Project Report

Human Activity Recognition using Smartphone dataset

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ABSTRACT

Data mining is one hot orientation in today's research field. Human activity recognition is meaningful in our daily living and is a significant aspect in data mining. Most previously research is almost based on tri-axial accelerometer.

Our daily activities including

1. **Walking**
2. **Running**
3. **Upstairs**
4. **Downstairs**
5. **Standing**
6. **Sitting**

A total of six categories are classified. The raw data from kaggle are recorded by smartphone according to different daily activities. To check which algorithm works best for activity recognition we are comparing the analysis by Decision Tree algorithm and neural networks. Besides, we compare the accuracy with neural network or decision tree. The result indicates that our method can achieve nearly 92% classification accuracy for the six kinds of daily activities.

To compare the two algorithms for activity recognition for collected data we are using random forest classifier (decision tree algorithm) and recurrent neural networks (neural network). Since neural networks perform better than decision tree algorithms in many cases we are expecting recurrent neural network to perform better (with better accuracy and less loss). Comparison of both algorithms is seen on a graph plot.

For neural network google's Tensor-Flow library is used and for random forest classifier Scikits library. Along with these libraries more libraries like numpy, pandas are used for ease of coding.

Introduction

The Human Activity Recognition dataset was built from the recordings of 30 study participants performing activities of daily living while carrying a waist-mounted smartphone with embedded inertial sensors. The objective is to classify activities into one of the six activities performed.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 on the waist. Using its embedded accelerometer and gyroscope, 3-axis linear acceleration and 3-axial angular velocity at a constant rate of 50Hz were captured. The obtained dataset has been randomly partitioned into two sets, where 70% of the volunteers was selected for generating the training data and 30% the test data.

The sensor signals (accelerometer and gyroscope) were pre-processed by applying noise filters and then sampled in fixed-width sliding windows of 2.56 sec and 50% overlap (128 readings/window). The sensor acceleration signal, which has gravitational and body motion components, was separated using a Butterworth low-pass filter into body acceleration and gravity. The gravitational force is assumed to have only

low frequency components, therefore a filter with 0.3 Hz cutoff frequency was used. From each window, a vector of features was obtained by calculating variables from the time and frequency domain.

Related Research

RANDOM FOREST CLASSIFIER

In random forests each tree in the ensemble is built from a sample drawn with replacement from the training set. In addition, when splitting a node during the construction of the tree, the split that is chosen is no longer the best split among all features. Instead, the split that is picked is the best split among a random subset of the features. As a result of this randomness, the bias of the forest usually slightly increases (with respect to the bias of a single non-random tree) but, due to averaging, its variance also decreases, usually more than compensating for the increase in bias, hence yielding an overall better model.

The scikit-learn implementation combines classifiers by averaging their probabilistic prediction, instead of letting each classifier vote for a single class.

The random forest (Breiman, 2001) is an ensemble approach that can also be thought of as a form of nearest neighbor predictor.

Ensembles are a divide-and-conquer approach used to improve performance. The main principle behind ensemble methods is that a group of “weak learners” can come together to form a “strong learner”. Each classifier, individually, is a “weak learner,” while all the classifiers taken together are a “strong learner”.

The data to be modeled are the blue circles. We assume that they represent some underlying function plus noise. Each individual learner is shown as a gray curve. Each gray curve (a weak learner) is a fair approximation to the underlying data. The red curve (the ensemble “strong learner”) can be seen to be a much better approximation to the underlying data.

RECURRENT NEURAL NETWORK

A **recurrent neural network** (**RNN**) is a class of artificial neural network where connections between units form a directed cycle. This allows it to exhibit dynamic temporal behavior. Unlike feedforward neural networks, RNNs can use their internal memory to process arbitrary sequences of inputs. This makes them applicable to tasks such as unsegmented, connected handwriting recognition or speech recognition

LONG SHORT TERM MEMORY

Long short-term memory (LSTM) were invented by Hochreiter and Schmidhuber in 1997 and set accuracy records in multiple applications domains.

Around 2007, LSTM started to revolutionize speech recognition, outperforming traditional models in certain speech applications. In 2009, Connectionist Temporal Classification (CTC)-trained LSTM was the first RNN to win pattern recognition contests, when it won several competitions in connected handwriting recognition.In 2014, the Chinese search giant Baidu used CTC-trained RNNs to break the Switchboard Hub5'00 speech recognition benchmark, without using any traditional speech processing methods.

LSTM also improved large-vocabulary speech recognition, text-to-speech synthesis, also for Google Android, and photo-real talking heads. In 2015, Google's speech recognition reportedly experienced a dramatic performance jump of 49% through CTC-trained LSTM, which was used by Google voice search.

LSTM broke records for improved machine translation, Language Modeling and Multilingual Language Processing. LSTM combined with convolutional neural networks (CNNs) improved automatic image captioning

Relevant Papers

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz. Human Activity Recognition on Smartphones using a Multiclass Hardware-Friendly Support Vector Machine. *International Workshop of Ambient Assisted Living (IWAAL 2012)*. Vitoria-Gasteiz, Spain. Dec 2012

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra, Jorge L. Reyes-Ortiz. Energy Efficient Smartphone-Based Activity Recognition using Fixed-Point Arithmetic. *Journal of Universal Computer Science. Special Issue in Ambient Assisted Living: Home Care*. Volume 19, Issue 9. May 2013

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz. Human Activity Recognition on Smartphones using a Multiclass Hardware-Friendly Support Vector Machine. 4th International Workshop of Ambient Assisted Living, IWAAL 2012, Vitoria-Gasteiz, Spain, December 3-5, 2012. *Proceedings. Lecture Notes in Computer Science* 2012, pp 216-223.

- Jorge Luis Reyes-Ortiz, Alessandro Ghio, Xavier Parra-Llanas, Davide Anguita, Joan Cabestany, Andreu Català. Human Activity and Motion Disorder Recognition: Towards Smarter Interactive Cognitive Environments. *21st European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN* 2013. Bruges, Belgium 24-26 April 2013.

Experimental Setup

1. Jupyter Notebook
2. Python3
3. Tensorflow
4. Pandas
5. Scikit-learn

Citations:

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz. A Public Domain Dataset for Human Activity Recognition Using Smartphones. 21th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2013. Bruges, Belgium 24-26 April 2013.

- “Random Decision Forests,” T. Ho (1995).

- Andrej Karpathy blog - http://karpathy.github.io/2015/05/21/rnn-effectiveness