PROJECT2. Human Action Recognition using Hidden Markov Model

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1. Introduction

Hidden Markov Model has such a good strength in analyzing sequential data, and had been widely used in language model, part-of-speech tagging and named entity recognition [1]. Based on Markov process, HMM infers probability distributions of the model from observations and find the most likely results so far. It is useful for cases unable to observe all datasets and only able to get its causal evidences, and can be applied in many different data restoring fields [2], e.g. multiple DNA sequence alignment, protein secondary structure prediction [3] and speech recognition. Datasets being used in HMM modeling should be time-serial. For example, speech recognition has temporal structure consisted of statistical models and can be encoded as a sequence of spectral vectors spanning the audio frequency range [4].

Likewise, we'd like to use temporal human action sensor data to make Human Action Recognition system (HAR) using HMM. We've trained our model with Human Activities and Postural Transitions datasets (HAPT) produced by Jorge L, *et al*. [5]. Measurement was done by 30 volunteers carrying a waist-mounted smartphone with embedded inertial sensors. Dataset includes 61 experiments with 30 participants and measured in 50Hz frequency and about 400s duration per experiment. Each experiment contains 12 types of human actions like standing, walking down, *etc*. We separated into 12 part of data so we can easily train our model by action type. Eventually, we've got 1,214 examples and randomly splitted as train and test dataset as 9:1 ratio respectively.

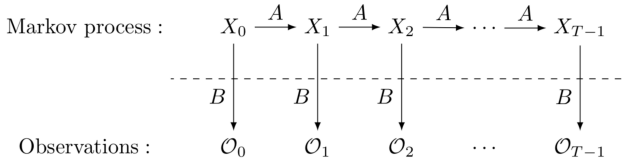
2. Related Works

Human activity recognition is nowadays an active research field which aims to understand human behavior and there have been lots of researches to figure out human behaviours. One of the approaches was method consisted of support vector machines (SVMs) and temporal filters of activity probability estimations within a limited time window [6]. Probability estimation after feature extraction was done by MAP filtering.

Rubén San-Segundo, *et al*. have implemented system comprising of three main modules: feature extraction, HMMs training and activity recognition. In the training module, 6 HMM modules were being trained to classify human actions with datasets of only six different physical activity types: walking, walking-upstairs, walking-downstairs, sitting, standing and lying down. Due to the lack amount of activity types they've obtained the recognition error rate of 2.5% [7].

3. Preliminaries

4. Hidden Markov Model



A hidden Markov model (HMM) allows us to talk about both observed events (like words that we see in the input) and hidden events (like part-of-speech tags) that we think of as causal factors in our probabilistic model. HMM model λ contains transition probability matrix A, a set of state variables X, a sequence of observations O, emission probabilities B, and an initial probability distribution over states π.

We can characterized HMM into 3 fundamental problems;

1. Given the model λ, we have to find likelihood $P(O|\lambda)$ whether the observation O is a probable sequence based on λ. 2. Given an observation sequenceOand an HMMλ=(A,B), discover the best hidden state sequenceQ.

5. Proposed Method

6. Empirical Analysis

7. Conclusion

References

[1] ratgo's blog

[2] Wikipedia, Hidden Markov model

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[4] M. Gales and S. Young "The Application of Hidden Markov Models in Speech Recognition". *Foundations and Trends in Signal Processing, Vol.1, No.3*, 2007

[5] Jorge L. Reyes-Ortiz, Davide Anguita, Alessandro Ghio, Luca Oneto and Xavier Parra, "Smartphone-Based Recognition of Human Activities and Postural Transitions Data Set" , 2015

[6] Jorge L, *et al*. "Human Activity Recognition on Smartphones with Awareness of Basic Activities and Postural Transitions" *ICANN 2014, LNCS 8681, pp.177–185*, 2014

[7] Rubén San-Segundo, Julián David Echeverry-Correa, Christian Salamea, José Manuel Pardo "Human activity monitoring based on hidden Markov models using a smartphone" *IEEE Instrumentation and Measurement Magazine*, 2016