RESEARCH STATEMENT
"Governance on Social and Behavioural Analytics"

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BACKGROUND AND OVERVIEW

I focus primarily on large-scale behavioural research, which explores the use of mobile sensor data to understand and shape human behaviour. My work involves developing smart systems that quantify user routines and social interactions in real-time to derive predictive insights for their health and wellbeing. Accordingly, these approaches are used to develop effective risk-screening and intervention-assessments at scale for everyday users. In the future, I hope to explore the full multi-disciplinary pipeline of integrating such technologies to understand the outcomes on different levels of human services: the individual, group, organisation and community.

The following research projects represent the bulk of my research interests and efforts, and are centred on several broad themes as highlighted:

Mobile Sensing and Analytics: Most recently, I have been investigating the possibility of detecting levels of stress and depression from continuously monitoring individuals' and group mobility patterns. I developed a system called *StressMon* (short for Stress Monitoring) [1], which leverages a thoroughly tested passive sensing technology to estimate the physical location of client devices connected to the WiFi network; thereby acts as a reasonable proxy of human location and does not require explicit user actions or app installation. *StressMon* encompasses different machine learning models for mental health and social metrics [2,3,4], which play significant roles in influencing stress and depression of an individual while being a part of a social system. Despite increasing progress in enabling technologies for large-scale behavioural research, public policy and ethical considerations remain challenging within the research community. For example, since *StressMon* considers the influence of social relationships for mental health purposes [4], the process of collecting and deriving behavioural patterns in groups of user data must abide by compelling ethical principles for real-world deployment. In ongoing work, my research involves implementing *StressMon* in other education environments to understand users of different ages and social settings.

Wearable Sensing and Intervention Design: Another form of sensing is based on wearable sensor data for gesture recognition. *WatchMe* is a work which brings personal meaning to me, as it offered me the experience of working with children who have neurodevelopmental disorders. The focus here is on using a wearable to help children manage problem behaviours which may hamper their learning development and social participation. For example, the detection of hand flapping or finger biting (excessively) [7] would trigger an instruction-based intervention, whenever the primary caregiver determines it to be appropriate. A particularly constructive element to the *WatchMe* study is working with teachers to design their primary intervention strategy for the smartwatch. In this study, I designed a proof-of-concept system that sent audio or visual-haptic notification and evaluated these notification designs on children with problem behaviours during their lessons [6].

Mobile User Interface Design: Besides experimenting with mobile and wearable sensing techniques, my work has looked at the interactive aspects of systems. An example is repurposing *KSketch* for fine motor skills rehabilitation [8]. The purpose of this work is to assess children's improvement in fine motor skills and understand what motivates them in using the sketch application. Separately, I assisted in conducting an empirical study which explored eye-based pointing techniques for eyewear application. With the increasing integration of augmented reality in mobile devices, the design of smart systems must account for environmental awareness and perceived social acceptability [5].

FUTURE RESEARCH DIRECTIONS

In the near future, I intend to expand my research investigations on social and behavioural analytics around different cultural and socio-economic contexts. Simultaneously, the widespread initiatives of smart technologies raise a pressing need for systems research to include policies and regulations – from involving human participation to analysing publicly-available data, developing standards for smart technologies and the inadvertent disruptions they bring to our lives. I find these research directions particularly controversial but exciting:

Social and Behavioural Analytics: I am excited by the possibilities of orchestrating both personal and environmental data within large settings (i.e., community, organisation) to address various context changes impacting individuals' health and wellbeing. At present, I am working to automatically detect the social identification of individuals towards their workgroup and how different types of psychological associations that individuals make with their social circle impact their behaviours. For example, with more organisations structuring work within teams, it is a growing interest to understand how social metrics, such as social identification, influence the model of team performance and productivity [4]. I want to understand how (human) social engagement, or lack thereof, could influence everyday behavioural decisions, and consequently, how smart systems can shape these behaviours for more positive outcomes.

Technology and Governance: My research work on *StressMon* has only scratched the surface of delivering promising applications to provide mental health benefits for individuals and collectives. While the system arguably follows the basic ethical principles in terms of the data it collects and analyses, appropriate policies protecting user rights and regulating public monitoring must be implemented for real-world use. It is hard to deny the advantages of smart technologies in making 'living' more comfortable on the whole, but it is impossible not to recognise the harmful by-products they create in other aspects of our lives. For example, trialling *StressMon* in professional workplaces can help organisations understand the nuances of workgroup dynamics to improve employees' performance and productivity. The question then becomes: how can we ensure such systems help those most at risk, yet make no discriminatory impact on their professional careers? Leveraging smart technologies for the betterment of society in every sector (e.g., healthcare, education, organisation) now requires a multi-disciplinary approach with Health, Strategic Management, Law and Public Policy professionals to identify, understand, and enhance smart technologies, so they comply with human rights treaties.

PUBLICATIONS

[1] **Zakaria, C.,** Balan, R., & Lee, Y. (2019). StressMon: Scalable Detection of Perceived Stress and Depression Using Passive Sensing of Changes in Work Routines and Group Interactions. Proceedings of the ACM on Human-Computer Interaction, 3(CSCW), 37.

[2] **Zakaria, C.**, Lee, Y., & Balan, R. (2019, June). Passive Detection of Perceived Stress Using Location-driven Sensing Technologies at Scale. In Proceedings of the 17th Annual International Conference on Mobile Systems, Applications, and Services (pp. 667-668). ACM.

[3] **Zakaria, C.**, Goh, K., Lee, Y., & Balan, R. (2019, June). Exploratory Analysis of Individuals' Mobility Patterns and Experienced Conflicts in Workgroups. In Proceedings of the 5th ACM Workshop on Mobile Systems for Computational Social Science (pp. 27-31). ACM.

[4] **Zakaria, C.,** Balan, R., Lee, Y., Goh, K. The Stress of Not Belonging: Predicting Social Identification for Stress using Mobility Patterns. (under review for CHI'20).

[5] Roy, Q., **Zakaria, C**., Perrault, S., Nancel, M., Kim, W., Misra, A., & Cockburn, A. (2019). A Comparative Study of Pointing Techniques for Eyewear Using a Simulated Pedestrian Environment. In Proceedings of the 17th IFIP TC.13 International Conference on Human-
Computer Interaction (INTERACT 2019). Springer-Verlag, Berlin, Heidelberg, 22 pages. To appear.

[6] **Zakaria, C.**, Davis, R. C., & Walker, Z. (2016, June). Seeking independent management of problem behavior: A proof-of-concept study with children and their teachers. In Proceedings of the The 15th International Conference on Interaction Design and Children (pp. 196-205). ACM.

[7] **Zakaria, C.**, & Davis, R. C. (2016). Wearable application to manage problem behavior in children with neurodevelopmental disorders.

[8] Davis, R. C., & **Zakaria, C.** (2014, November). K-Sketch: Digital storytelling with animation sketches. In International Conference on Interactive Digital Storytelling (pp. 242-245). Springer, Cham.