Sociability-Driven User Recruitment in Mobile Crowdsensing Internet of Things Platforms

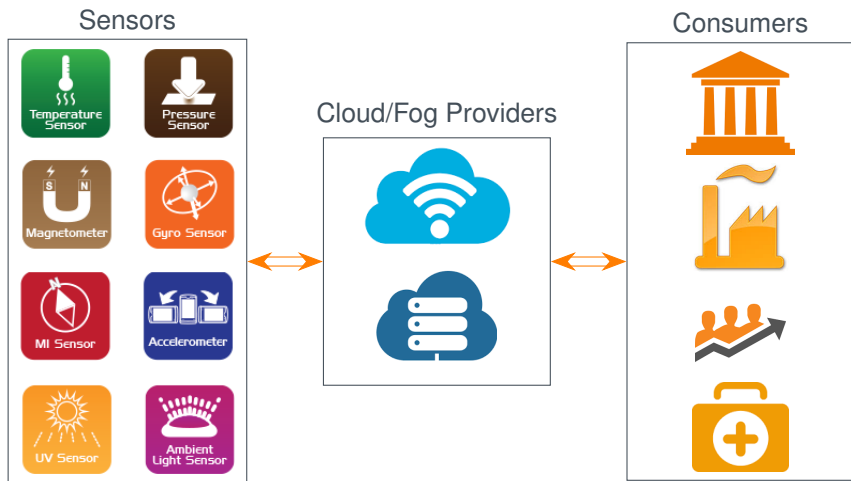|		
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Smart Cities: Introduction

- ▶ 50% of worldwide population lives in cities
- ▶ Cities account for
  - ▶ 80% of worldwide gas consumption
  - ▶ 75% of global energy consumption
  - ▶ 60% of residential water use

N. B. Grimm, S. H. Faeth, N. E. Golubiewski, C. L. Redman, J. Wu, X. Bai, and J. M. Briggs, "Global change and the ecology of cities," in Science, vol. 319, no. 5864, 2008, pp. 756–760.

Sensing as a Service (S²aaS) for IoT

Sensors

Temperature Sensor · Pressure Sensor · Magnetometer · Gyro Sensor · MI Sensor · Accelerometer · UV Sensor · Ambient Light Sensor

Cloud/Fog Providers

Consumers

Mobile Crowdsensing

- Appealing paradigm for sensing and collecting data
  - Monitoring phenomena in smart cities
- Sensing as a Service (S^2aaS) business model
- Sensors commonly available in mobile and IoT devices

Mobile Crowdsensing

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Figure: Diffusion of mobile devices

Mobile Crowdsensing

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Figure: Diffusion of mobile devices

► Two sensing paradigms

Participatory

► Active user engagement
► Sensing and reporting user-driven
► Centralized, direct task assignment

Opportunistic

► Minimal user involvement
► Sensing and reporting application- or device-driven
► Distributed, no direct task assignment

User Recruitment in Mobile CrowdSensing

The recruitment problem

- ▶ Select users able to fulfill the task with high accuracy
- ▶ Minimize costs of the organizer/users
- ▶ Recruit a minimum number of users N

- ▶ Factors define user eligibility
  - ▶ Distance from sensing task
  - ▶ Sociability

- ▶ Task acceptance driven by sociability
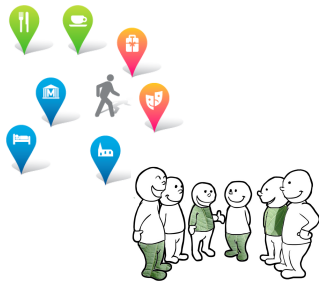
Recruitment Modes
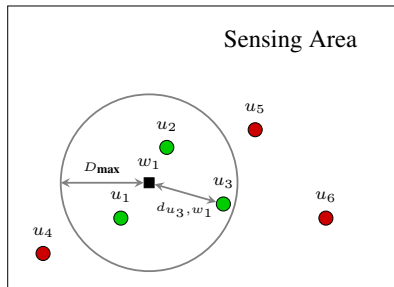
▶ Select users with highest recruitment factor r_i:

$$r_i = \alpha \cdot \frac{1}{d_{u_i,w_j}} + (1 - \alpha) \cdot s_i;$$

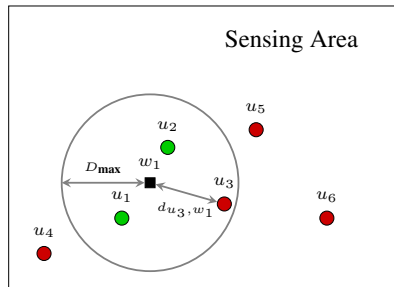 ▶ d_{u_i,w_j}: distance location user u_i and task w_j
  ▶ s_i: sociability

▶ Two modes
  ▶ $\alpha = 0 \longrightarrow$ Sociability-Driven Recruitment Mode (SDRM)
  ▶ $\alpha = 1 \longrightarrow$ Distance-Based Recruitment Mode (DBRM)

Example

■ w_i: Sensing task i; ● u_j: User j assigned to task i ● u_k: User k not assigned to any task.

(a) SDRM

(b) DBRM

Sociability Factor: $s_1 = 0.8$; $s_2 = 0.9$; $s_3 = 0.7$; $s_4 = 0.25$; $s_5 = 0.1$ $s_6 = 0.5$.

CrowdSenSim

- Custom simulator for crowdsensing activities
  - Access and download: `http://crowdsensim.gforge.uni.lu`
  - Contact: `crowdsensim@gmail.com`

CrowdSenSim Mobile Crowdsensing Simulator

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About the Simulator

CrowdSenSim is a discrete-event simulator designed for research use in Mobile Crowd Sensing. It allows simulation of large-scale crowd sensing activities in urban scenarios and can be used to develop novel solutions in data collection, task assignment, monitoring and resource management. It is released under the GNU General Public License version 3.
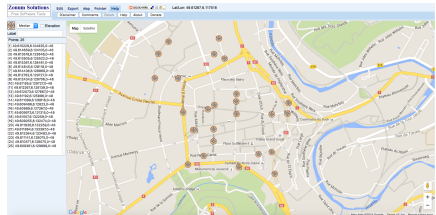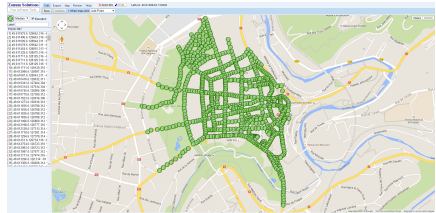
© 2015-2016 - CrowdSenSim - University of Luxembourg
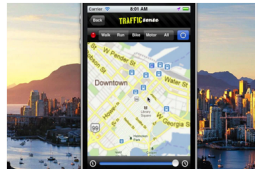
CrowdSenSim: Features and Architecture

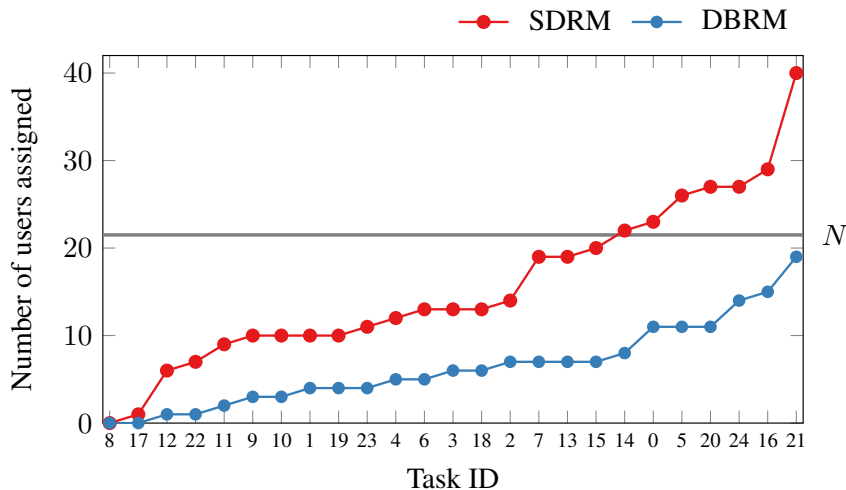- Large scale (time-space)
- Realistic urban environments
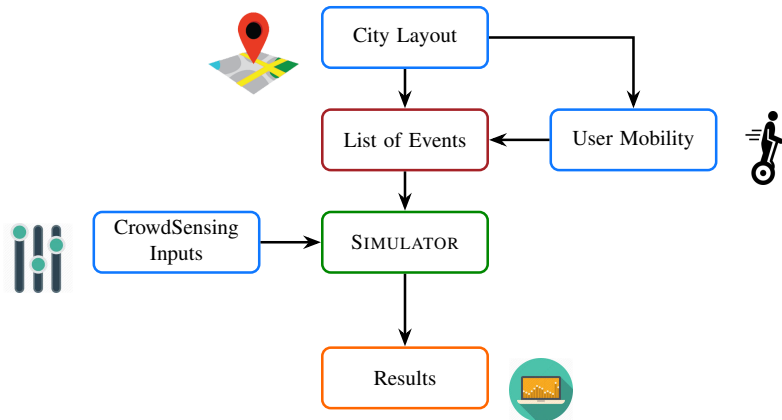
Evaluation Settings

- Luxembourg City center

- Users: 1000-10 000
- Walking speed: $\mathcal{U}$ [1 − 1.5] m/s
- Walking period: $\mathcal{U}$ [10 − 30] min
- Simulation period: 8 AM - 2 PM

- Set of 25 tasks
- Task duration: {20; 25; 30; 35; 40; 45; 50} timeslots
- D_{max}: 30m

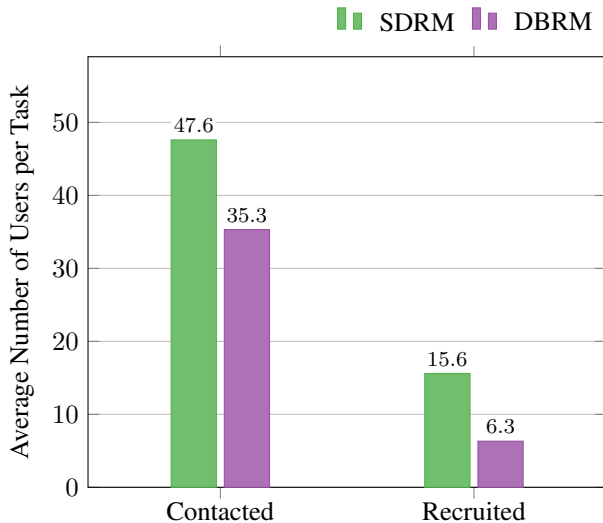# Number of Assigned Users per Task

▶ SDRM always outperforms DBRM in assigning users to the tasks

Average Number of Contacted vs. Recruited Users

Conclusion

Summary

▶ Sociability-based recruitment policy
▶ Performance evaluation in large scale realistic urban environments

Take home message

▶ Sociability essential to improve recruitment
▶ **CrowdSenSim**: simulator for Mobile Crowdsensing
  ▶ Access and download: `http://crowdsensim.gforge.uni.lu`
  ▶ Contact: `crowdsensim@gmail.com`

Thank You!

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`<claudio.fiandrino@gmail.com>`
`<claudio.fiandrino@uni.lu>`