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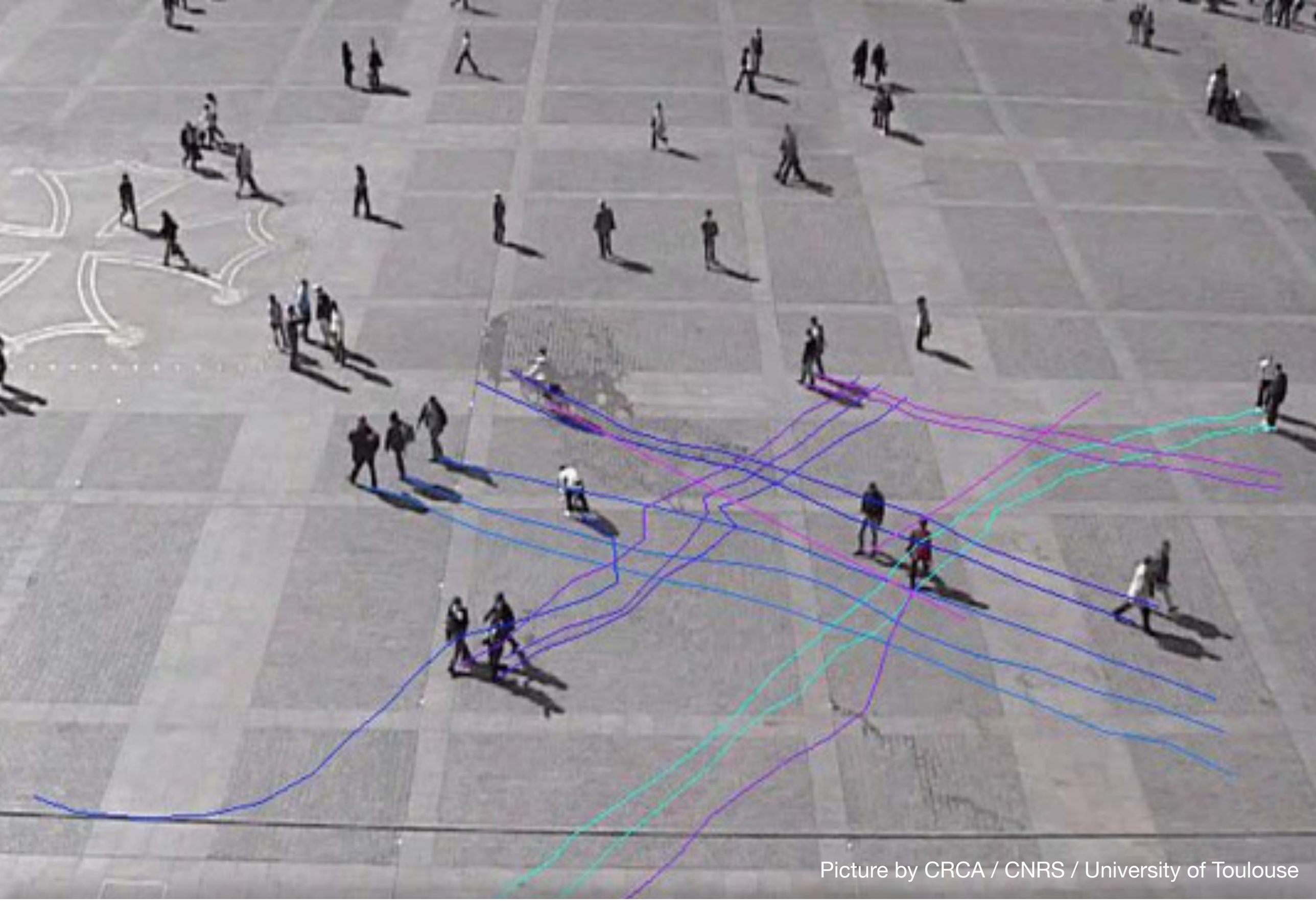
Detecting Group Formations using iBeacon Technology

Kleomenis Katevas, Hamed Haddadi, Laurissa Tokarchuk, Richard G. Clegg

https://www.sensingkit.org

4th International Workshop on Human Activity Sensing Corpus and Application:
Towards Open-Ended Context Awareness



Picture by CRCA / CNRS / University of Toulouse

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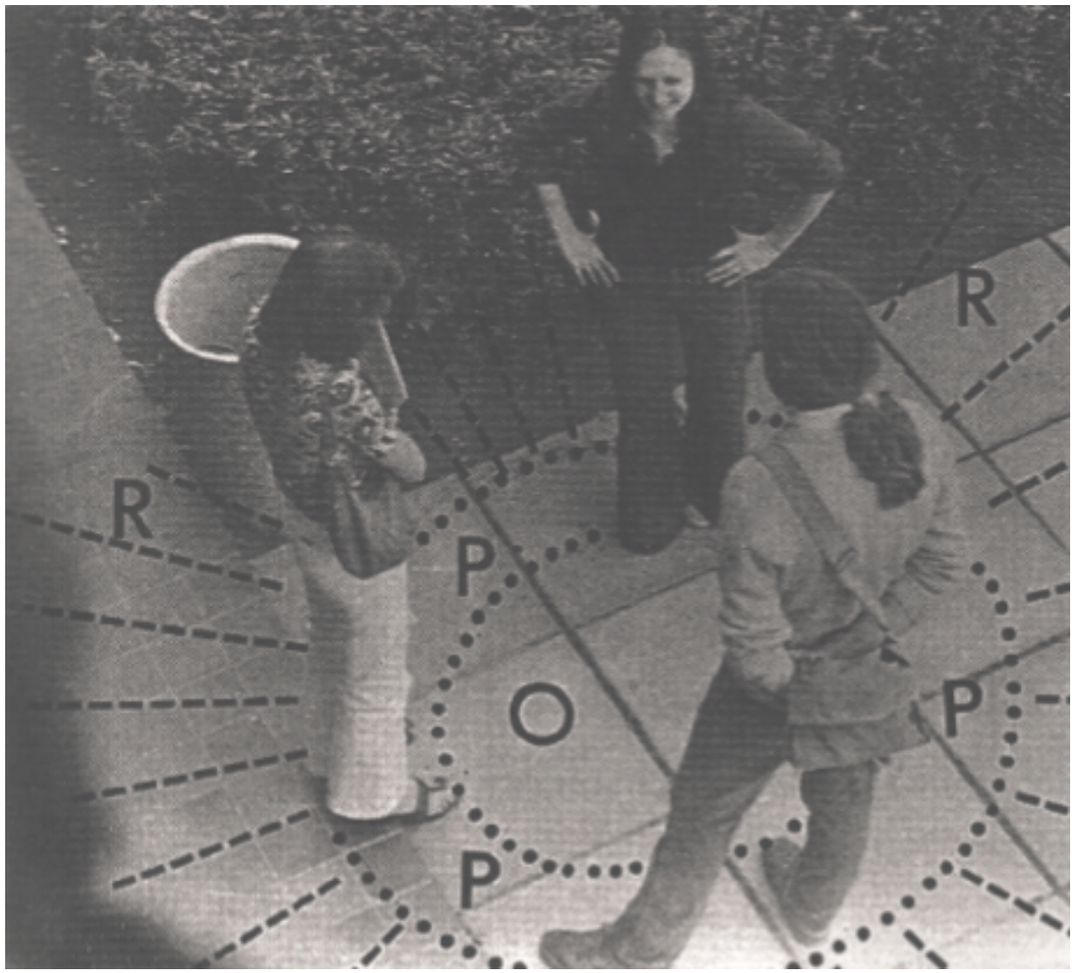
Kendon's F-formation System

"two or more people cooperate together to maintain a space between them to which they all have direct and exclusive access" (Kendon,1990)

- Directly facing each other.
- A distance between people exists (O-space).
- Rarely cross the "O-space".
- Re-adjusting their position to maintain the F-formation.
- They remain structured and organised among most situations.



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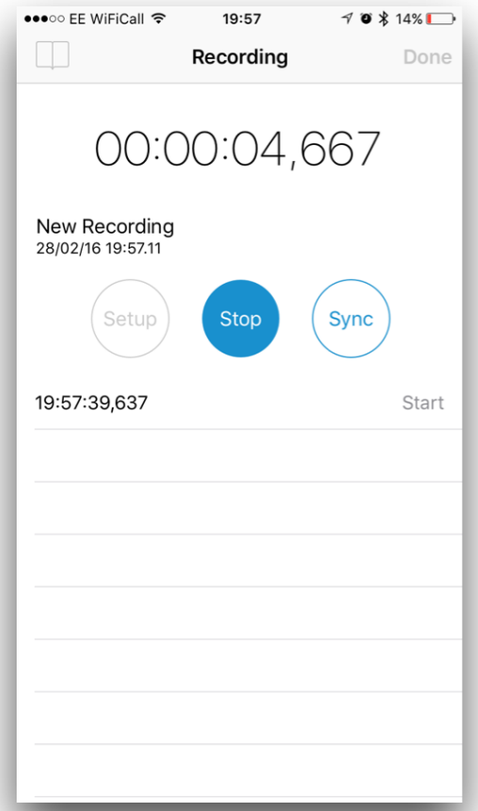
Detecting Proximity

CrowdSense for iOS



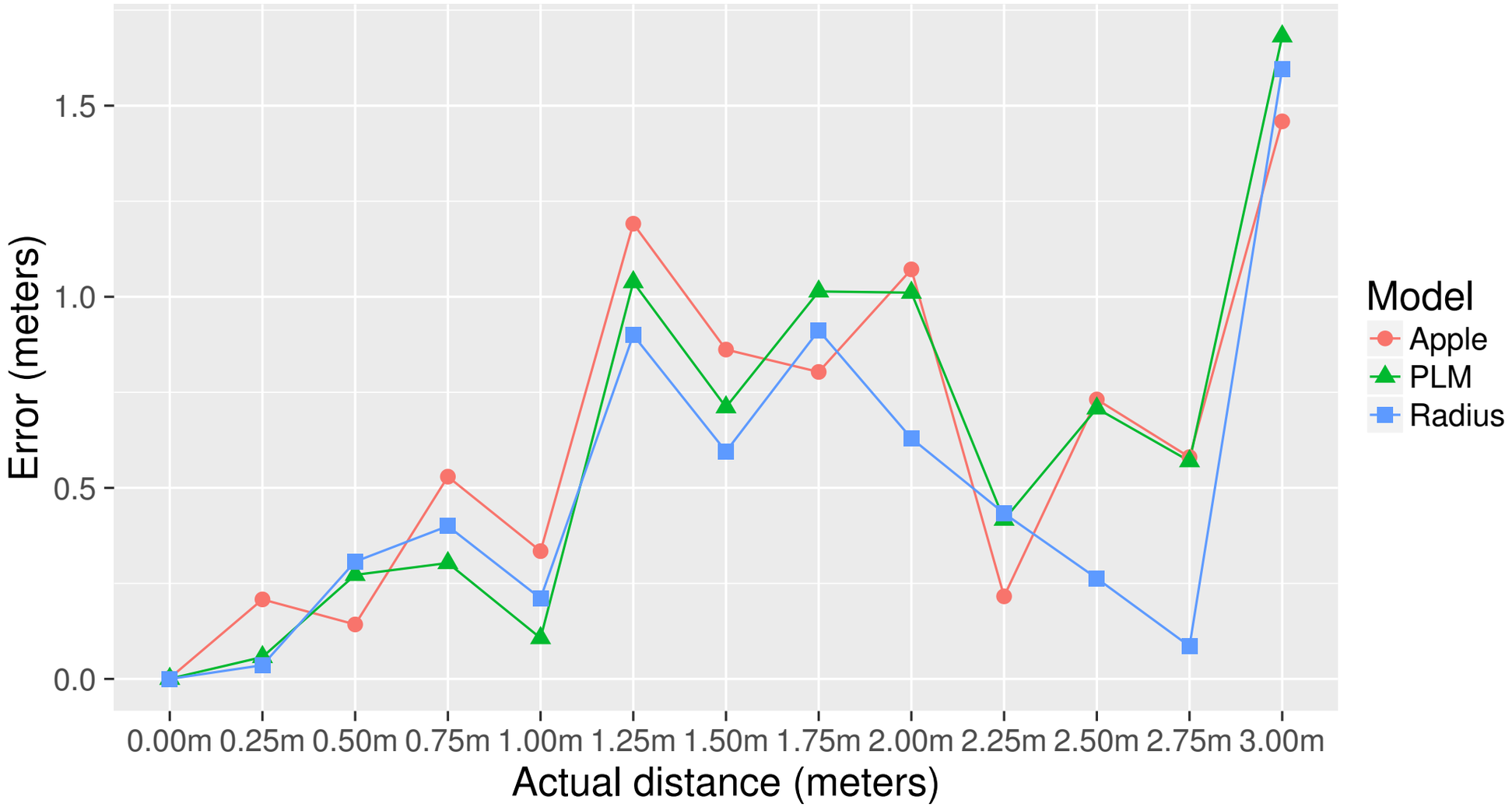
iBeacon™

- 2 iPhone devices (5S and 6S) running CrowdSense App.
- Recording iBeacon Proximity data for 5 minutes in various distances (0m - 3m by 0.25).

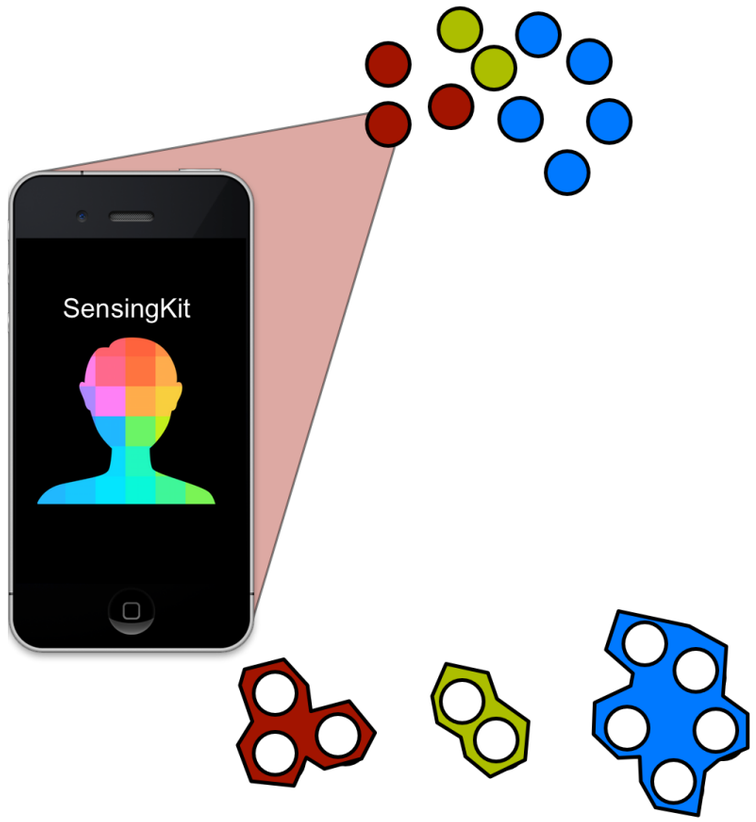
Download on the App Store

GNU LGPL v3

Detecting Proximity



Detecting Group Formations



ELAN 4.9.3 — ELAN 4.9.3 - Experiment_3_Elan.eaf

File Edit Annotation Tier Type Search View Options Window Help

00:07:02.120 Selection: 00:07:02.120 - 00:10:20.746 198626

Selection Mode Loop Mode

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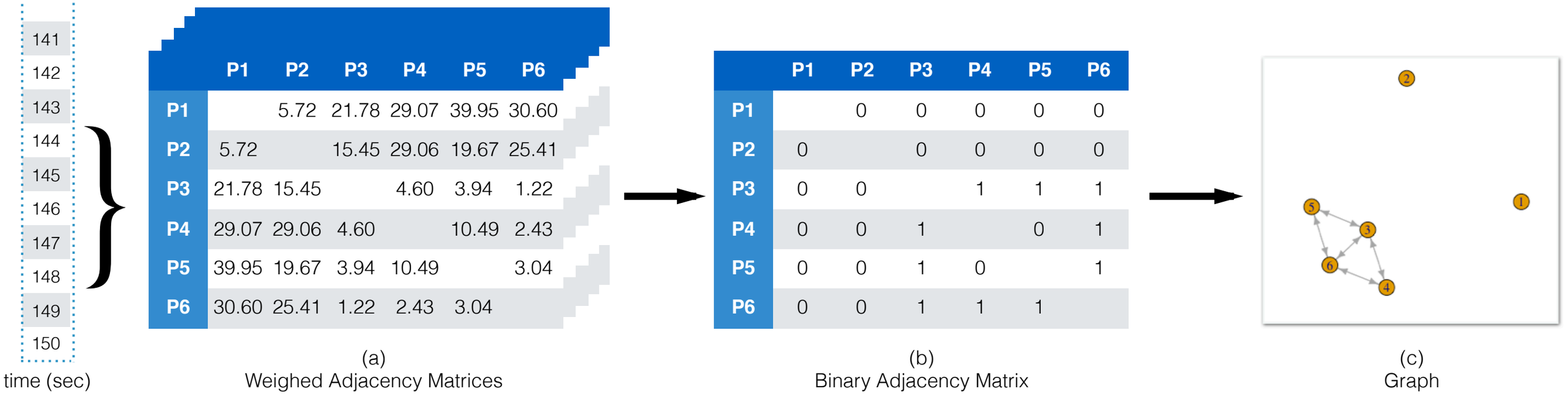
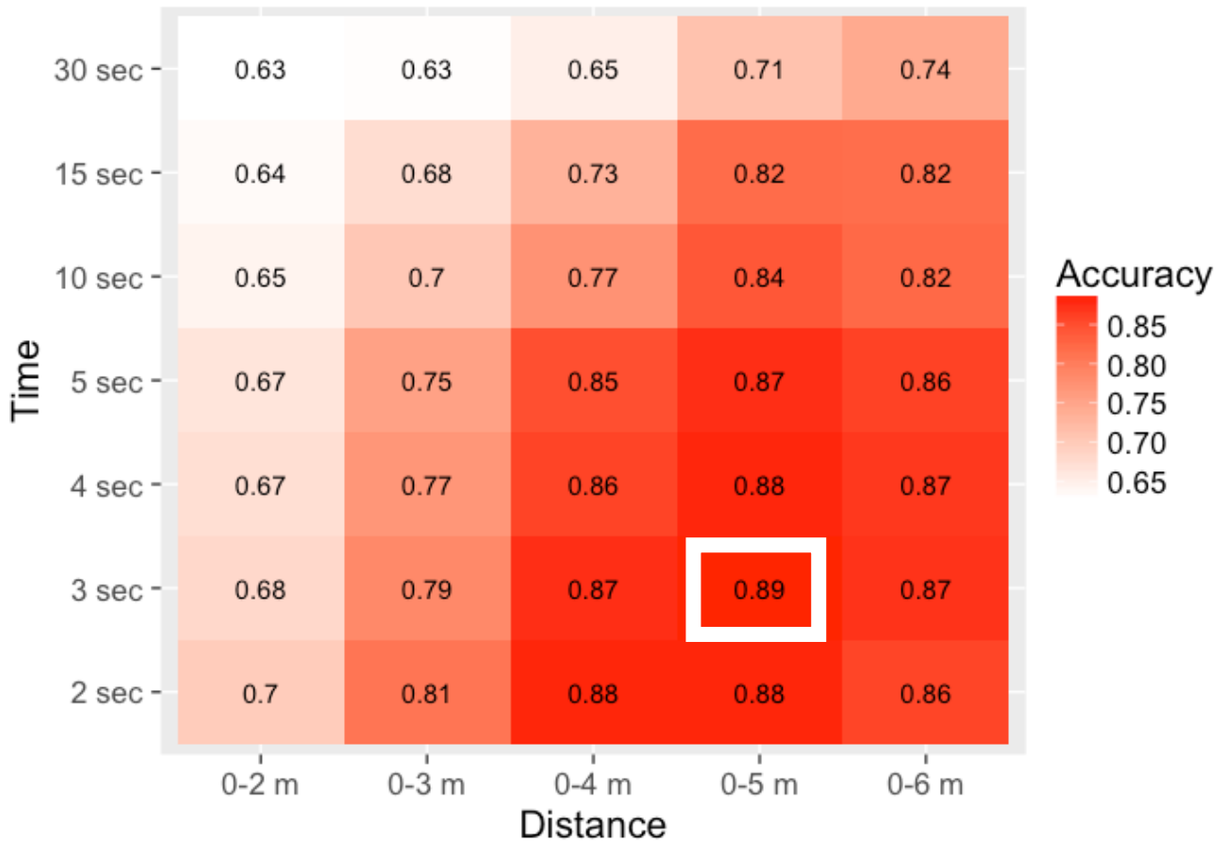


Algorithm 1 Vertice creation of binary adjacency matrix

if $activity$ is not $stationary$ **then**
  $w \leftarrow 0$
else
  if $from \leq distance \leq to$ **and** $time \geq x$ **then**
    $w \leftarrow 1$
  else
    $w \leftarrow 0$
  end if
end if

Results



Confusion Matrix

Actual / Predicted	Positive	Negative	Total
Positive	**1052**	248	1139
Negative	87	**1598**	1846
Total	1155	1830	2985

$precision = 0.809, accuracy = 0.888$

Conclusions

- We introduced an early work that detects group formations with a variety of sizes inside crowds.
- Detection depends entirely on the embedded sensors of smartphone devices.
- Using graph theory models, we were able to predict group formations inside a small group of people with 89% accuracy.
- We believe that this work will lead to more complex techniques capable of detecting actual social interactions in variety of crowd sizes.

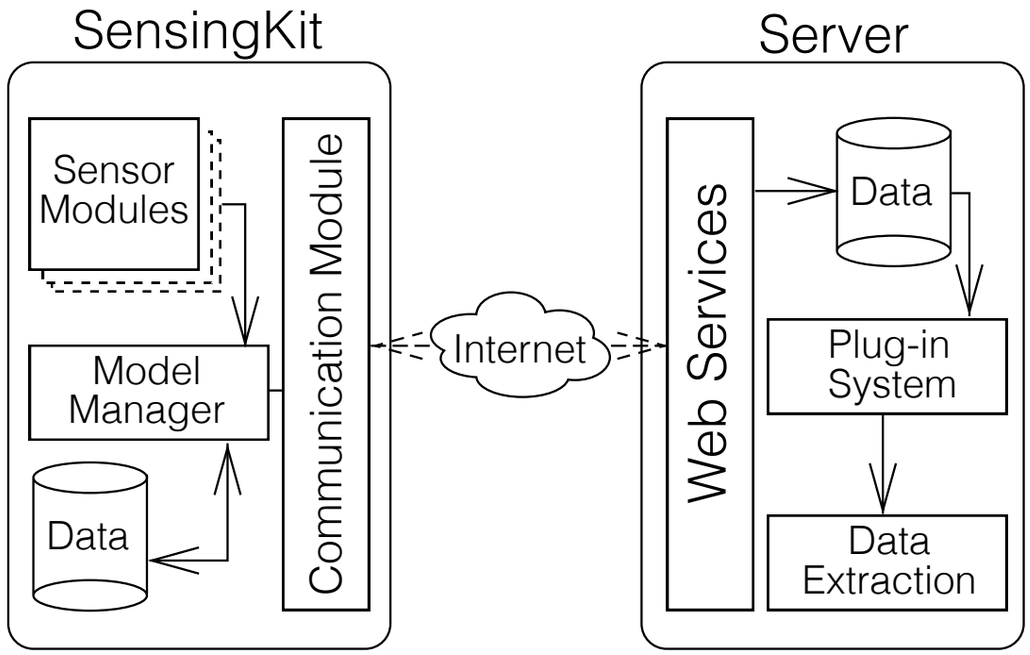
Future Work

- Improve the proximity estimation using trained regression models.
- Explore the use of the gyroscope sensor for estimating the orientation of each user.
- Repeat the experiment in a real-world social event, evaluate its accuracy and finally present analytics about the ways in which people are interacting.

SensingKit: A Multi-Platform Mobile Sensing Framework

Platform Characteristics

- Works in Android and iOS mobile systems.
- Supports most of the available smartphone sensors: Accelerometer, Gyroscope, Magnetometer, Device Motion, Motion Activity, Pedometer, Altimeter, Battery, Location, Microphone, Ambient Temperature, Light.
- Power efficient proximity sensing using iBeacon™ / Eddystone™ technology over Bluetooth Smart (BLE).
- Easily extensible using a modular design.
- Available in open-source under the GNU LGPL v3.0.



SensingKit

Available at www.sensingkit.org

Hamed Haddadi

Laurissa Tokarchuk

Richard G. Clegg

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Thank you!

More about SensingKit:

Kleomenis Katevas, Hamed Haddadi and Laurissa Tokarchuk, “SensingKit: Evaluating the Sensor Power Consumption in iOS devices”, 12th International Conference on Intelligent Environments (IE'16), September 2016, London, UK.

K. Katevas, H. Haddadi, and L. Tokarchuk. Poster: Sensingkit: A multi-platform mobile sensing framework for large-scale experiments. In Proceedings of the 20th Annual International Conference on Mobile Computing and Networking, MobiCom ’14, pages 375–378, New York, NY, USA, 2014. ACM.

Available at www.sensingkit.org