Aalto University
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Mobile User Context Quantified

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Outline

- Introduction
- What is mobile user context?
- How we see mobile user context?
- Results from our mobile user context research
- Future work
- Conclusions

Introduction

- Context information is regarded as one of the key components in developing services and user experiences that adapt to mobile users' capabilities and needs
- Proper usage of context information will benefit a range of stakeholders from the end users to mobile service providers and all the way to, for example, retail stores
  - E.g., McKinsey (2011) estimates there is globally a $600 billion potential annual consumer surplus of using personal location data
- Collection of rich context data is enabled by the new and more capable mobile devices (e.g., smartphones)
  - Our research is based mainly on handset-based data collected directly from smartphones of opted-in panelists

What is mobile user context?

- **Context:** ’*the interrelated conditions in which something exists or occurs’* (**Merriam-Webster online dictionary)**
- **Context in the ubiquitous computing community:** *’Context is any information that can be used to characterize the situation of an entity’* (Dey, 2001)
- Dey’s definition of context is the most cited one and possibly the most useful in the mobile domain
- Thus, following Dey**: Mobile user context** *is any information that can be used to characterize the situation of a mobile user*

How we see mobile user context?

- **We have divided mobile user context into:**
  - General context categories (personal, environmental context)
  - Data source based categories (profiled, sensed, derived context)
- **Easier to communicate which context elements are studied**

	Personal Context			Environmental Context		
	User	**Social Environment**	**Activity/Task**	**Conditions**	**Infrastructure**	**Location**
Profiled Context*	identity age gender nationality	phone contacts	meeting, etc. (from calendar entries)	visible conditions (from user taken photos, videos)	device operating system	semantic place (from user tags) place of an event (from calendar)
Sensed Context	heart rate body temp. blood pressure	surrounding devices noise level/voices	calling messaging using apps	temperature noise level pressure light level	battery level signal strengths access alternatives device orientation	coordinates network cell altitude velocity, acceleration
Derived Context	at sleep/awake health condition physical state mental state	surrounding people co-location social network	commuting studying buying etc.	weather day/night summer/winter	network quality device operating range (in time, in distance)	semantic place indoors/outdoors stationary/moving transport mode

Time

* In addition to provided examples, includes everything that can be asked directly from the user

Research on mobile user context

	Personal Context			Environmental Context		
	User	Social Environment	Activity/Task	Conditions	Infrastructure	Location
Profiled Context	**Identity** (User ID) **Gender** **Age**					**Semantic place** (User tags for: Home, Office/School, Other meaningful, Elsewhere)
Sensed Context			**Application usage**			**Network cell IDs** **WLAN Acces Points**
Derived Context						**Semantic place** (Categories: Home, Office/School, Other meaningful, Elsewhere)

Time

Our research

Profile of current handset-based mobile user context research (~20 articles)

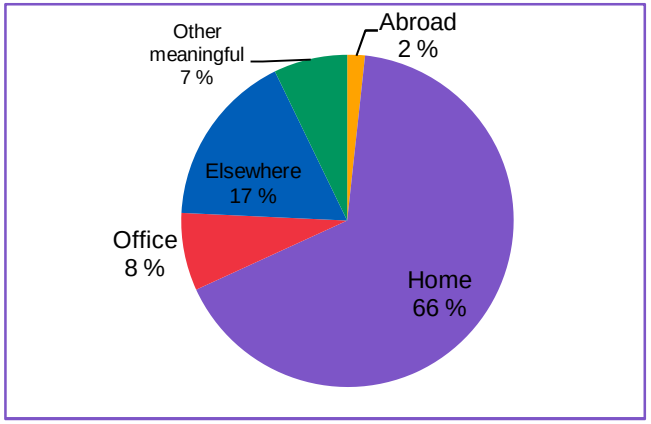
	Personal Context			Environmental Context		
	User	Social Environment	Activity/Task	Conditions	Infrastructure	Location
Profiled Context	5 %	2 %	1 %	1 %	1 %	2 %
Sensed Context	0 %	7 %	18 %	7 %	5 %	29 %
Derived Context	4 %	4 %	0 %	2 %	0 %	12 %

Time

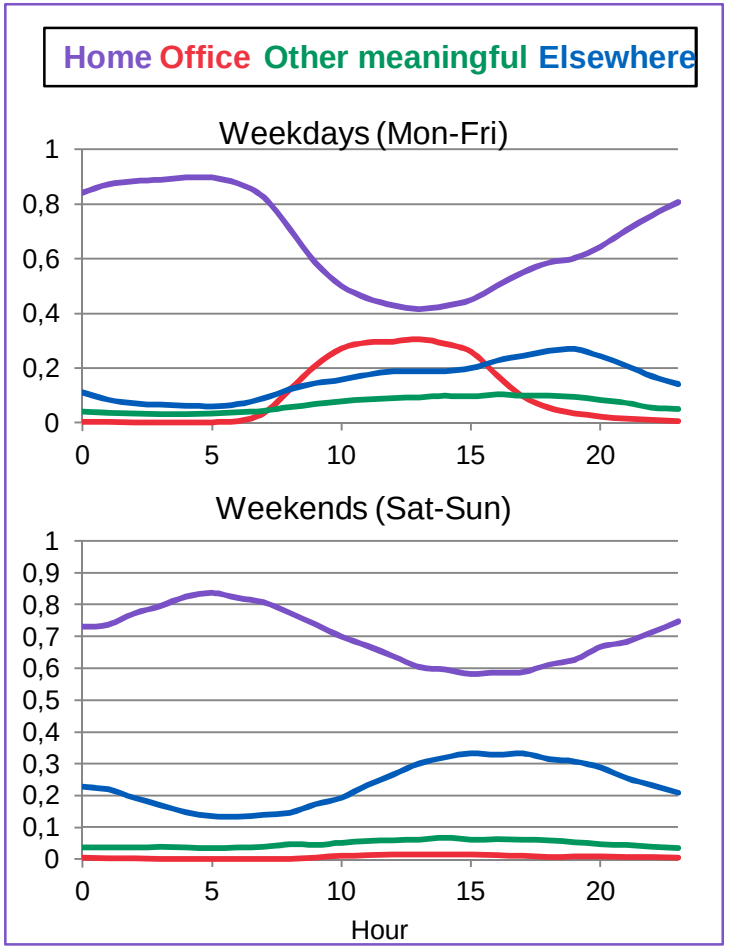
Contextual user behavior in general

$N = 140$

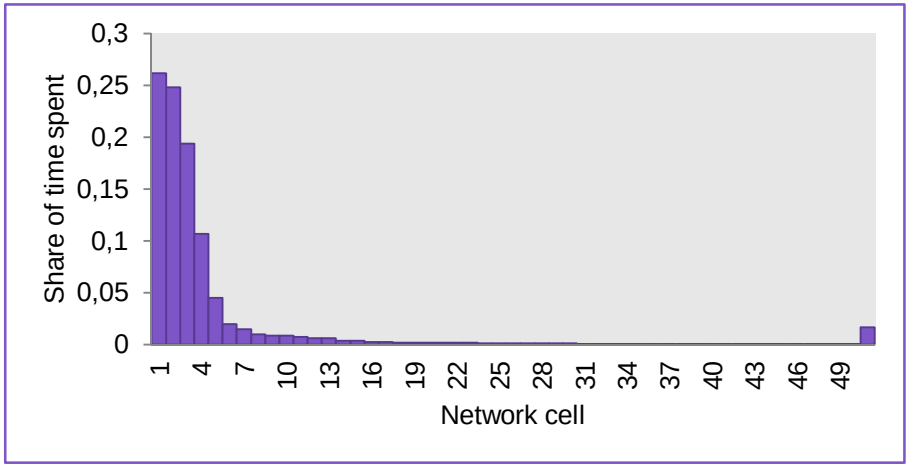
Time spent in different contexts



Hourly distribution of time spent

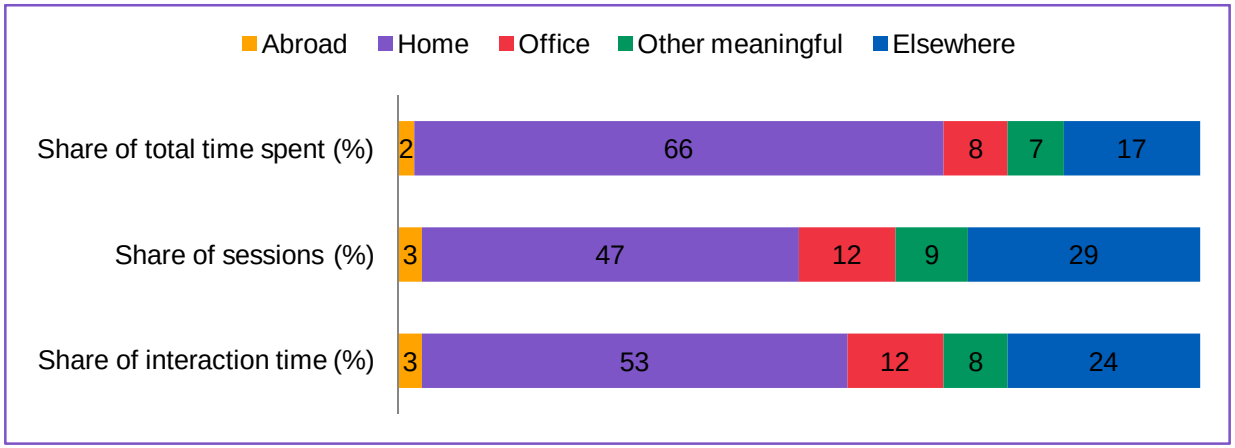


Time spent in different network cells (example user)

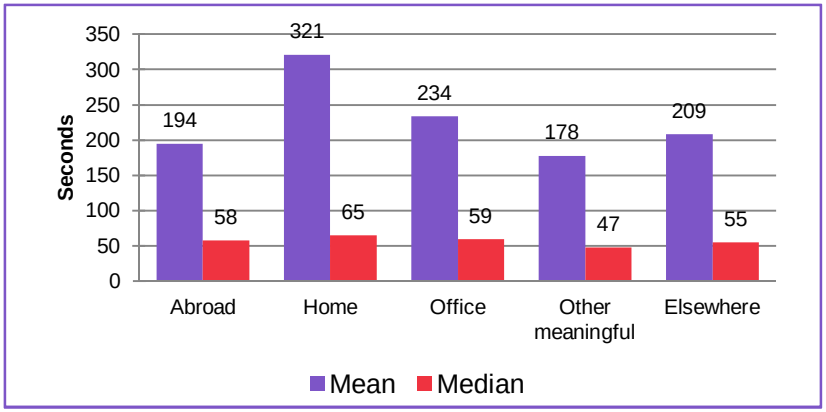


Contextual usage of smartphones

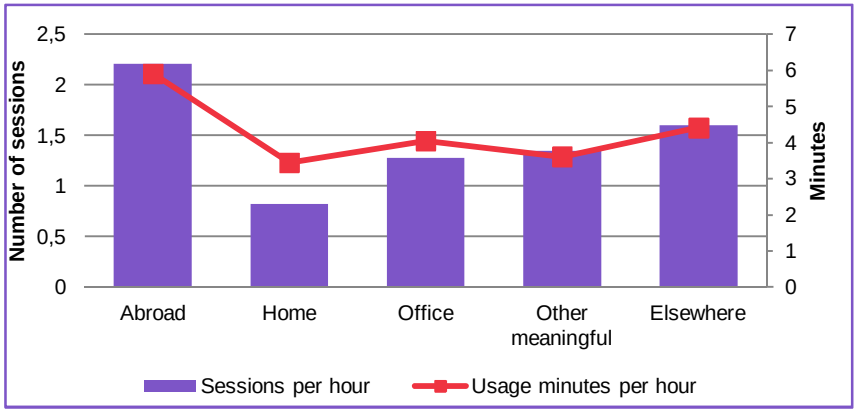
Shares per user context



Mean and median session lengths per context

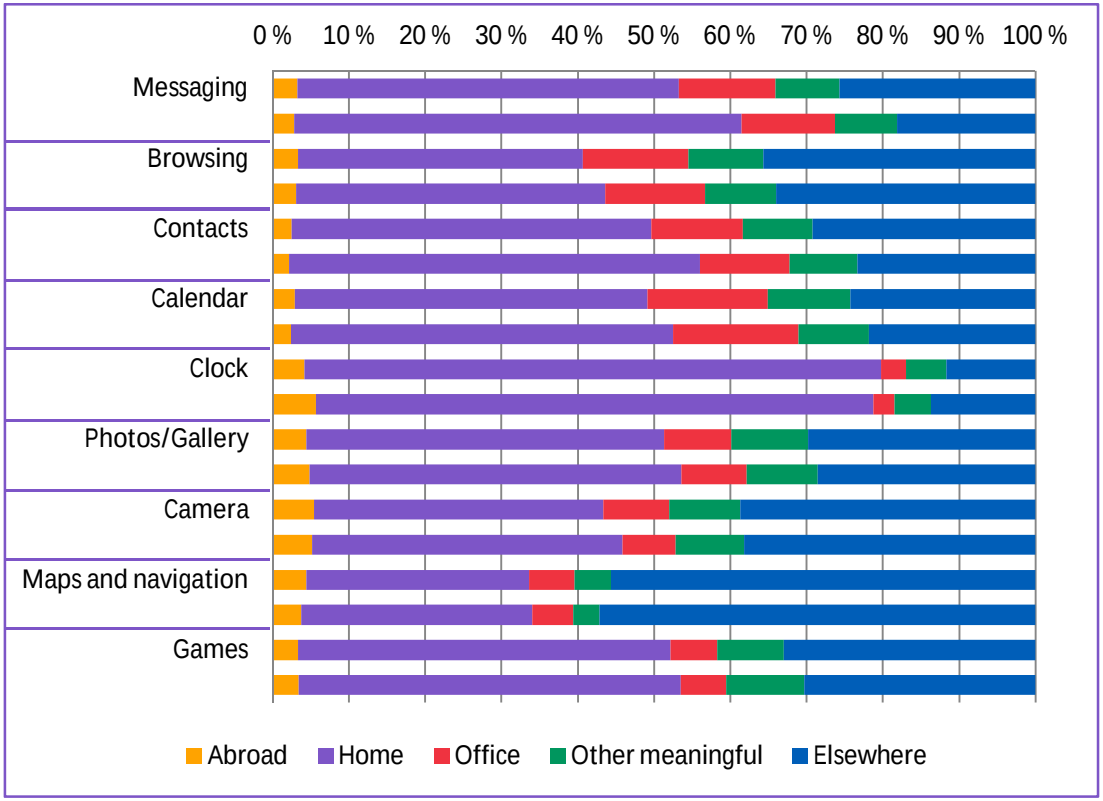


Usage intensity per context



Contextual usage of smartphone applications

Usage per context; application launches (top), usage time (bottom)



Overall usage

	% of launches	% of usage time
Messaging	21.01 %	23.10 %
Browsing	11.71 %	15.99 %
Contacts	14.82 %	14.95 %
Calendar	3.98 %	4.63 %
Clock	4.68 %	5.51 %
Photos/Gallery	1.33 %	1.29 %
Camera	1.89 %	1.69 %
Maps and Navigation	2.24 %	3.70 %
Games	0.78 %	2.37 %

Future work

- **Expand the context coverage**
  - E.g., transport mode; buying, commuting and social contexts
- **Combining context information for deeper insights**
  - E.g., user's route to buying: from where -> with what transport -> what was bought -> to where (and with what transport)

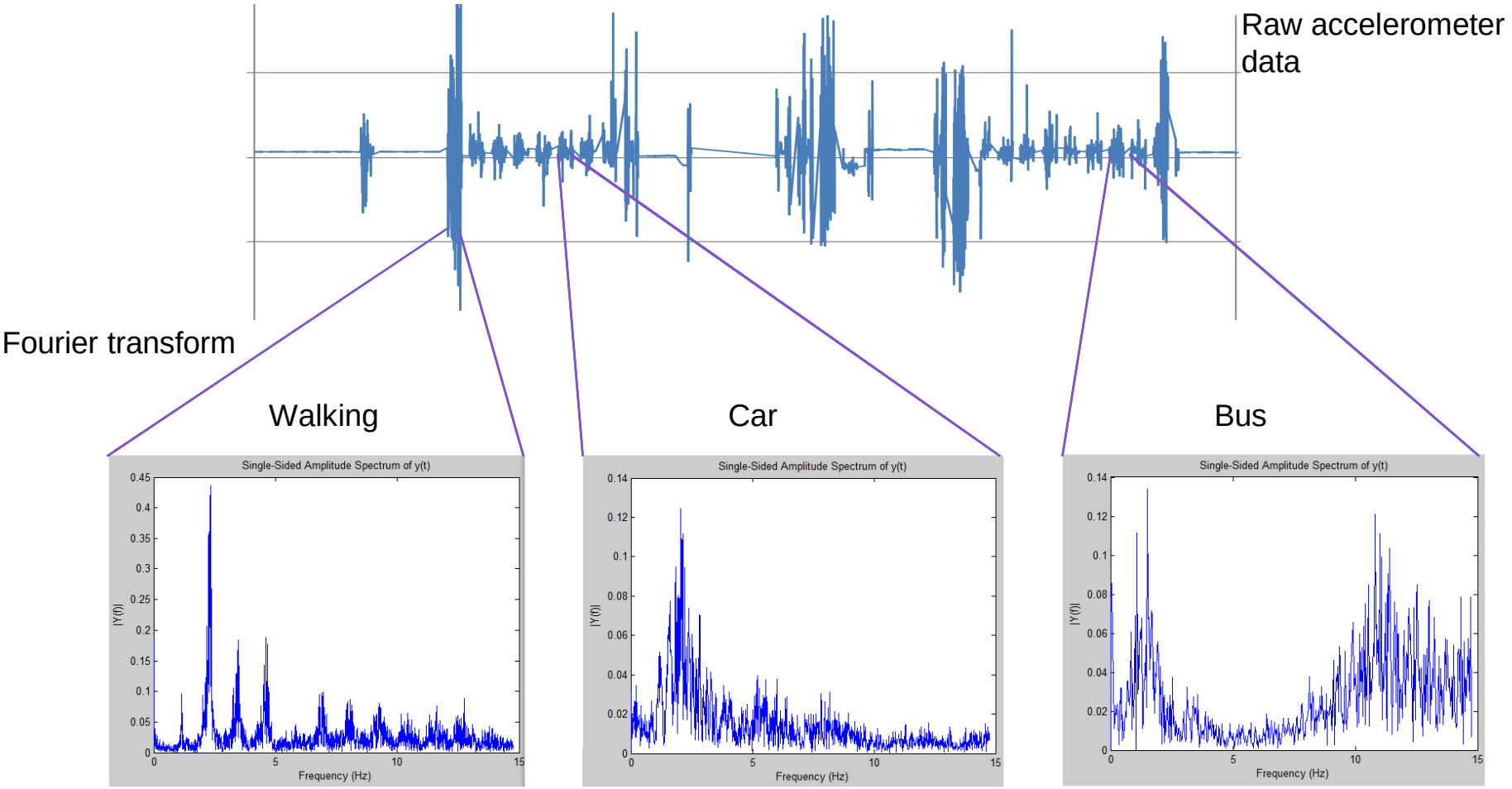
	Personal Context			Environmental Context		
	User	Social Environment	Activity/Task	Conditions	Infrastructure	Location
Profiled Context	Identity (User ID) Gender Age					Semantic place (add: store, etc.) Transport mode
Sensed Context		Surrounding devices	Application usage		Signal strengths Connection speed	Network cell IDs WLAN Acces Points Acceleration GPS, Velocity
Derived Context		Surrounding people	Commuting Buying		Network quality	Semantic place (add: store, etc.) Moving/stationary Transport mode

Time

Previous work

Future work

Future work: Transport mode example



Conclusions

- **In general, information about (mobile user) context is regarded important**
  - However, the term context is sometimes used as a ”buzzword” and even in research settings its usage can be somewhat unclear
- **We have provided a framework or a categorization for communicating clearly context elements under study**
- **We have also shown that certain context elements (semantic place) affect the usage of smartphones**
- **This paves way for future research where the view on mobile user context can be expanded in order to gain deeper insights of mobile user behavior**

Thank you!

- **The presentation is based on the following research articles:**
  - Soikkeli, T., Karikoski, J. and Hämmäinen, H. (2013). Characterizing Smartphone Usage: Diversity and End User Context. International Journal of Handheld Computing Research, 4 (1), pp. 15-36.
  - Karikoski, J. and Soikkeli, T. (2013). Contextual usage patterns in smartphone communication services. Personal and Ubiquitous Computing, 17 (3), pp. 491-502.
  - Soikkeli, T., Karikoski, J. and Hämmäinen, H. (2012). An end-user context framework for handset-based studies. The 19th ITS Biennial Conference. Bangkok, Thailand, November 18-21 2012.
- **Other references:**
  - Dey, A.K. (2001). Understanding and Using Context. Personal and Ubiquitous Computing, 5 (1), pp. 4-7.
  - McKinsey & Company (2011). Big data: The next frontier for innovation, competition, and productivity. At: http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation