Human Activity Recognition Using Smartphones

Raviram Mamidi 201501008

1 Problem Definition

Human Activity Recognition using smart phones is a sub-part of a broader concept called Context Aware Computing or Ubiquitous computing.In this type of computing the sensors of the device take in the data continuously which will in turn help in assisting the user in the task.And this task can vary depending on the field.

For this project I have used Neural Networks and Softmax Classifier models to classify the actions of the user.

2 Motivation

Smart phones have been a crucial part of our life since the mobile industry boom all over the world and especially the market for a smart phone Android or iOS. Most of the smart phones come equipped with a number of the basic sensors like accelerometer ,magnetometer etc which can take readings continuously. Making use of this sensor data to analyze what he or she is doing could pave a new way in which the mobile phone interacts with you.With the device understanding what state you are in , it can make use of the processing power to make your interaction smooth.

Like for example if the device detects that you are running then it can increase the device performance so that you have a stutter free experience. Or if it detects that you are sleeping it can try to go into a sleep mode .Medical help can also be given if the device gets to know you usual pattern of activity.

There are many research papers and articles referring to such possibilities.It can be used for automatic activity recognition which is used to help soldiers with their after action reports.Human activity recognition helps the hospital staff in their daily work in estimating their activities.The daily activities of the person can be learnt so that later it can detect any abnormality so that it can report to a personal doctor or caretaker.

3 Literature Review

[1] This paper discusses the various possibilities and usages of the HAR(Human Activity Recognition) in various fields of science and health care. Like how it can help people to recognize abnormalities in their daily activity.And shows the various aspects of HAR in daily life activities.
[2] This paper discusses the historical emergence and ubiquitous use of smart phones in the 21st century. And they explain how easy it is now to acquire interial sensors at an cost effective price and size , which can be worn and carried around easily.

The paper then discusses different approaches for this classification. Like Naive Bayes Classifier, Random Forest classifier, Random Committee, Lazy IBK Classifier etc. Then they go on and explain the different results from all these classifiers and they try to explain the performance metrics.

They try to explain which method is better for a use case.They go on to explain that Naive Bayes method of classification is only good for baseline classification and it takes less load on the system too, and it is easy to understand and implement.Decision Tree method is also easy to implement but it's best feature is, it can show it's user the useful features or sensor readings which will be the determining attribute (the one which gets us more entropy difference when we split the tree). With the variation of the target classes and data sets the most important features might vary accordingly.

[3] This paper is the most important paper, which inspired me to take up this idea .Written by Akram Bayat and Marc Pomplun this paper explains in detail the different features in HAR data sets thoroughly and the significance time interval of measurement for the experiment which was conducted by the students to populate the dataset.

The authors discuss the performance mtrics of standard classification techniques. With these of-the-shelf techniques they come to the conclusion the methods like Neural Networks and their variants have a higher chance of extracting the hidden aspects. Because the neural networks can work over non-linear classifications easily and they need no inherent adjustments to satisfy the data sets.

Then they discuss the theoretical way of combining two classifiers to form a new method of classification, which then they find that only gives a slight improvement in the accuracy, when run on their systems.

4 Objective of Experiment

The human activity recognition dataset is having records of acceleration and angular velocity measurements from different physical aspects in all three spatial dimensions (X, Y, Z) is used to train a machine and predict the activity from one of the six activities performed. Then with the testing data we measure the performance of the training models over their accuracy over time.

5 Dataset Description

The experiments have been carried out with a group of 30 volunteers within an age bracket of 19-48 years. Each person performed six activities (WALKING, WALKING_UPSTAIRS, WALKING_DOWNSTAIRS, SITTING, STANDING, LAYING) wearing a smartphone (Samsung Galaxy S II) on the waist. Using its embedded accelerometer and gyroscope,3-axial linear acceleration and 3-axial angular velocity at a constant rate of 50Hz was captured.

The signals were then preprocessed by applying noise filters and sampled in a sliding window of 2.56 seconds and 50% overlap. A total of 561 features were acquired for each training example. The training set is (7352, 563) matrix. The testing set is (2947, 563) matrix. The link to the dataset is [4] here

6 Experiment

Approaches

- Neural Network

  The old classic neural network , which is built on layered perceptrons. The input layer carries forward the input layer data into the hidden layer , and then bias is added to each perceptron and then this is passed to the output layer. The training of the neural network involves the tweaking of the weights of each perceptrons so that a it macthes the correct outputs.

  COST FUNCTION:The logit function is the inverse of the sigmoidal "logistic" function or logistic transform used in mathematics, especially in statistics. When the function's variable represents a probability p, the logit function gives the log-odds, or the logarithm of the odds p/(1 p).

  OPTIMIZER: Adam's Optimizer or Stochastic Gradient Descent This is the same as Gradient Descent but in this case, we move somewhat directly towards an optimum solution, either local or global. Additionally, batch gradient descent, given an annealed learning rate, will eventually find the minimum located in it's basin of attraction. Stochastic gradient descent (SGD) computes the gradient using a single sample.

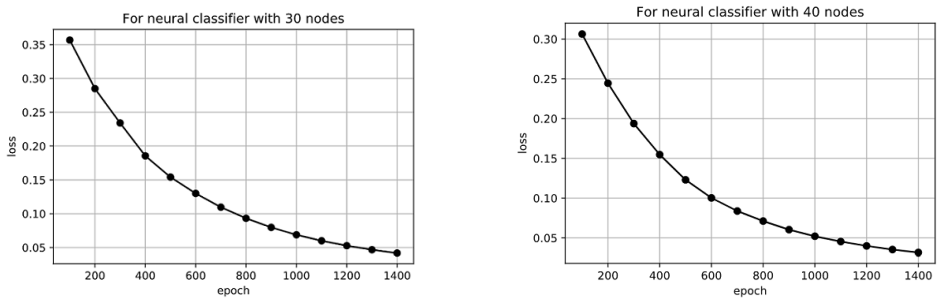

Figure 1: Accuracy of 95% and 96.1% respectively for 30 and 40 nodes

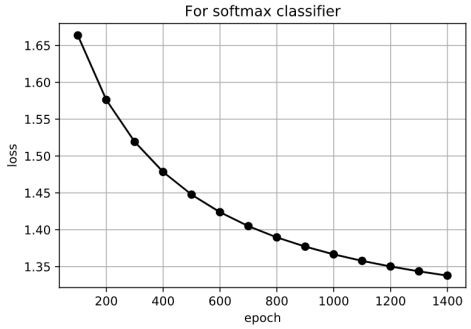

Figure 2: Accuracy of 95.11% for softmax

- Soft Max Classifier

  A model that converts the unnormalized values at the end of a linear regression to normalized probabilities for classification is called the softmax classifier.

  COST FUNCTION: is Logits function as described above .

  OPTIMIZER:is Gradient Descent Algorithm.Which finds the optimum change in each weights according to the slope or gradient of the cost function so as to minimize it.

- One Vs Rest Classification One-vs-All Logistic Regression Classifier for Multi-classification. The basic idea is to change multiple classes into two classes, and construct one logistic classifier for each class. We set the value of y (label) of one class to 1, and 0 for other classes.

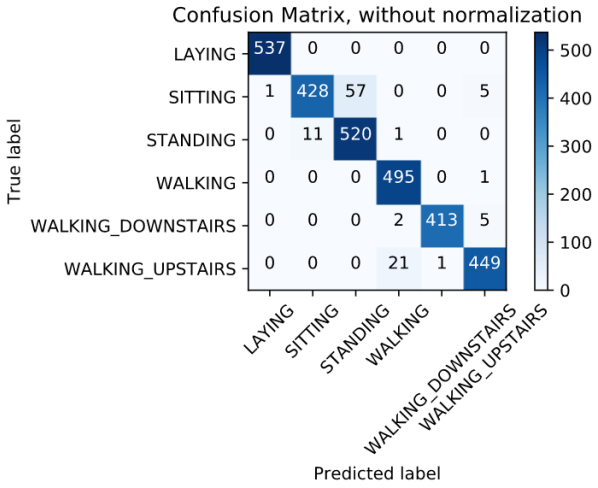

Figure 3: Accuracy of 96.4% for One Vs Rest

7 Conclusion

So we can conclude that of we want higher level abstraction or features of data,Neural Network comes in handy to tackle this . One Vs Rest yielded the highest accuracy when compared to the rest two when implemented initially. Neural networks however with the increase in the number of perceptrons got a slight bump in the accuracy which is good.And One Vs Rest got better in accuracy by increasing the training data size. And SoftMax classifier was normal and did not show much variance with the changes.

Neural Networks can bring out or extract more features if the hidden layer nodes or layers are altered. This can be helpful when we want to classify the data into more than six classes which I have already implemented.With them being computationally costly, doing it in the cloud or server is a better option than running on a local device like a mobile phone or Personal Computer when we are doing context aware computing. So svm based methods like OneVsRest classifier or the probabilistic classifier like SoftMax can be used on local machines as even though they are memory intensive but computationally they are less costly than Neural Networks.Their accuracy is also comparable to the Neural Networks in some instances.

References

[1] Human Activity Recognition with Smartphones,Rao Fu,Yao Song,Weipu Zhao from Simon Fraser University

[2] Smart Phone Based Data Mining For Human Activity Recognition,Girija Chettya, Matthew Whiteb, Farnaz Akthera,*International Conference on Information and Communication Technologies (ICICT 2014)*

[3] A Study on Human Activity Recognition Using Accelerometer Data from Smartphones Akram Bayat, Marc Pomplun, Duc A. Tran *The 11th International Conference on Mobile Systems and Pervasive Computing (MobiSPC-2014)*

[4] Human Activity Recognition Dataset Using Smart Phone , UCI Machine Learning Repository.