GPS-based Travel Diaries
Handling GPS Signal Loss using Accelerometer Data

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Motivation for automated GPS data processing

Complementation for travel diaries

Reliable information on
• Route choice
• Times
• Short trips / activities

Longer observation periods due to reduced response burden for participants.
Application for automated GPS data processing

Smartphone App: Persuasive Advisor for CO2-reducing cross-modal trip planning

Calculation of CO2 emissions based on automated travel diary

Personalized recommendation of modes and routes based on
• travel history (e.g. mode share, walking speed)
• current mode of transport (near real time)
• trip purpose
Processing framework for GPS and accelerometer data

- cleaning and smoothing
- detection of stop points and stages
  - stop points
    - activities
    - mode transfer
  - trip purpose imputation
- mode identification
- map-matching
- data analysis and application
Stop point and mode identification – up to now

Determine stop points point density, low accelerometer, **GPS gaps**
Calculate features resulting stages
Mode identification using fuzzy rule system
Stop point and mode identification – new approach

Calculate features for overlapping windows:
- More training data
- Near real time capability
- Determination of stop points and mode in one step
Stop point and mode identification – classification problem

GPS, accelerometer

\[\text{calculate features per segment}\]

<table>
<thead>
<tr>
<th>training data</th>
<th>test data</th>
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\[\text{truth} \rightarrow \text{classifier}\]

\[\text{prediction per segment}\]

\[\text{smooth prediction}\]

window size (40s), overlap (50%)

cut timeline in the middle per person

Minimum durations
Activities: 3 min
Walks: 1.5 min
Data

GPS and accelerometer - 1 point / second

[Graph showing speed and accelerometer data over a map of a region.]
Features

GPS:
- Speed (mean, percentiles)
- Density

Accelerometer
- Min, max, mean, standard deviation of the absolute of the accelerometer vector
- Energy and root mean square of STFT (short term fourier transform)
- Mean, max of the change in direction of the accelerometer vector
Random forests: Ensemble of decision tree

A random forest consists of many decision trees. Each tree has one vote.

Randomness:
1. Random subset of observations to grow tree
2. Random feature set to decide on best split
Smoothing predictions

1. **Determine activities**

   - Min duration
   - Min duration

2. **Determine walks**

   - Min duration

3. **Set mode for remaining movements**
Results – bad example
Results – bad example
Results – good example
Results – good example
Results – Metro stages

Activity
Car
Metro
Bike
Walk

truth
prediction

0 200 400 600 800 1000 1200 1400
Conclusion and outlook

Preliminary results promising:
• Distinction between activities and movement is good
• Determination of mode not yet

Improvement potential:
• Use all available data (approx. 10 times more)
• Test different classifiers
• Analyze influence of window size and overlap
• Analyze prediction smoothing (minimum duration)
• Feature selection (e.g. add public transport network)

Define when a diary is well represented
Questions

?
Random forests: Ensemble of decision trees

diameter smaller 3cm?

yes

no

color is green?

yes

no

Apple

Grape

Cherry
First approach: feedback during stop point detection

**moving gap** if simple speed > threshold (5m/s)

use accelerometer of gap to distinguish between movement and no movement / walk