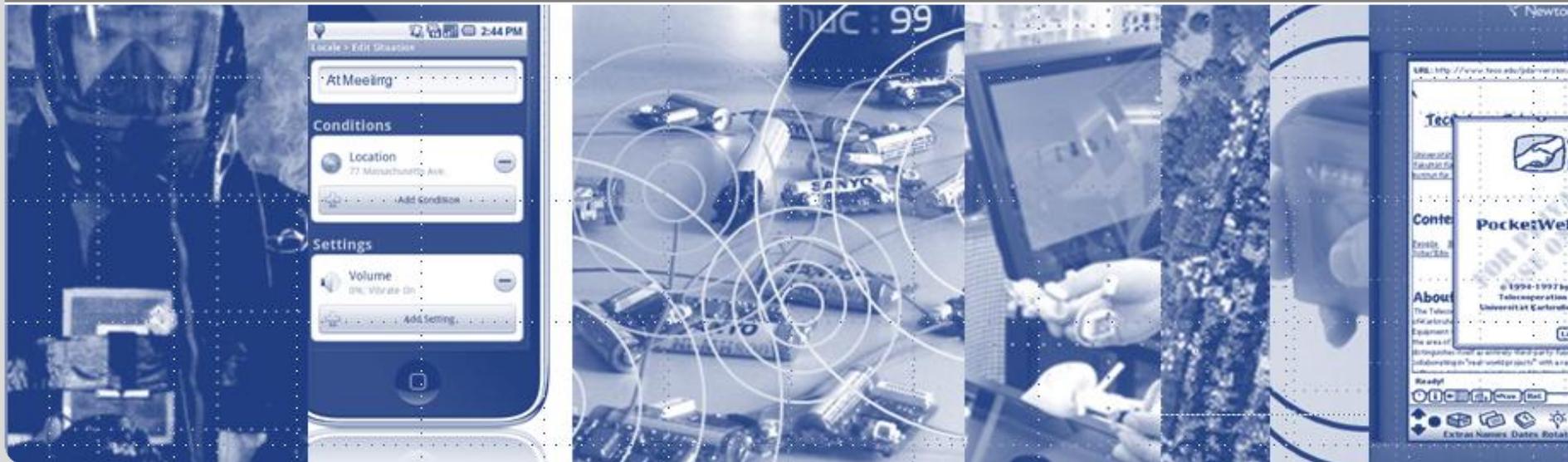


Group Activity Recognition using Mobile Devices

Doctoral Colloquium – PERVASIVE 2012 – Newcastle, England

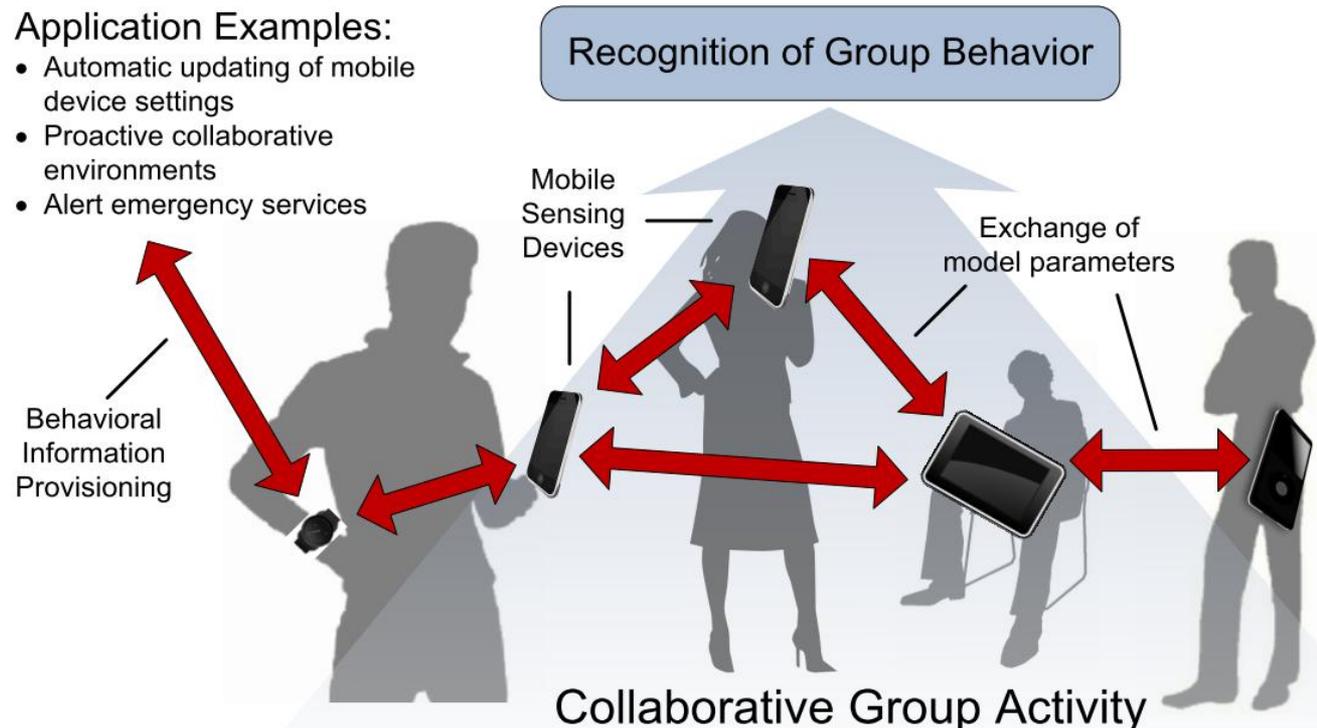
Dawud Gordon, Karlsruhe Institute of Technology (KIT), TecO
gordon@teco.edu, <http://www.teco.edu/~gordon/>



What is Group Activity Recognition?

- Human / Single-user (HAR)
 - Track activities of a single user over period of time
- Multi-user (MUAR)
 - Tracking activities of several users in parallel
 - Solo, cooperative, conflicting activities
- Group (GAR)
 - Group is an abstract entity: **organism**
 - Emergent behavior based on activities and interactions of individuals: **flocking**
 - GAR is estimation of group behavior classes:
 - Analogous to HAR with multiple sensing modalities/locations, but **interactions complex**

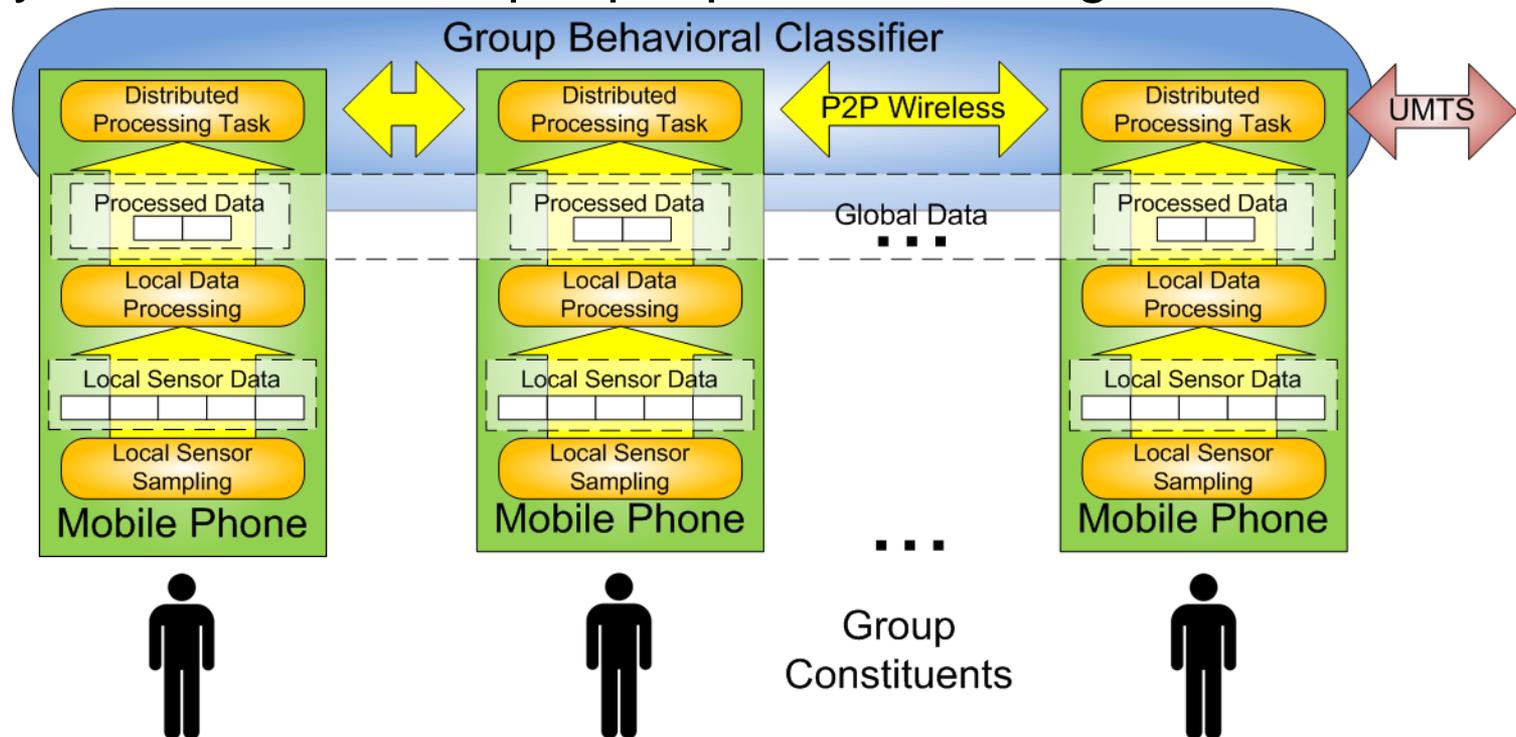
- Devices of group members can collaborate to estimate group behavior being generated
 - Recognition in mobile sensing network solves **infrastructure issues**



Research Questions

■ Problems

- Distributed execution – reducing communication/processing
- Observing identity – not just what...but from whom?
- Dynamic membership – people come and go



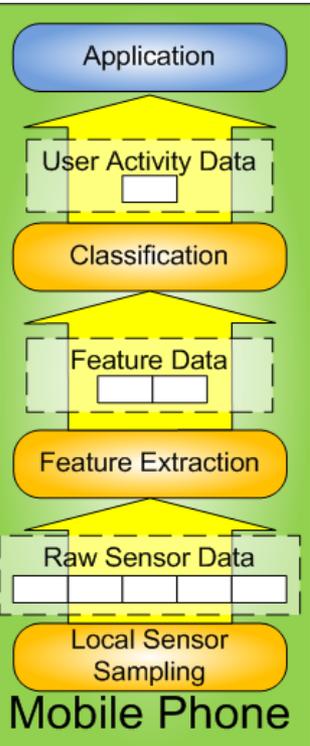
Gordon et al.: Recognizing Group Activities using Wearable Sensors

Before We Start - Abstraction Level?

- How high up the context/activity data processing chain should distributed fusion to group activity be carried out?
 - Explored using distributed sensing system
 - Using distributed features provides **high accuracy**
 - Clustering data is **promising**
 - Using local activity information presents **several issues**

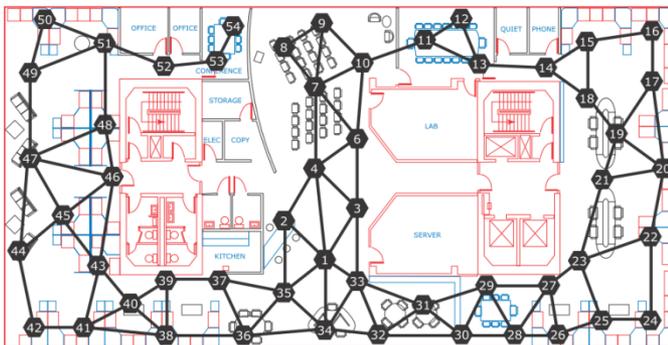
■ Status: **complete** ✓

Data Basis	DT	
	Acc.	F-meas.
Features	0.962	0.962
Clusters	0.762	0.764
Activities	0.507	0.524



Distributed Classification – Probabilistic Appr.

- Distributed probabilistic inference (DPI) using belief propagation (BP)
 - Evaluated for distributed sensor calibration
- Usefulness for GAR will be evaluated
 - **Human factor**: human interaction more complex than sensors
- How DPI-BP works
 - 1) Estimate group activity based on local sensors
 - 2) Exchange estimation with neighbors
 - 3) Re-estimate using local sensors + neighbor estimations
 - 4) repeat from 2
- Converges to “correct” answer
- single-user, multiple sensor location experiments: **in progress**
- Multiple-user, single sensor location (iPhone): **planned**



Paskin & Guestrin.: Robust Probabilistic Inference in Distributed Systems

$$\Pr \{ \mathbf{X}, \mathbf{M} \} = \underbrace{\left[\frac{1}{Z} \prod_{\mathbf{C} \in \mathcal{C}} \psi_{\mathbf{C}}(\mathbf{C}) \right]}_{\text{factorized prior } \Pr \{ \mathbf{X} \}} \prod_{k=1}^K \underbrace{\Pr \{ M_k \mid \mathbf{B}_k \}}_{\text{measurement model}}$$

Dynamic Membership – using Role

- Problem: people come and go, each individual affects group behavior differently
 - Experience (prior) learned for one individual may not fit the next one
- Solution, **factorize prior using social role** of individual
 - Role: characterization of behaving similarly w.r.t. to the group activity
 - Assumption: priors transferrable within role
 - Requires expert knowledge of roles a priori
 - People may change roles (out of scope)
- **Evaluation:**
- Simulate replacement of subjects in a group data set
- Exchanging subjects of same role vs. random
- **Crunch zone!**

Further uses of Role

- Role can be seen as **user's bias** to a group activity
- Extracting a user's role
 - If the group activity is known: infer role
 - Over time, estimations of social role of members improves, converging.
- Using role to improve GAR
 - If role is known: infer activity
 - Knowing a member's bias improves inference of correct group activity
- **Evaluation:**
 - Role recognition using human flocking behavior data set
 - Roles: leader and followers in a flock
 - Planned time line: Sep. through Nov. 2012 at IfE / WCL (Dr. Roggen) ETH

Conclusion

- GAR presents a novel problem
 - Similar to HAR: but complex interactions between members
 - Similar to MUAR: distributed sensing but total is more than sum of individuals
- Complexity of **human interactions** and **dynamic group membership** pose issues
- **DPI+BP** is a promising distributed approach
- **Roles** can solve dynamic group membership issues
- Expected result: DPI+BP with prior factorized over roles provides generalizable solution for GAR