

Walking in Sync: Two is Company, Three's a Crowd

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Pedestrian Flocks

“A number of people walking together as a compact, coherent unit for some time.”

(Kjærgaard et al., 2012)

- Flocks prefer to move together as a unit.
- They walk side by side as long as the space is not crowded.
- Typically, individuals in the same group will walk at the same speed and follow the same trajectories.
- They quickly reform after they become separated.
- Very often, they synchronise their gait!



Image by CRCA / CNRS / University of Toulouse

Intentional Gait Synchronisation



Unintentional Gait Synchronisation







Mile End Park, London



Mile End Park, London

Scenario I

P1

P2

Mile End Park, London

Scenario 2

P1

P3

P2

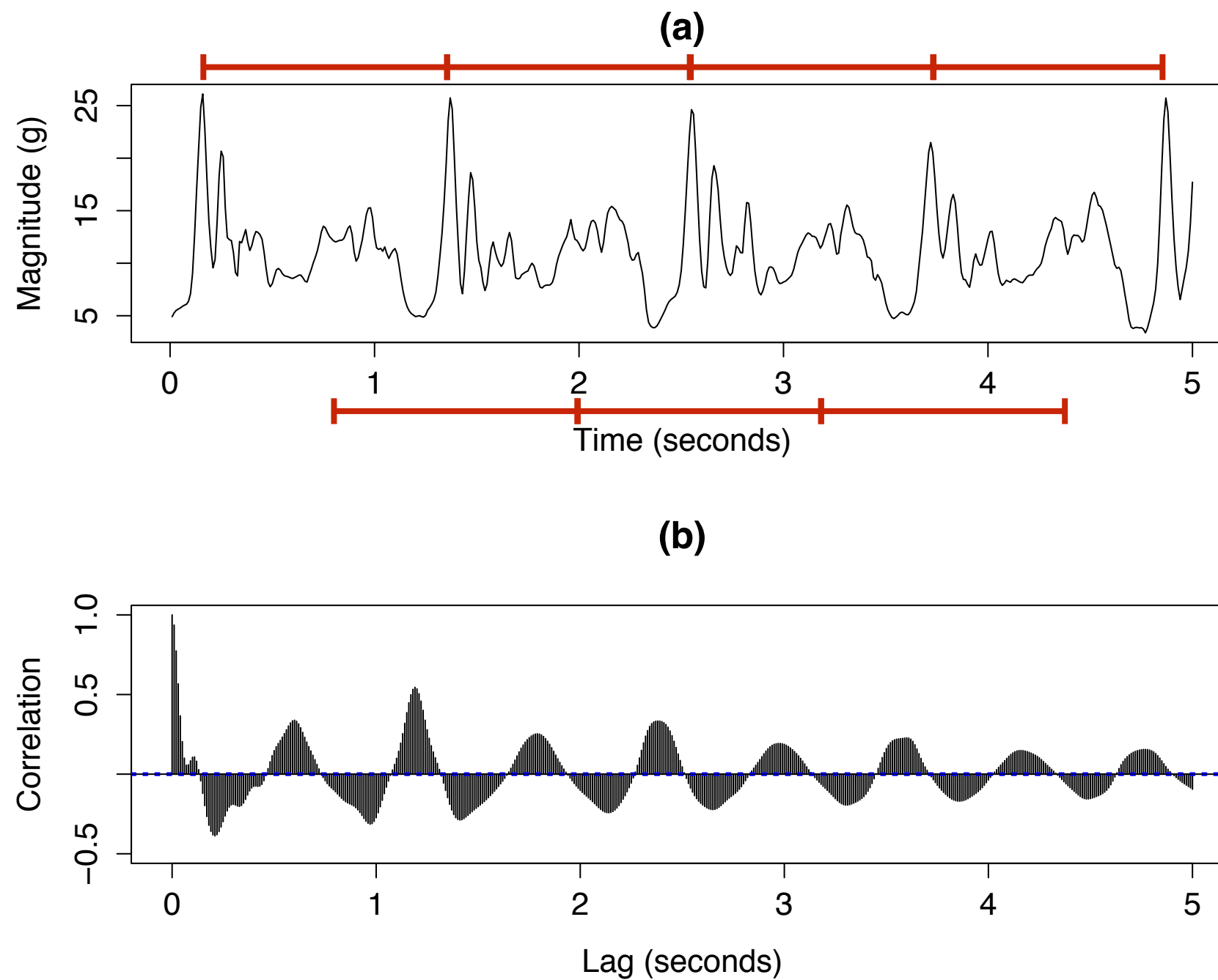
Mile End Park, London

Scenario 2

P1

P3

P2



Acceleration Magnitude of 5 sec (a) and Autocorrelation (b) of Participant 1 in Scenario 1.

Scenario I (2 People)

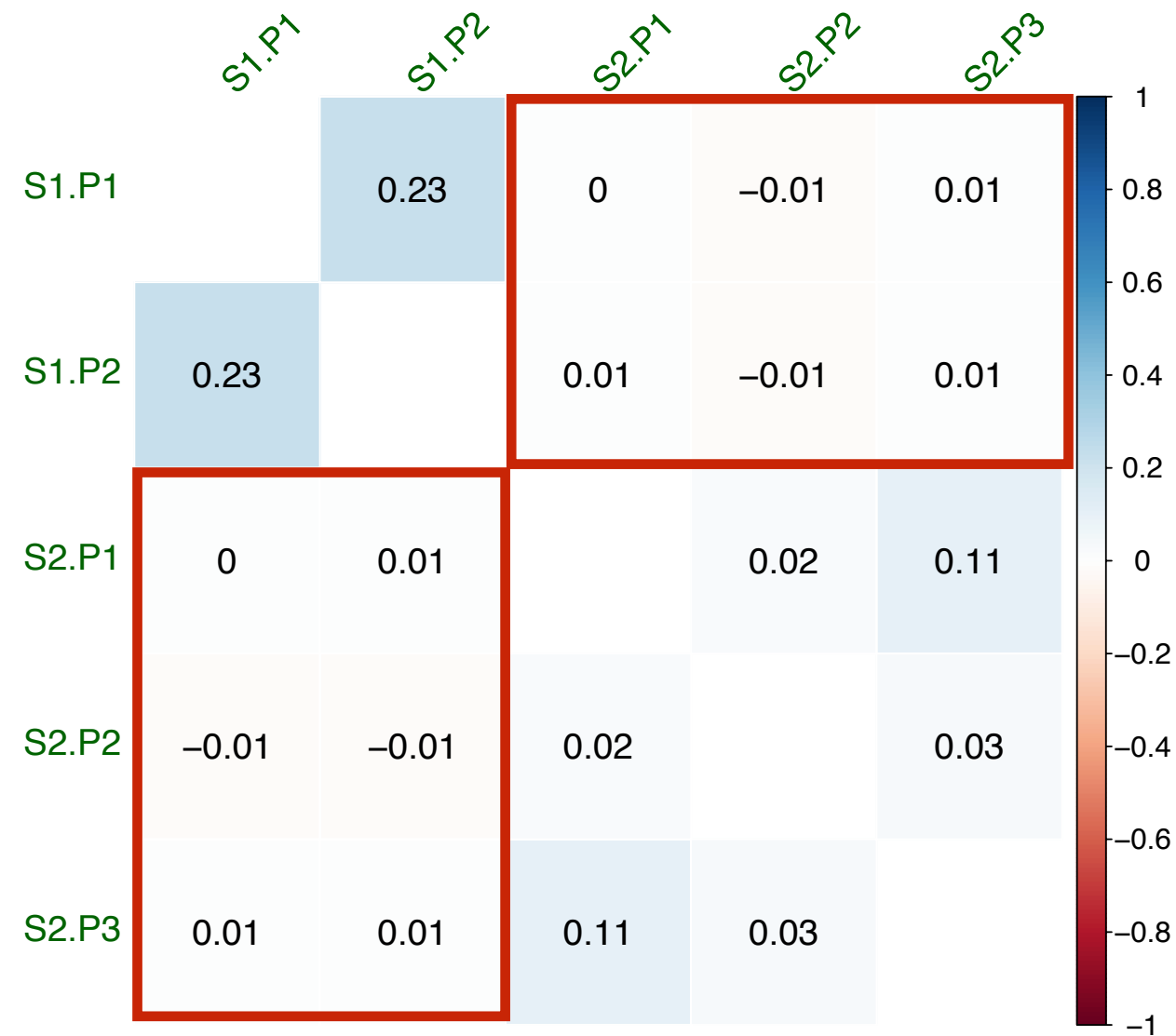


Pearson Correlation matrix of all 5 datasets, visualised as a heat map plot.



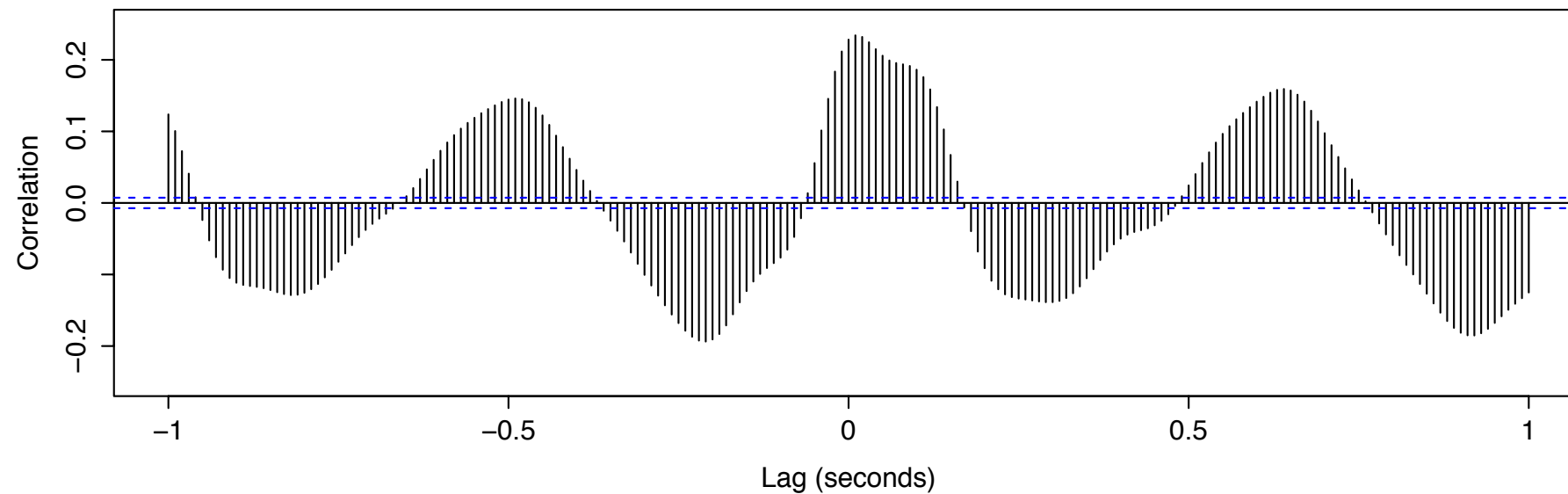
**Scenario 2
(3 People)**

Pearson Correlation matrix of all 5 datasets, visualised as a heat map plot.

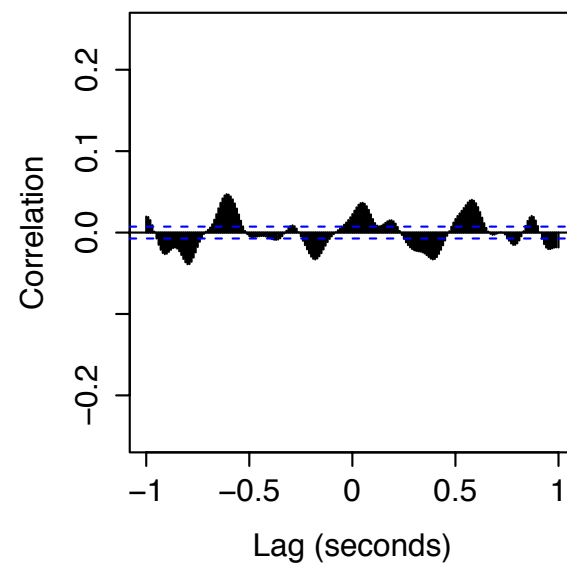


Pearson Correlation matrix of all 5 datasets, visualised as a heat map plot.

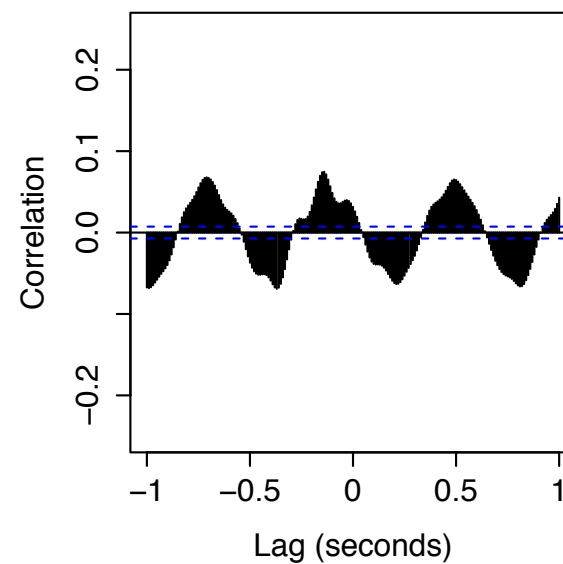
(a) Scenario 1 (P1 and P2)



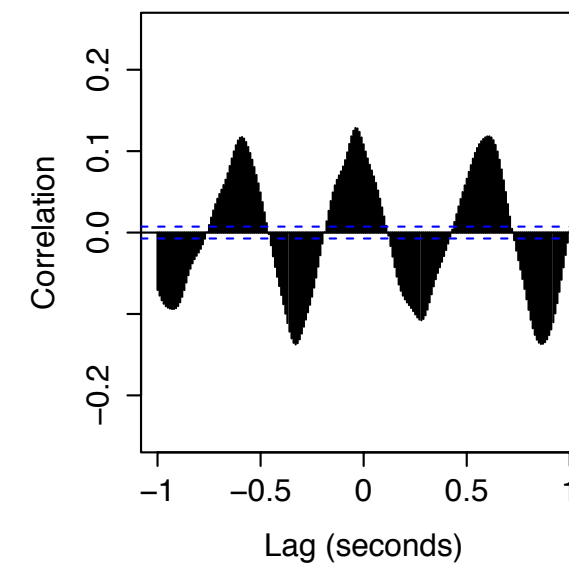
(b) Scenario 2 (P1 and P2)



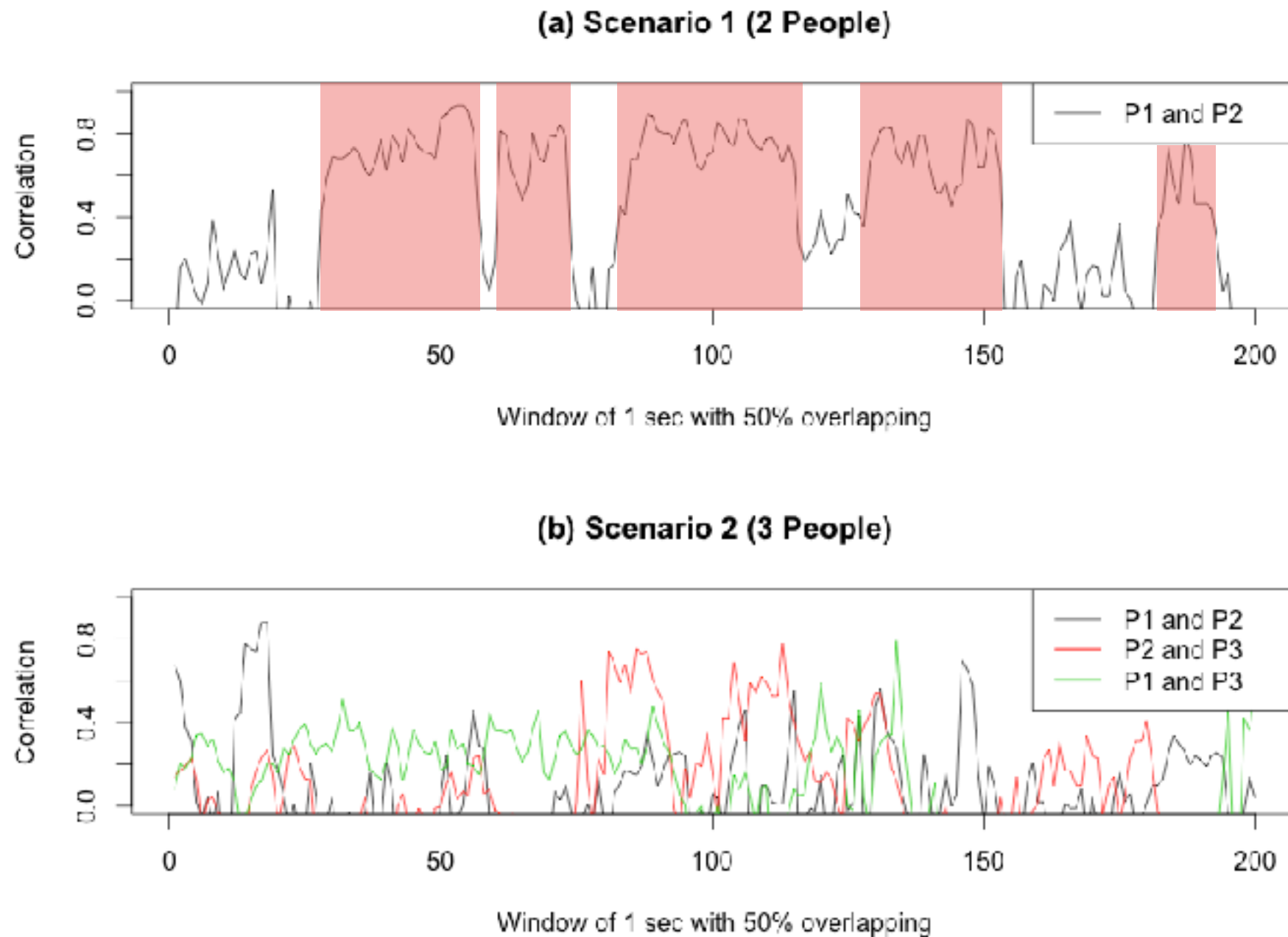
(c) Scenario 2 (P2 and P3)



(d) Scenario 2 (P1 and P3)

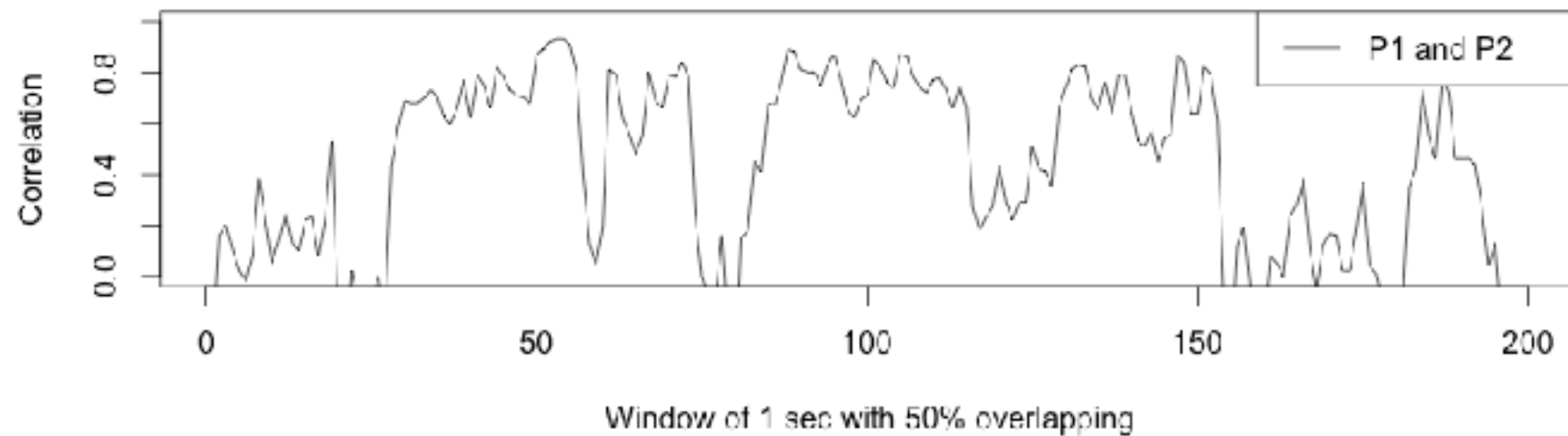


Cross-correlation analysis of Scenario 1 (a) - 2 people walking, and Scenario 2 (b, c, d) - 3 people walking in a park for 12 minutes.

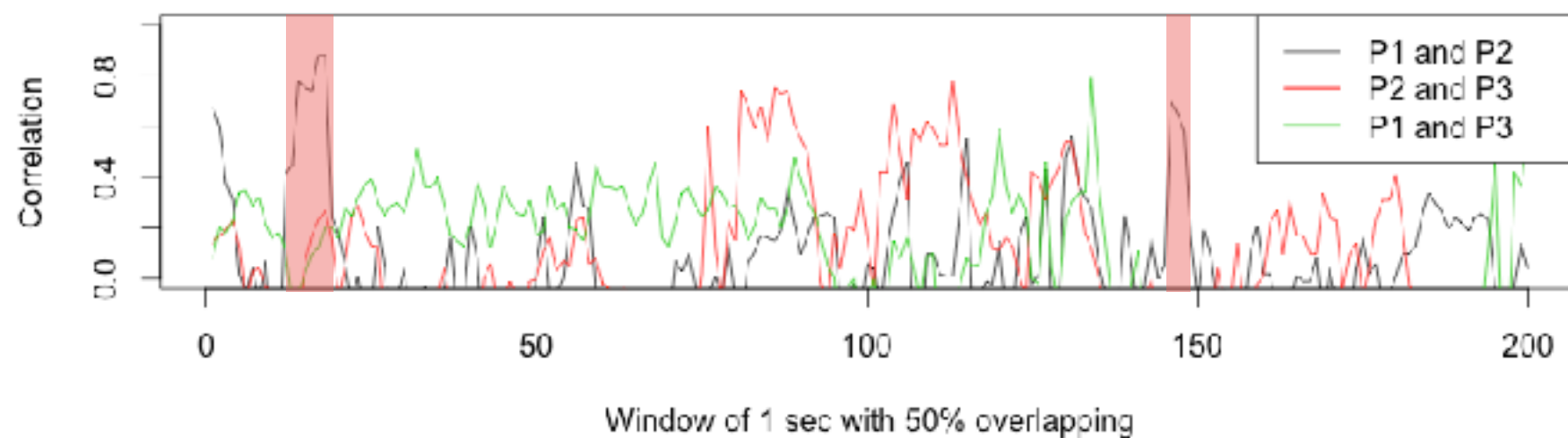


Pearson Correlation applied to windows of 1 sec (with 50% overlap) for Scenario 1 (a) and Scenario 2 (b).

(a) Scenario 1 (2 People)

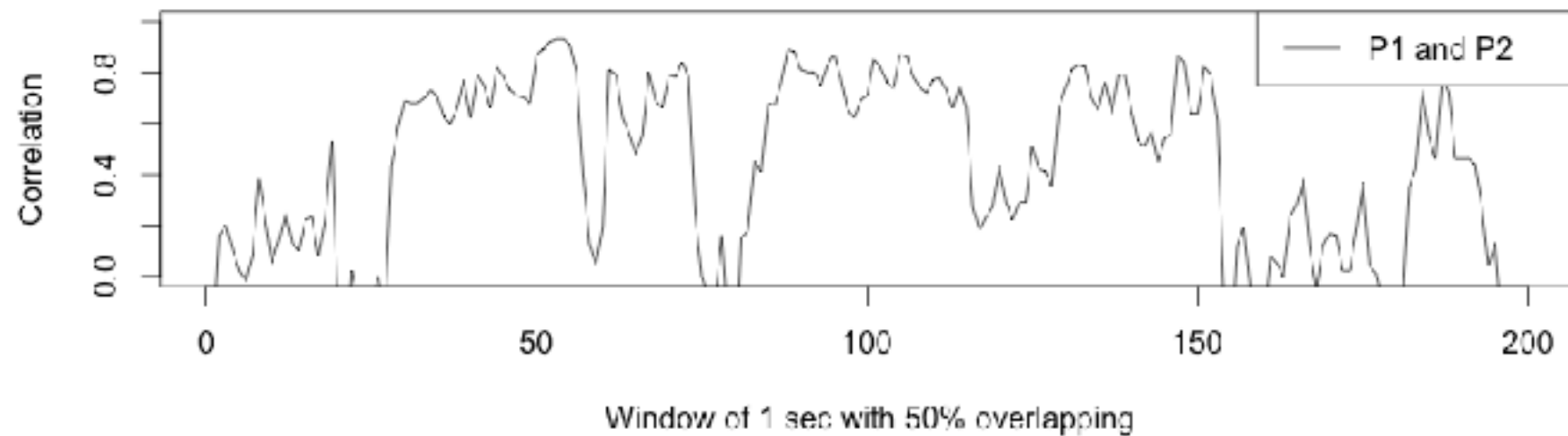


(b) Scenario 2 (3 People)

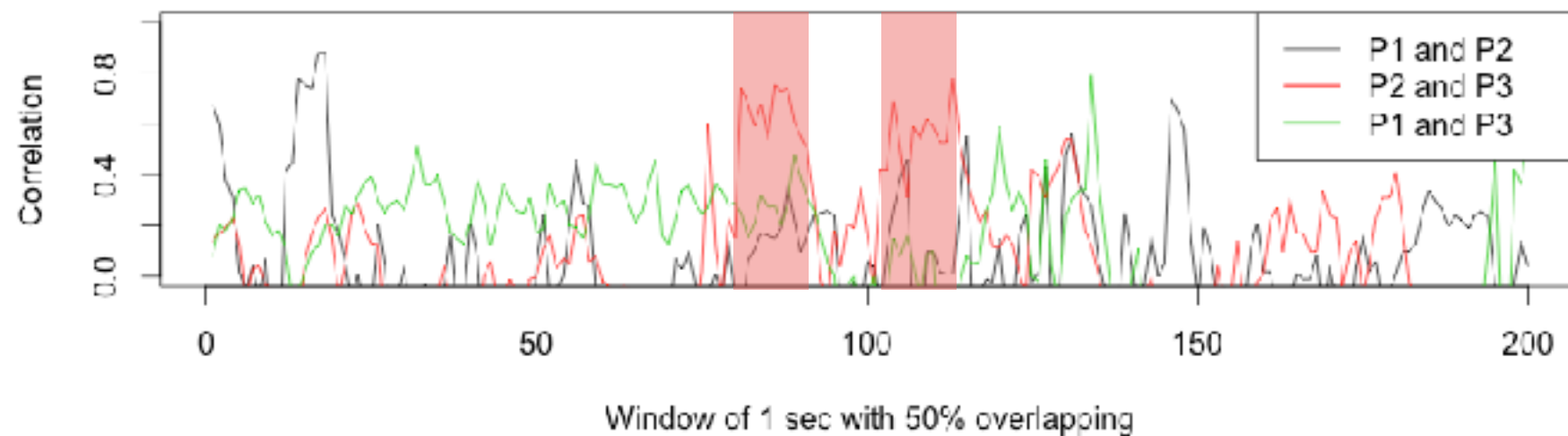


Pearson Correlation applied to windows of 1 sec (with 50% overlap) for Scenario 1 (a) and Scenario 2 (b).

(a) Scenario 1 (2 People)

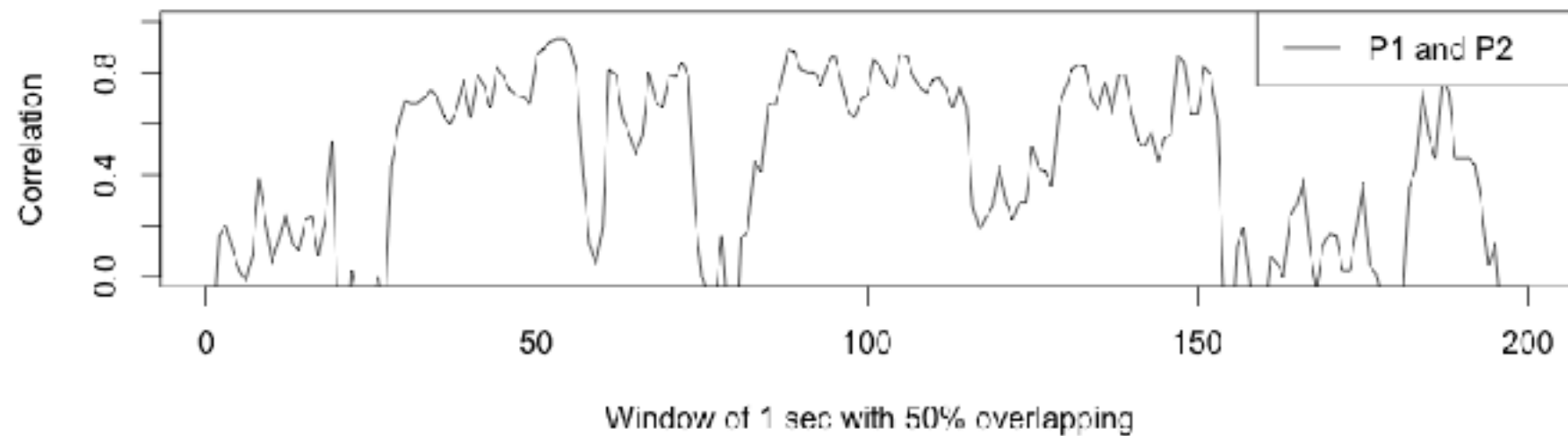


(b) Scenario 2 (3 People)

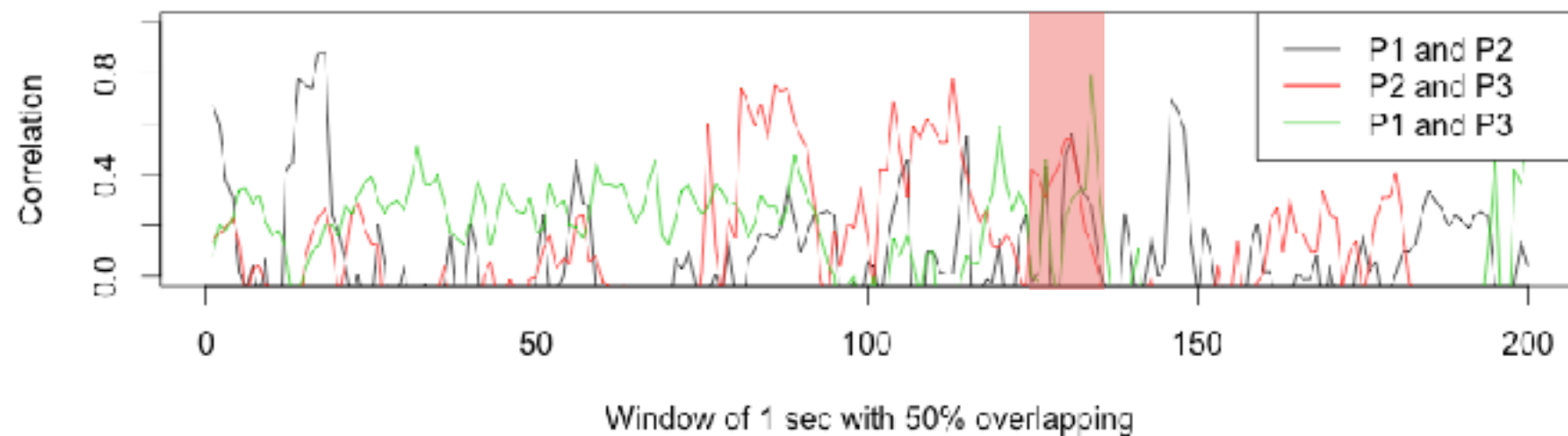


Pearson Correlation applied to windows of 1 sec (with 50% overlap) for Scenario 1 (a) and Scenario 2 (b).

(a) Scenario 1 (2 People)



(b) Scenario 2 (3 People)



Pearson Correlation applied to windows of 1 sec (with 50% overlap) for Scenario 1 (a) and Scenario 2 (b).

Conclusions

- Rich information about individuals' relationships, through analyses of subconscious actions such as gait synchronisation.
- Availability of highly sensitive smartphones enables us to capture these interactions with high accuracy.
- Non-verbal social signals such as **gaze**, **head orientation** and **gestures** between individuals play a significant factor in gait synchronisation.
- A third person can distort the synchronisation.

Future Work

- Use video recording for grounding.
- Investigate the required resolution of the data.
- Analyse negative gait synchronisation.
- Detect hidden individuals.
- Use of multiple sensors (e.g. iBeacon/Bluetooth Smart, Gyroscope, Magnetometer).

Future Work

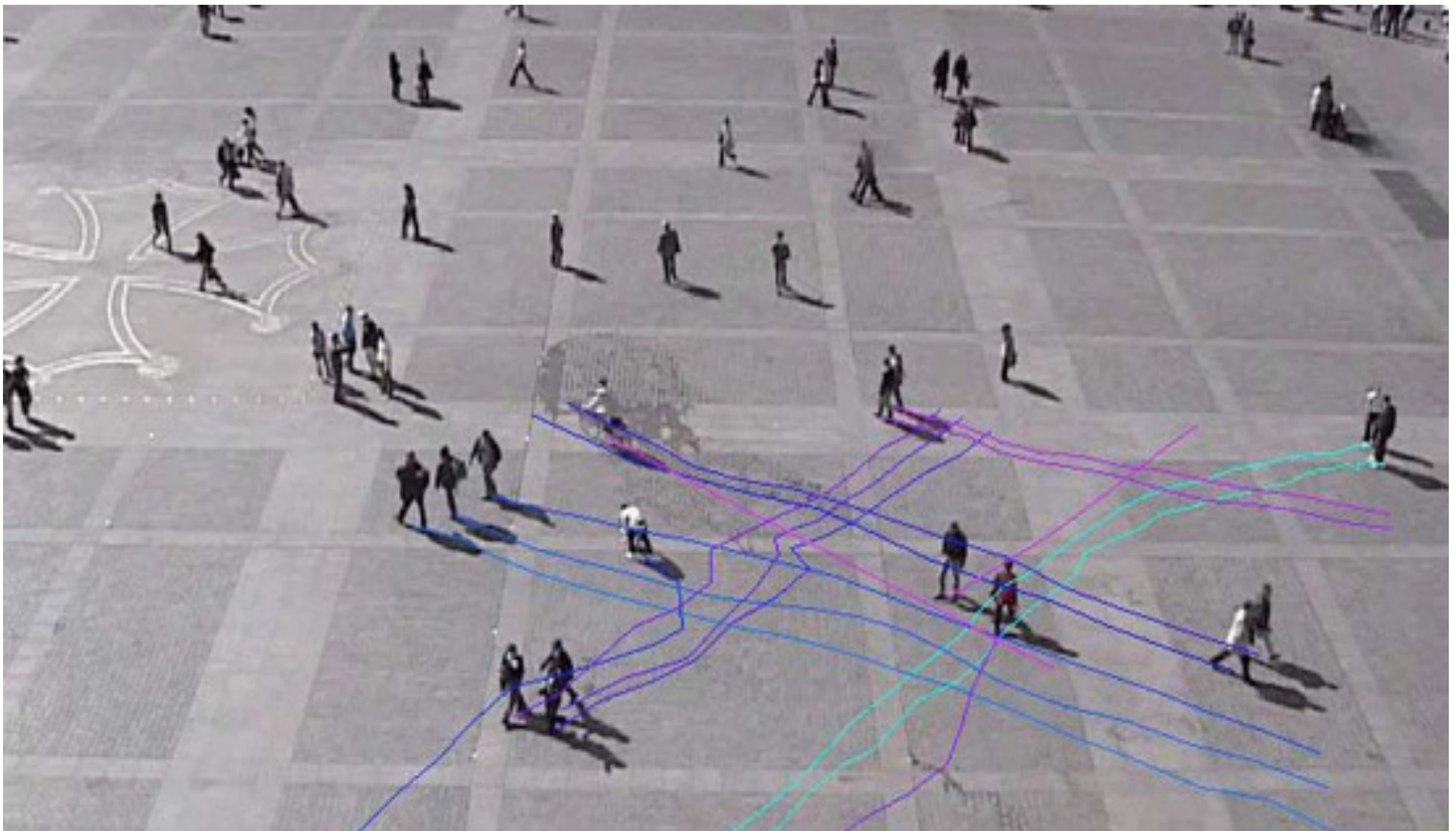
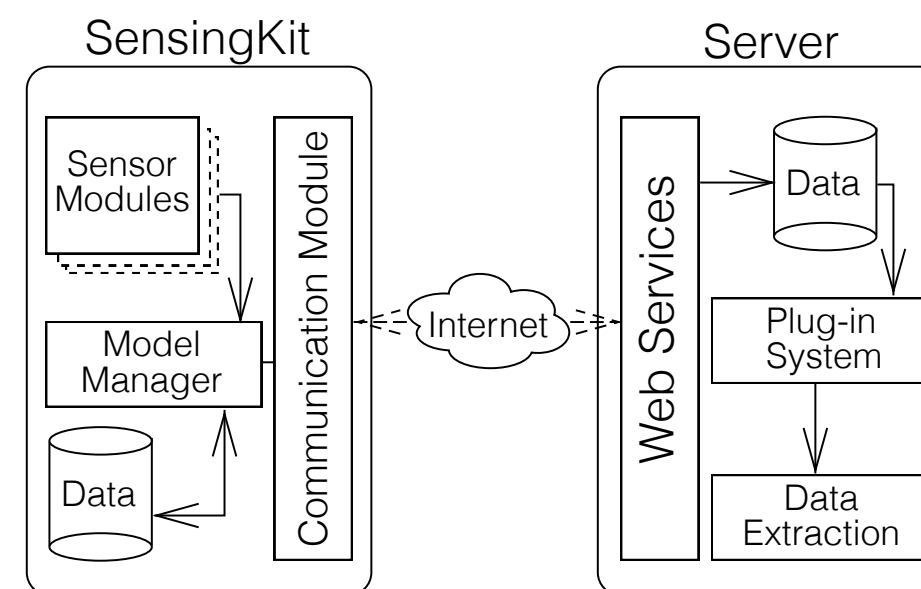


Image by CRCA / CNRS / University of Toulouse

SensingKit: A Multi-Platform Mobile Sensing Framework

- Works in Android and iOS mobile systems.
- Captures Motion, Orientation, Activity, Location, Proximity, Audio (+more).
- Power efficient using Bluetooth Smart (4.0).
- Easily extensible using a modular design.
- Available in open-source at www.sensingkit.org.



Kleomenis Katevas, Hamed Haddadi and Laurissa Tokarchuk, “Walking in Sync: Two is Company, Three’s a Crowd”, ACM MobiSys 2nd Workshop on Physical Analytics (WPA), Florence, Italy, May 2015.

Kleomenis Katevas, Hamed Haddadi, and Laurissa 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.