Periodicity Detection in Lifelog Data

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Abstract

Lifelogging technology is getting attention from industry, academic and market, such as wearable sensors and the concept of smart home. We are proposing a framework which could handle those aggregated multimodal and longitudinal data. The system will take advantage of the rich information carried chronologically and implement process such as data cleaning, low and high level patterns detection and giving feedback to users.

1. Motivation

Multinational companies launched platform that collecting data from wearable sensors and centralizing the management of those collected data. HealthKit, HealthVault and Google Fit coming in succession, revealing a trend that dealing with multimodal, longitudinal data. Challenges we are facing is to mine hidden patterns in collected data, especially reoccurring patterns, and make it useful for users.

2. Problem Statement

Events an/or activities people doing generate data that could be captured by sensors. Uniqueness of when and how people doing those events and/or activities indicates person's lifestyle. Lifelogging researchers are able to segment events/episodes, detect concepts in lifelog data and model probability distribution of the concepts. But there is much more information contained in the chronological relationship within lifelog data, such features as periodicity of lifestyle in daily routine.

3. Related Work

Challenges of effective structuring, searching and browsing of this image collection for locating important or significant events in a person's life has been addressed and a media process which could 1) capture and upload images 2) post processing images 3) accessing images, has been described in [2]. Based on previous researches, [1] raised a framework which enable effective memory retrieval facilitate with reminiscence therapy.

4. Research Question

In order to implement a system that is able to mining reoccurring patterns in aggregated multimodal longitudinal data, the following research questions can be addressed:

What Data cleaning techniques can we use to fill the missing gaps?

How can we detect periodicity in low-level and high-level data series? What methods can we use to transform low-level data to high-level data?

What methods can be used to give feedback of detected periodicity to user?

5. Hypothesis

Can we not only detect events, but also identify and mine periodicity patterns with considering time correlation within one modality and/or cross-correlation between different modalities and finally make good effect to users.

6. Proposed Solution

Time series analysis techniques, such as autoregression will be used to model each single modality and/or multiple modalities. Machine learning methods will be applied to model the correlation among different modalities. We will detect the periodicity of time series using a combination of correlograms and periodograms, using various signal processing algorithms. We will use graph-theoretic approaches such as the horizontal visibility algorithm to detect low level periodicity in time series. Automatic feature extraction methods like deep learning will be used to map low-level data to high-level semantic labels. The resultant stream of symbols will be analysed for partial and full periodicities using "segment and symbol periodicity detection".

7. Evaluation

The quality of the analysis will be evaluated using quantitative techniques on annotated data, and also qualitatively by presenting results to users for feedback. To evaluate results quantitatively we will calculate the accuracy of predicted missing data gap. And compare annotated periodicity with detected periodicity in real data.To evaluate periodicity detection qualitatively, we need user involvement. Interviews would be a good way to confirm detected periodicity with users. Cross-user comparison can be used to find out common patterns in user interviews.

References

[1] A. R. Doherty. *Providing effective memory retrieval cues through automatic structuring and augmentation of a lifelog of images*. PhD thesis, Dublin City University, 2009.

[2] H. Lee, A. F. Smeaton, N. E. O'Connor, G. Jones, M. Blighe, D. Byrne, A. Doherty, and C. Gurrin. Constructing a sensecam visual diary as a media process. *Multimedia Systems*, 14(6):341–349, 2008.