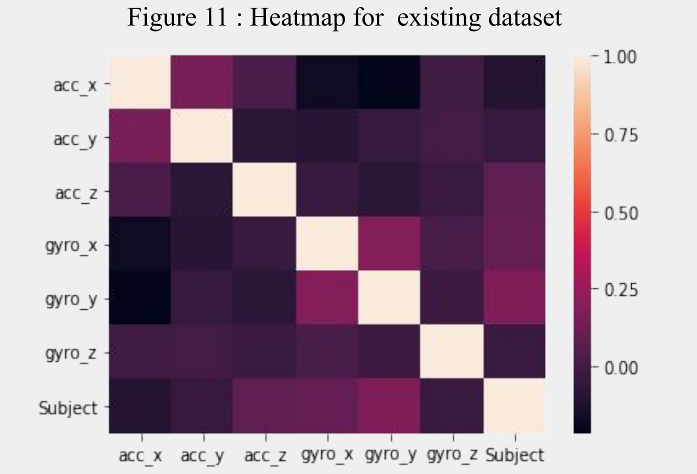

Figure 5 : Heatmap for new dataset