Classification of movement data and user’s activity recognition via mobile phones

Spyridoula Tragopoulou
Harokopio University of Athens
Magdalini Eirinaki
San Jose State University

Iraklis Varlamis
Harokopio University of Athens
varlamis@hua.gr

Contents

- The idea
- Related applications
- Architecture
- Implementation
- Experiments
- Conclusions and future work

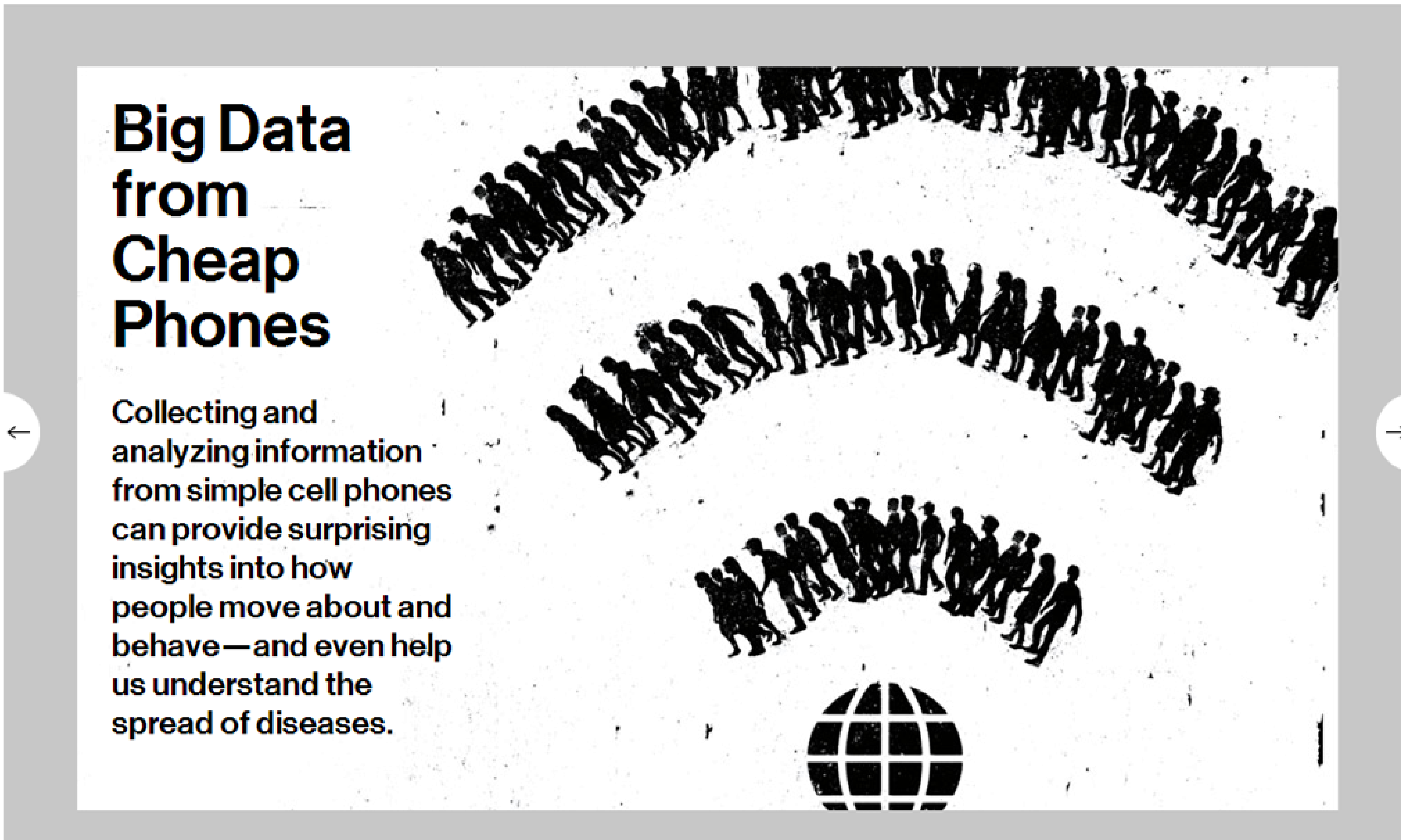
2/6/2014
WIMS 2014 - GPSTracker

THE IDEA

Motivation

MIT Technology Review

10 BREAKTHROUGH TECHNOLOGIES 2013



2/6/2014
WIMS 2014 - GPSTracker

The challenge

- Collect user activity information with a smart-phone
  - Position, speed, altitude and time information
- Analyze collected data using the smart-phone
  - Real-time classification of user’s movement
- Visualize user trail
- Store user information in a data repository for future usage
  - Extract habits and make recommendations

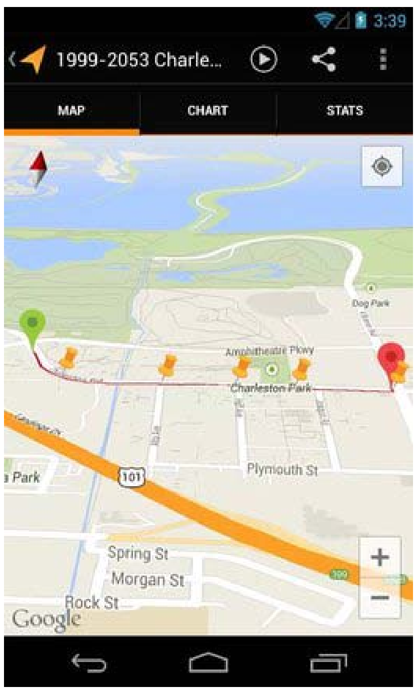
GPSTracker Android Application

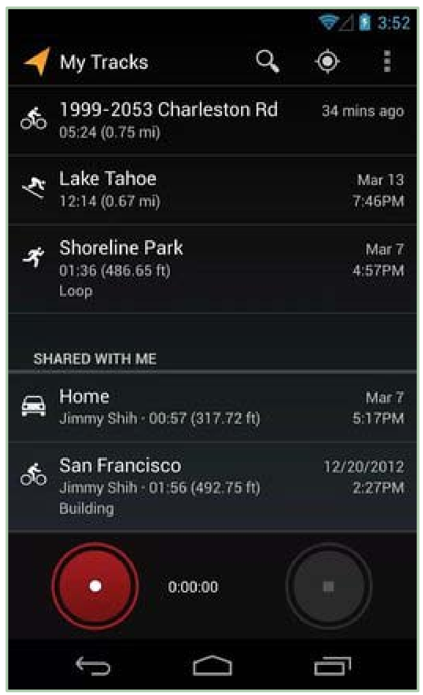
http://galaxy.hua.gr/~it20934/

2/6/2014
WIMS 2014 - GPSTracker

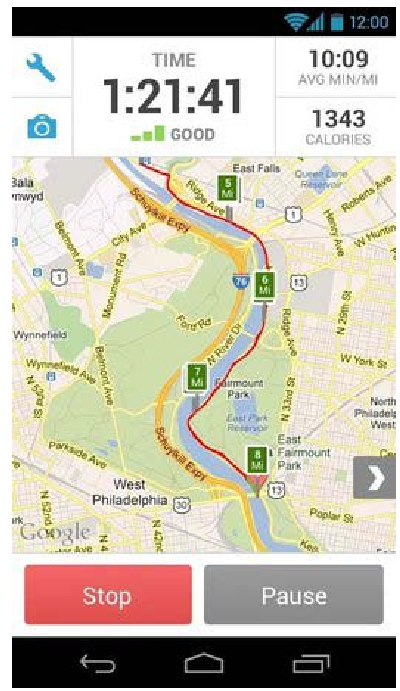
Related Applications

MyTracks





RunKeeper

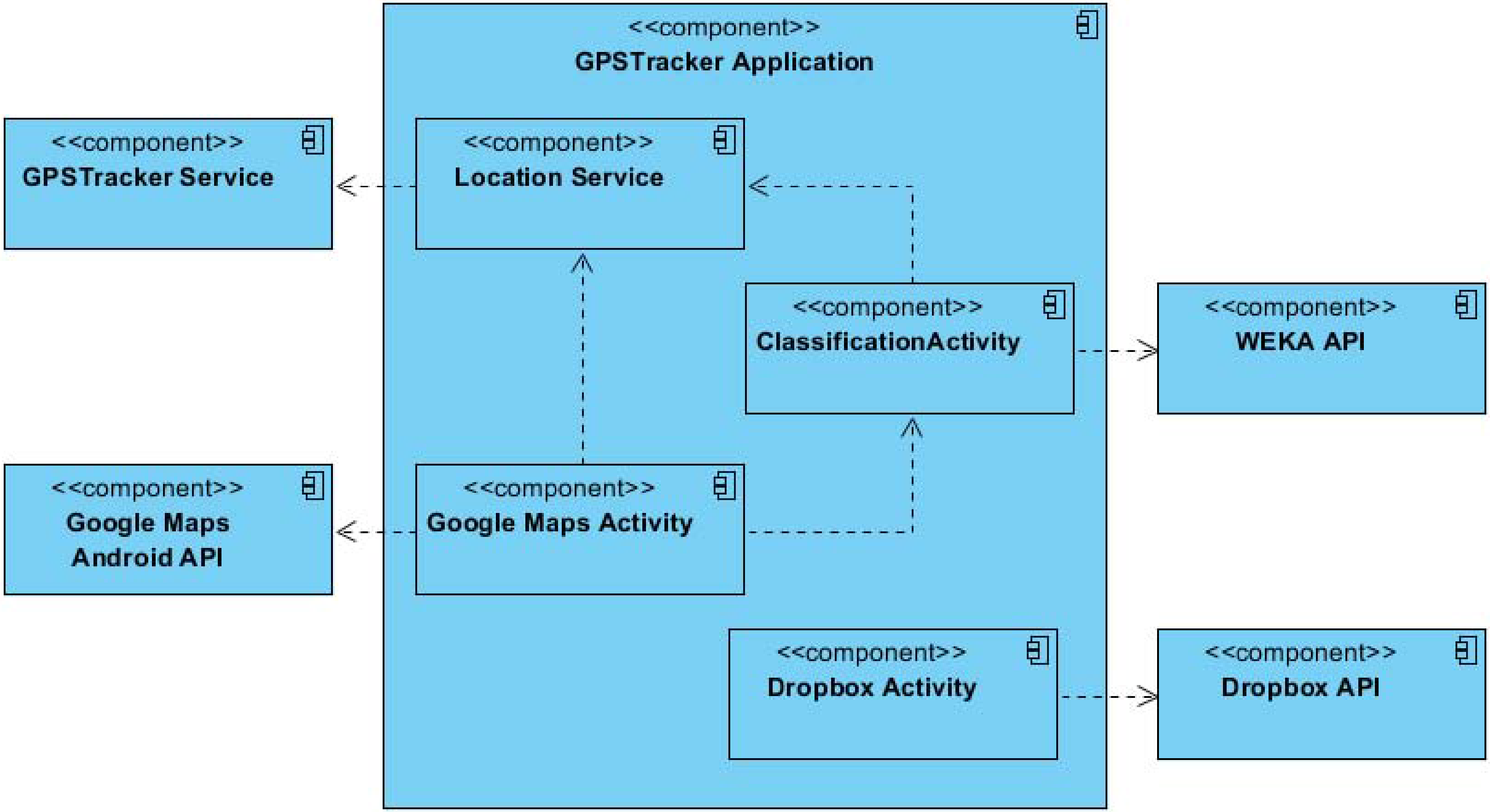


Features

Application	Motion Classification	Show on map	Biosignals
MyTracks	No	Yes	Yes
RunKeeper	No	Yes	Yes
GPSTracker	Yes	Yes	No

2/6/2014 WIMS 2014 - GPSTracker

GPSTracker Architecture



2/6/2014 WIMS 2014 - GPSTracker

Data Recording

- Android Service running in background
- Features
  - Longitude, Latitude, Average speed, Smoothed average speed, Near Metro Station, Altitude, Altitude change, Timestamp, Time zone, Day of the week, GPS Signal status
- An instance (*movement*) every 30 sec

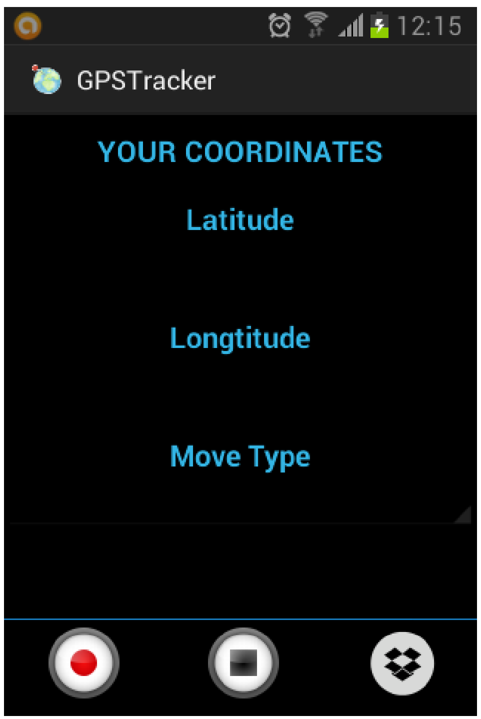
Movement Classification

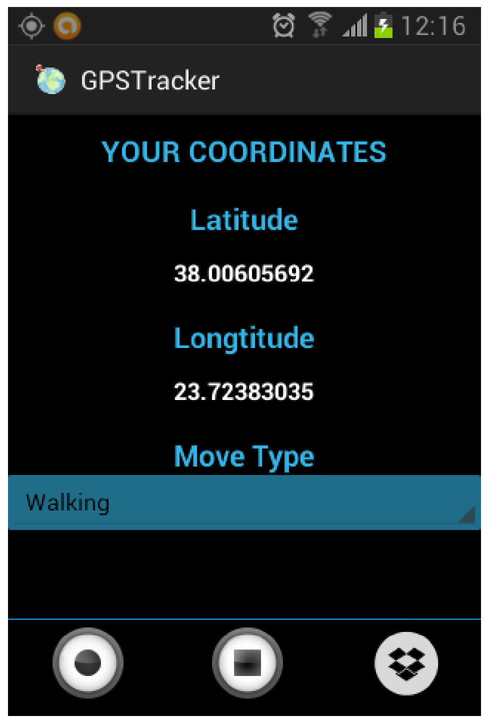
- Recognize the type of each user movement
- Movement Types: Walking, Running, Biking, Driving, Metro, Bus, Motionless

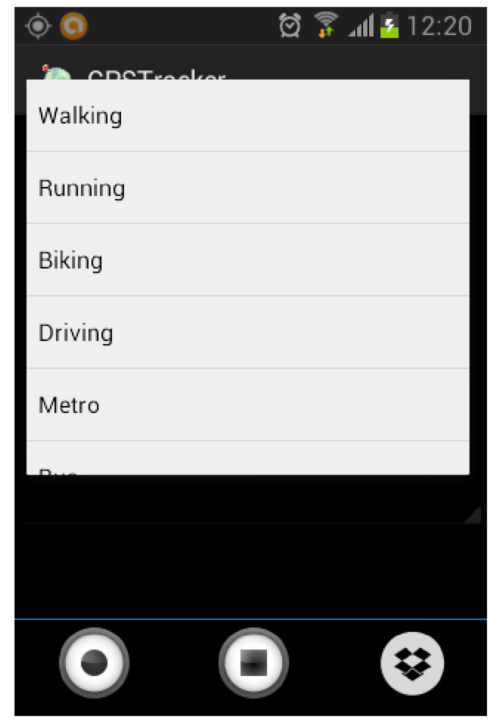
- ***Collect training data*** for every type
- Build a ***classification model***
- Store the model in the device
- Classify every new movement instance

2/6/2014 WIMS 2014 - GPSTracker

Training Data Collection







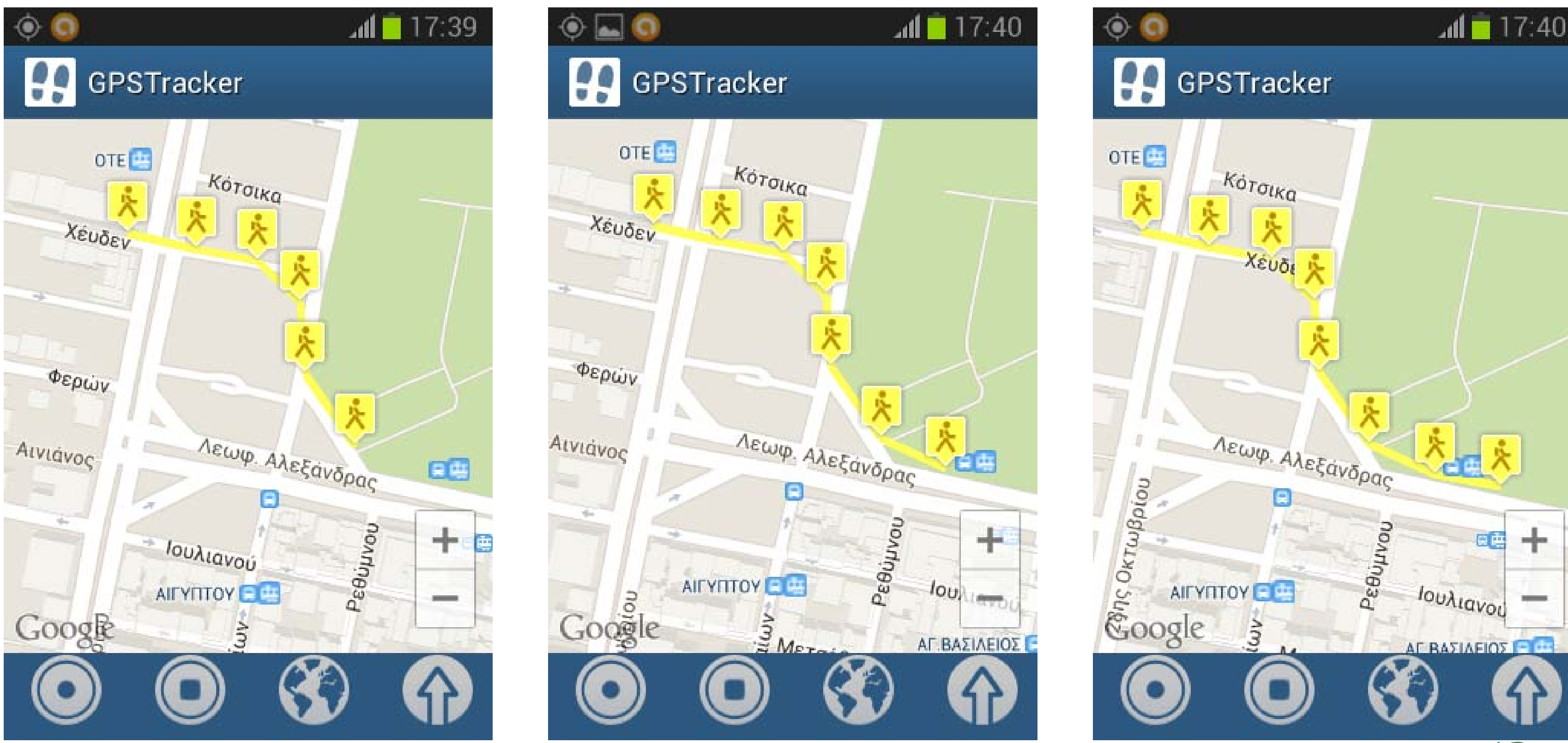
Classification algorithm

- Weka API for Android
  https://github.com/rjmarsan/Weka-for-Android
- Tree-based classifiers
  - Fast predictions on mobile devices
  - Light model
  - Good performance
- RandomForests had the best performance

2/6/2014 WIMS 2014 - GPSTracker

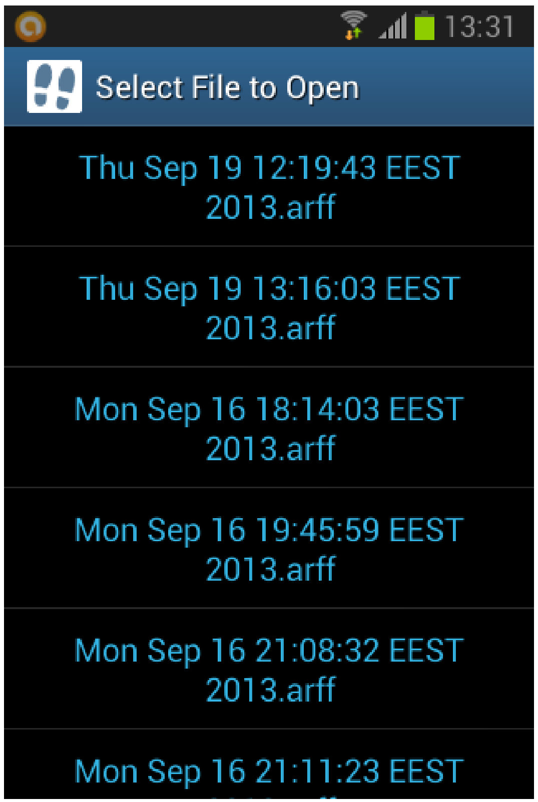
Real-time Trail Visualization

- Google Maps API for Android



IMPLEMENTATION

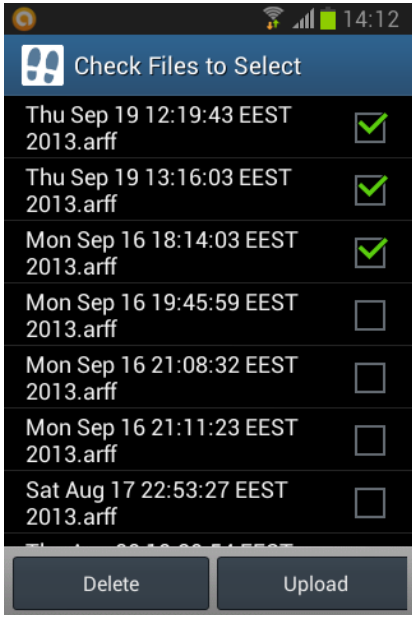
Visualization of stored trails

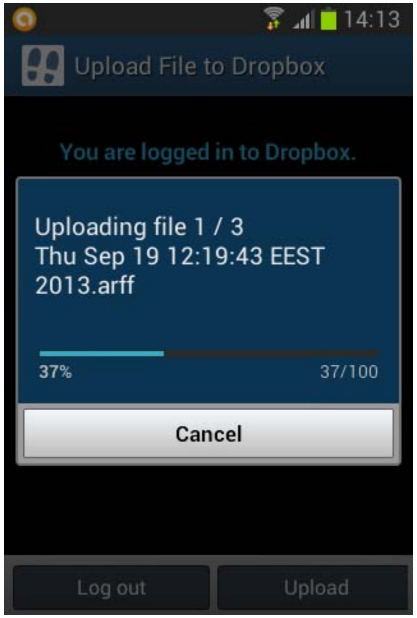


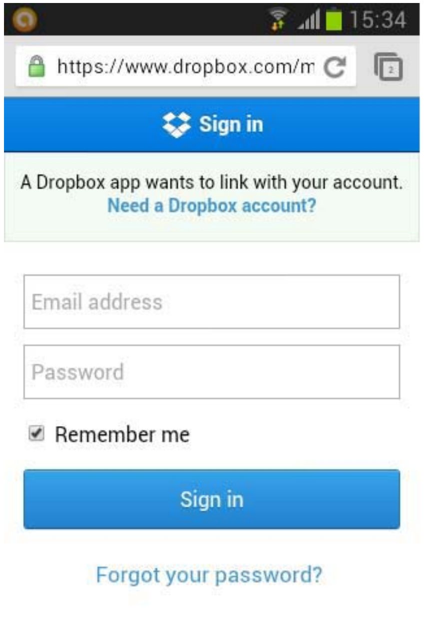
2/6/2014
WIMS 2014 - GPSTracker

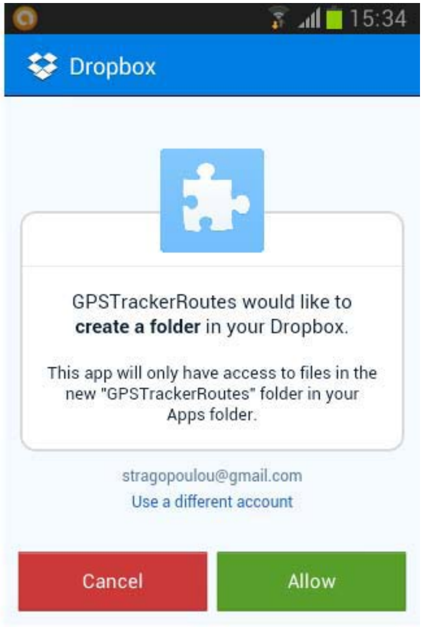
Repository of user trails

- Upload user files to an online data repository
- Use Dropbox API so that data are stored in a private repository for each user









2/6/2014

WIMS 2014 - GPSTracker

Training Dataset

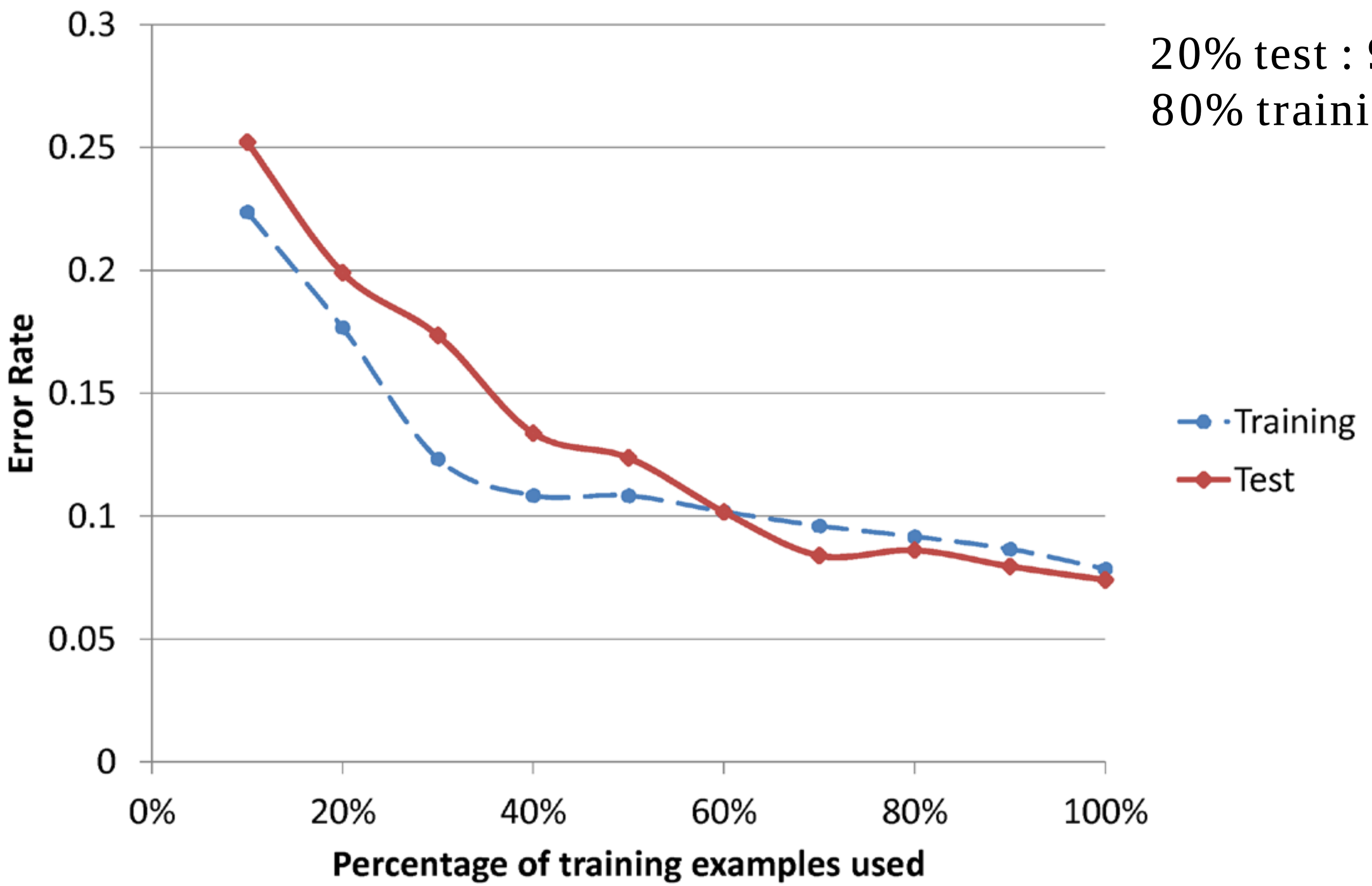
- 4518 training samples
- 10-fold cross validation on the training data
- Tree-based classifiers
- RandomForests had the best performance (92.81±0.99 at 99% confidence level)
- Confident model for movement predictions

Movement Type	Number of training samples
Walking	770
Running	177
Biking	343
Driving	650
Metro	1256
Bus	534
Motionless	788

Algorithm	Accuracy (%)
J48	90.73
LMT	85.79
RandomForests	***92.81***
REPTree	87.61
RandomTree	91.05

2/6/2014 WIMS 2014 - GPSTracker

Learning Curves – Random Forests



20% test : 904 instances
80% training

2/6/2014
WIMS 2014 - GPSTracker

Future Work

- Extension of the set of features for motion classification
- Long term analysis of user information
- Post-processing of movement data from multiple users
  - using a shared data repository (and users' consent)
  - extract significant places and user habits
- Geospatial extension of SQLite RDBMS including public transportation stops and routes, parks, malls and shopping areas
- Personalized notification system

2/6/2014 WIMS 2014 - GPSTracker

Thank you for your attention?

Questions?

2/6/2014 WIMS 2014 - GPSTracker

Accuracy on test data

Algorithm	Accuracy %	Accuracy % (no speed smoothing)
J48	89.12	88.43
LMT	80.47	84.33
RandomForests	*92.14*	92.00
REPTree	86.55	86.71

2/6/2014 WIMS 2014 - GPSTracker

EXTRAS

Confusion matrix on test data

a	b	c	d	e	f	g	<−classified as
135	2	0	2	2	2	11	a = Walking
1	32	0	0	0	0	1	b = Running
1	0	70	0	0	0	0	c = Biking
1	0	0	127	1	0	1	d = Driving
4	0	0	0	243	2	1	e = Metro
12	0	0	0	1	93	1	f = Bus
12	1	0	1	4	1	139	g = Motionless

2/6/2014
WIMS 2014 - GPSTracker