Do we dream or do we have a nightmare?

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1. Introduction

Sleep is fundamental

- Four stages of sleep
  - 1, 2, 3, and REM
  - characterized by different properties such as brain wave form, body movement, etc.
  - sleep cycles through these stages
- Pattern of sleep
  - each full cycle through the stages lasts on average 90 minutes
  - when we sleep and how we sleep is largely affected by daily behavior and environmental conditions
  - the more consistent our routine, the better we sleep
  - each person has unique sleep patterns

2. Problem description

Analyze a user's sleep / wake patterns

- Android Application
  - collect accelerometer data during the sleep duration
  - data is stored in cloud server
  - aggregate user data over a period of time (1 week)
- Analyze sleep behavior
  - precise modeling of aggregated user data
  - use collected data to display patterns of sleep
  - optimize to demonstrate saving in one metric of interest (accuracy vs. performance)

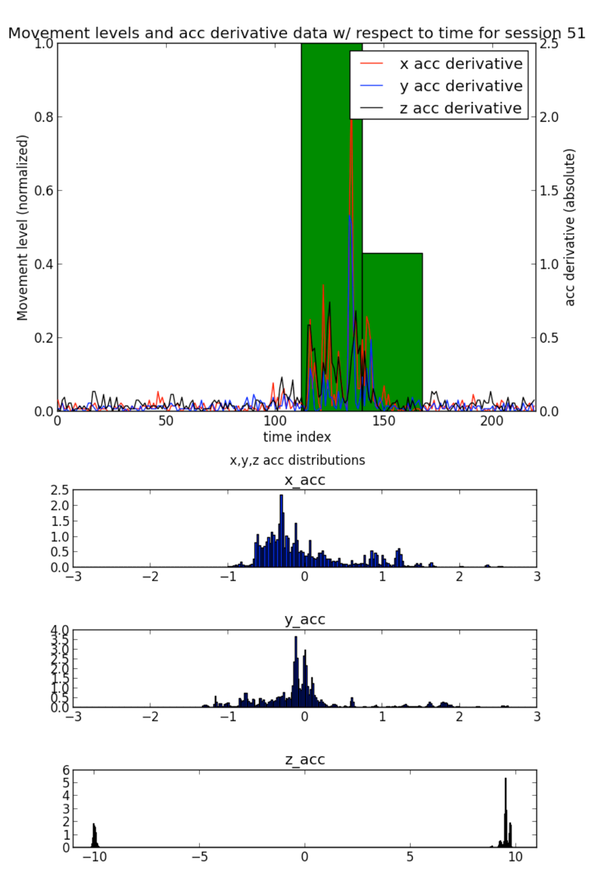
3. Approach

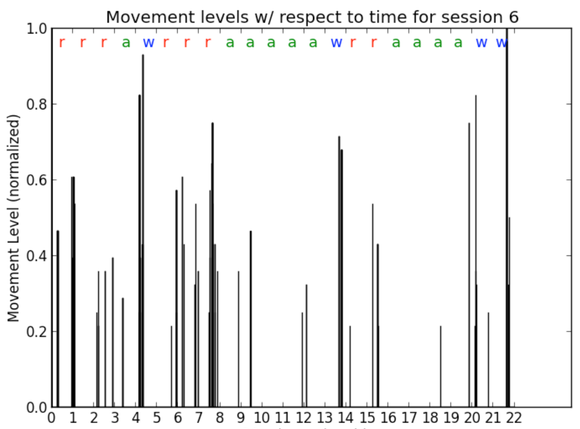
Details

- Data collection
  - android application records five acc readings (x, y, z) per second
  - each user records five sessions where they lay still in different positions (on back, on stomach, on left side, on right side, empty bed)
  - training set of users label each 20 minute time window as "restless", "asleep", or "woke up"
- Identify movements
  - establish acc derivative threshold values [-b1, +b1] for each user's no movement sessions
  - acc reading outside threshold is considered a movement
  - count number of movements within each two second window
- Classify sleep
  - train classifier using aggregated user data to recognize labels for each 20 minute time window
  - update classifier using individualized user behavior information
  - display time-based graph of user sleep with generated labels and key metrics

4. Results

Plots





classification results

	accuracy	precision	recall	f1-score
kNN	0.81	0.84	0.81	0.82
svm	0.83	0.82	0.84	0.82
kmeans	0.69	0.81	0.69	0.73

Summary

- Accurately classifies user's sleep
  - 5 users with a total of 31 nights of acc data
  - classifier learns user's sleep patterns
  - app provides predictions about their sleep patterns