IUW 2021 Schedule and Program

8:30am Log in, introductions of IUW planning committee, who to go to for what, overview of program and tools

9:00am **Transition from Graduate School to Beyond – Panel Discussion** We will be joined by exceptional ISE masters and PhD graduates who are working in academia and industries, focusing on healthcare and human-machine modeling, user experience, as well as quality and safety issues. They will share their experience and journey in the transition from graduate school to a career, as well as suggestions on what to do once you have found a position. Panelists include: Sudeep Hedge, Adam Houser, Xueqian Liu and Angel Nardolilo.

10:00am **Work From Home Tips and Tricks**: Networking Coffee Break – come and go as you please during this break to meet other IUW participants and share and discuss tips and tricks you have (or need help with) for working from home. Event hosted by Connor Wurst.

10:15am **Student Lectures *(abstracts are at the end of the program)*:**

Alia Galal, Birsen Donmez, Matthew Roorda - *Truck driver hazard anticipation skills training and testing to improve truck-vulnerable user safety*

Ebru Kamis - *Perception of Behaviour and Personality in Robotic Vacuum Cleaners*

Yovela Murzello, Shi Cao, Silby Samuel - *Age Differences in the Situation Awareness and Takeover Performance in a Semi-Autonomous Vehicle Simulator*

Ece Uereten, Catherine Burns - *Exploring expertise development, interface design and evaluation in neuro-critical care*

Qian Zhang - *A pilot study on the use of changes in facial features to assess physical workload in real-time.*

11:25am **After graduating, I want to**: Networking Coffee Break – come and go as you please during this break to meet other IUW participants and share and discuss your post-graduation ambitions. Event hosted by Su Shen.

11:40am **Student Lectures *(abstracts are at the end of the program)*:**

Elliot Biltekoff, Matthew Bolton - *Computational Virtue Ethics for Understanding and Preventing Moral Injury*

Olamide Olatoye, Catherine Burns, Kathleen Andres, Erica Patterson - *Understanding Clinicians' Needs, Requirements, and Perception of a Sepsis Clinical Decision Support System (CDSS) to support successful implementation*

Ryan Tennant, Sana Allana, Kathryn Mercer, Catherine Burns - *Exploring Family Caregiver Perspectives about Information Management and Communication in Complex Home Care: A Qualitative Study*

Kang Wang, Shi Cao, Plinio Morita - *Optimizing public health data collection from Internet of Things sensors: An integrated data-sharing platform*

12:50pm **Lunch Break – offline**

1:30pm **Keynote Address: Trust, Adaptation and Future Work** – Dr. John Lee
Ubiquitous sensors, wearable and distributed computing, and powerful algorithms are transforming work. This transformation will eliminate jobs, displacing as many as 47% of today's workers. This transformation will also change jobs with nanomanagement and AI teaming. Nanomanagement risks usurping human autonomy and AI teaming risks dreadful surprises. AI teaming and nanomanagement are examples of responsive automation. Responsive automation is not only observable and directable but also observant and directive. This automation will direct and adapt people, and people will direct and adapt it. This adaptation depends on trust; trust smooths interactions and governs societal acceptance. This presentation describes a new framing of trust in automation. It describes the process of trusting that depends on the situation, semiotics, sequence, and strategy.

2:30pm **Networking Strategies:** Networking Coffee Break – come and go as you please during this break to meet other IUW participants and share and discuss your networking strategies, including but not limited to conferences, virtual conferences, and networking platforms. Event hosted by Qian Zhang.

2:45pm **Student Lectures *(abstracts are at the end of the program)*:**
Kate Kazlovich - *Development and evaluation of a non-wearable intelligent multi-camera system for intraoperative video recording of open surgery.*
Taylor Kunkes
Pengyuan Wan, Matthew Bolton - *A Taxonomy of Forcing Functions for Addressing Human Errors in Human-machine Interaction*
Pedro Velmovitsky, Plinio Morita - *Mobile Health Platform for Individual and Population-Level Surveillance*
Rong Bing Xu, Shi Cao - *Modelling Pilot Flight Performance in a Cognitive Architecture*

4:00pm **Human Factors Success and Failures in our Everyday Life**: Networking Coffee Break – come and go as you please during this break to meet other IUW participants and share and discuss the things you notice as human factors successes and failures all around you. Event hosted by Elliot Biltekoff.

4:15pm **Debating Inclusions Practices in Human Factors**: Being inclusive in our research and design is integral to working in human factors, but there are a lot of aspects of how to be inclusive that we need to figure out. Human Factors Inclusion Advocates and Experts will debate different aspects including appropriate research methods for lab and field

work, where to draw the line on inclusion, how to get other collaborators on board and inclusive approaches for both qualitative and quantitative data. The panel is moderated by Rupa Valdez and the debate panelists include: Natalie (Nat) Benda, Rich Holden, and Abby Wooldridge.

5:30pm **Closing remarks and awarding prizes.** *Note: You must be present to receive your prize*

*If a session ends early, we enter the break early and get back on schedule with the next non-networking session.

Student Lecture Abstracts (in presentation order)

Truck driver hazard anticipation skills training and testing to improve truck-vulnerable user safety

Alia Galal, Birsen Donmez, Matthew Roorda

This research will examine commercial vehicle drivers' ability to detect vulnerable road users (VRUs) and will assess driver training techniques to enhance anticipation and detection of VRUs in proximity to trucks using a truck simulator and eye tracking equipment. Hazard anticipation is defined as a set of driver behaviours including knowledge and awareness of traffic risks and threats to safety, visual search to detect direct and indirect elements contributing to unsafe situations, predicting latent or hidden hazards and responding accordingly to avoid potential conflicts. The research steps include compiling a list of latent hazards through online interviews with truck driving instructors, road safety experts and trainees, creating simulator experiment scenarios to test trainee drivers' hazard anticipation skills, and proposing and validating a training and testing module for latent hazard anticipation.

A better understanding of the latent hazard anticipation skills of commercial vehicle drivers in presence of VRUs and the development of a specific training and testing procedure to improve and assess these skills will help enhance VRU safety.

Perception of Behaviour and Personality in Robotic Vacuum Cleaners

Ebru Kamis

The research problem I want to address is whether it is possible to improve human-robot interaction in robotic vacuum cleaners by ascribing personality during the design phase. Through collecting people's perceptions of the robot with different personality characteristics in a reliable survey, human's attitudes towards the robots in various scenarios will be explored. Also, the personality characteristics of a desired robotic vacuum cleaner will be determined. The findings from the survey will be used as a guideline to design robotic behaviours and features based on the characteristics of an overall desired robotic personality.

The application of Laban Movement Analysis to robotics have been studied by several scholars and the findings indicate that motion behaviours in robots are successful in conveying the allocated personality to them. However, the two other factors of the Laban System Efforts, Weight and Flow, have not been studied in relation to robotic motion behaviours and features. This study aims to achieve enhanced human-robot interaction by allocating a personality-based motion system inspired by the LMA

framework. The type of robot chosen for the study is a robotic vacuum cleaner (iRobot Roomba Create 2) because they are the most adopted robots in people's everyday lives and are increasingly taking over the cleaning task in many households.

Age Differences in the Situation Awareness and Takeover Performance in a Semi-Autonomous Vehicle Simulator

Yovela Murzello, Shi Cao, Silby Samuel

Road traffic collisions continue to be the leading cause of injuries and deaths among adolescents, and a contributing factor is their risky driving style and behaviours associated with poor road safety. Conversely, deterioration in mental functions that are essential for safe driving can negatively impact the performance of older drivers on the road leading to accidents and risky maneuvers. However, it has been suggested that driving assistance features and self-driving cars might aid older adults with continuing their independence and mobility. With Level 3 semi-autonomous vehicles, drivers have the opportunity to engage in secondary non-driving-related tasks during vehicle automation but must be available to take over when the system reaches its limit. Hence, the purpose of this research is to examine the age differences when driving a semi-autonomous car on different road conditions while performing a secondary distracting task. Young, middle-aged and older drivers' takeover performance and situation awareness will be examined when taking over on a straight versus a curved road on a highway and in an urban scenario after being distracted with a non-driving related task. Participants will complete the driving task in a simulator where they will drive the simulator car, engage Autopilot, perform a secondary distracting task and then execute a takeover at some point in their journey. Their situation awareness, reaction time and takeover quality will be measured. Situation Awareness will be assessed using SAGAT scores after takeover and eye-tracking data. Their performance will be compared in a non-distracting condition. The research outcomes have implications in improving the safety of semi-autonomous cars for younger and older drivers given their different driving styles.

Exploring expertise development, interface design and evaluation in neuro-critical care

Ece Uereten, Catherine Burns

Developing expertise is a complex process which takes years if not decades. Especially in dynamic and critical socio-technical systems it is of utmost importance to highly perform. A very important domain is healthcare with its critical specialization of neuro-critical care. There, expertise is required to provide the patient with correct and timely treatment. In case of lacking expertise, the effects of treatment can contain mistakes, incompleteness and even lead to life threatening situations. Two parties are involved in expert development: the person who develops expertise which is the resident (novice) in this application case and the mentor (senior physician/expert) who supports to develop expertise.

Throughout this process, technology also plays a role in representing patient data and thus is an important factor for decision-making. This research contributes to the development of expertise through investigating the requirements for a bedside monitor used in neuro-critical care (adult patients) and identifies the effects of a comparison between two versions of interfaces, i.e. a non-ecological vs. ecological interface. The Cognitive Work Analysis (CWA) approach helps to analyze the differences between novices and experts, their environment and tasks to be taken in specific cases.

The requirements for an ecological interface were thus identified through the CWA models and observation in a mixed-Intensive Care Unit. The findings will then be confirmed and expanded in bidirectional interviews with residents and senior physicians. The implemented changes on the bedside monitor will then be evaluated in comparing the performance of two groups. Examples of measures for expertise are the amount and severity of mistakes, strategies, Situation Awareness and order of actions. The chosen research method is an experiment among residents who will be assigned to a non-ecological vs. an ecological interface and asked to perform actions to given scenarios. The observations have shown that the management of Intracranial Pressure is crucial for developing expertise in neuro-critical care and thus will be focused on during the development of an ecological interface as well as provided scenarios. The expected finding of this study is that novices perform higher when they use the ecological interface compared to the non-ecological interface.

A pilot study on the use of changes in facial features to assess physical workload in real-time.

Qian Zhang

Background: An understanding of the level of physical workload experienced by an operator is important for designing workplace interventions that minimize fatigue and reduce injury risk. Existing methods for physical workload assessment can be disruptive to the work, intrusive to workers, are highly sensitive to the environment, and may not be feasible to implement in real-time on the manufacturing shop floor. The goal of this study was to investigate the potential of using changes in facial features as a method for real-time physical workload assessment for a constrained physical task.

Method: Four participants performed an assembly task during two sessions completed on different days with at least a week interval. During the assembly task, each participant was requested to screw a nut over a bolt as fast as possible, and as many times as possible, until exhaustion, while maintaining a static standing up-straight posture. The participant was instructed to maintain a controlled posture of dominant hand to screw the nut with upper arm abduction angle 45º and flexion angle 30º. An assembly box (length 0.4m×width 0.4m×height 0.3m) was used to hold a bolt with a nut at the center of upper surface and placed at the center of a workstation (length 0.8m×width 0.5m×height 0.7m). Participants adjusted elbow flexion and rotation angle, forearm position (with pronation and supination), and wrist angle in order to reach the bolt located at a fixed height (1.1m), and then were instructed to maintain a controlled upper arm posture. Exhaustion was defined based on a self-reported inability to continue the task or after 30 minutes passed, whichever was shorter. Ratings of perceived exertion (RPE) were acquired every two minutes. Performance of each participant was counted based on the number of finger movements when screwing the nut. Changes of facial features were captured via a camera placed 30 cm away from the participant aligned to the eye height. Fourteen facial landmarks, that were related to five facial components eye, eyebrow, mouth, face and head, were calculated on the basis of Euclidean distance between 3D coordinates of the landmark on each frame and the first frame of task recording. Pearson product-moment correlation was used to assess the relationships between the facial feature changes and the RPE and task performance.

Result: Average pixel movement of facial features for the eyebrow ($t=-2.76$- -3.04, $p<0.05$), head ($t=-3.19$, $p=0.02$), right and up eye up lid (Right: $t=-2.71$, $p=0.03$; Left: $t=-2.96$, $p=0.02$), and lip top and bottom point (Top: $t=-2.99$, $p=0.02$; Bottom: $t=-3.10$, $p=0.02$) increased significantly from the start to the end of assembly task. There were significant positive correlations between the average head movement and the arm, shoulder, back, and whole body RPE scores ($r = 0.38$-0.56, $p<0.001$), and a significant

negative correlation with performance ($r = -0.22$, $p=0.01$). Similarly, the average movement of the facial landmarks of the right and left inner eyebrow, and bottom point of lip were significantly correlated with RPE scores ($r = 0.28$-0.59, $p<0.001$) and performance ($r = -0.17$ - -0.22, $p<0.05$).

Conclusion: Changes of facial features, such as head movement, left and right inner point of eyebrow and bottom point of lip may be potential measurements to assess physical workload in real-time onsite manufacturing without disruption and intrusiveness to human operators.

Computational Virtue Ethics for Understanding and Preventing Moral Injury

Elliot Biltekoff, Matthew Bolton

Individuals' ethics can be complex and difficult to predict. This poses a significant barrier to understanding and preventing Moral Injury: when an individual perpetuates, fails to prevent, witnesses, or learns about acts that transgress deeply held moral beliefs, codes, or rules. MI is of particularly significant concern in populations that A: Have a higher than average exposure to potentially morally injurious situations (such as individuals in the armed forces) or B: Have predispositions or conditions which could make them more susceptible to MI (such as individuals with underlying mental health issues. MI is highly correlated with reductions in physical and mental health and increased symptoms of posttraumatic stress disorder (PTSD) and depression, which are separate constructs from MI. This can lead to significant practical issues and humanitarian concerns. For example, in the armed forces population, MI can lead to poor performance on duty, increased costs in veteran services, and risk of suicide (the second leading cause of death of members of the armed forces). Without a comprehensive way of assessing if a particular scenario may conflict with an individual's ethics, it is difficult for an institution or individual to formally determine if they are putting someone at risk of MI. In order to develop a better understanding of the cognitive mechanisms involved in the manifestation of MI, to facilitate the development of computational tools that can perform proactive assessments, a method of representing ethics is needed. Existing methods of computationally modeling ethics have shortcomings in the context of understanding/preventing MI. Virtue ethics provides a fundamental philosophical basis for modeling decisions with moral content. Combining this with the computational and representative power of fuzzy logic systems can allow for the development of highly specific, individual models with sufficient predictive capacity to lead to breakthroughs in the prevention of MI. Currently, work that is concerned with mitigating/improving the subjective experience of MI is almost exclusively intervention based. In order to prevent MI, we must be able to predict and explain it in a meaningful way.

Understanding Clinicians' Needs, Requirements, and Perception of a Sepsis Clinical Decision Support System (CDSS) to support successful implementation

Olamide Olatoye, Catherine Burns, Kathleen Andres, Erica Patterson

Clinicians are faced with ever increasing patient data as well as medical evidence which are all required for them to make the best possible decisions [1]. Clinical Decision Support Systems (CDSS) are computer technology that analyse patient data using the information to make diagnoses and provide patient-specific recommendations to assist clinicians in their decision making [1] [2]. CDSS can be in form of solicited information, unsolicited information, physician order, disease management systems and integrated information systems [1]. They have been proven by research to improve patient safety, clinical management, cost containment, administrative functions, and diagnostics support [3]. They are commonly integrated into EMRs/EHRs in the healthcare organisation [3] [4][8].

According to the Centers for Medicare & Medicaid Services (CMS), a CDSS should 'deliver the right information, to the right people, through right channels, in right intervention formats and at the right points in the workflow'[4]. However, many healthcare organisations encounter significant challenges regarding implementing user-friendly CDSS that fit into clinician's workflow[4]. Research has shown that CDSS are more likely to be used if they are properly integrated into work processes [6]. CDSS can disrupt workflow if the design does not follow human cognition and behaviours. Disrupting clinicians' workflows can cause increased cognitive workload, longer time to complete tasks and reduced interaction with patients. Some studies have shown that as a result, clinicians with more experiential knowledge are less receptive to the use of CDSS [3][6]. Poor implementation of CDSS also results in alert fatigue and clinical burnout [3] [4][6][8]. In the nearest future, it is expected that machine learning, and AI will be heavily applied to make these tools smarter [9]. It is therefore important for healthcare organisations to deal with these foundational human factors challenges by focusing on the end user's requirements in the design and implementation process for decision support tools.

Research and literature have shown that mimicking cognitive process, properly investigating user's needs, prioritizing usability, monitoring, and getting feedback are all strategies that can help with the successful implementation of CDSS [5][7]. Usability score by end-users and time to completion for tasks are amongst the key performance indicators outlined by CMS to understand the impact of a CDSS [4]. This project is looking to investigate the needs and requirements of SickKids clinicians regarding a Sepsis clinical decision support tool to be implemented. The project is in two phases, a semi-structured one-on-one interview and an observational phase. The project aims to use human factors study to drive the successful implementation of the Sepsis BPA in the organization. The objectives of the study include eliciting clinicians' requirements, perception of the Sepsis Best Practice Alert (BPA) tool, and discovering possible usability issues, acceptance, usage behaviour, and cognitive workload. We anticipate that the study would result in a better understanding of how to fit CDSS into clinicians' workflow, while simultaneously learning about the perception and acceptance of decision support tools in the healthcare community.

Although this current research is focused on the Sepsis tool at SickKids, the knowledge gained and results obtained can inform developers, researchers and health systems designers on the development of decision support.

Exploring Family Caregiver Perspectives about Information Management and Communication in Complex Home Care: A Qualitative Study

Ryan Tennant, Sana Allana, Kathryn Mercer, Catherine Burns

Background: Family caregivers of children with special health care needs are responsible for managing and communicating the information regarding their child's health in their home. While family caregivers currently capture information through non-digital methods, digital healthcare applications are a promising solution to support human-information interaction and standardization in complex home care across their child's health care team. However, family caregivers continue to use paper-based methods where the adoption of digital health tools is low. With the rise in home care for children with complex health care needs, it is critically important to understand the caregiving work domain to inform the design of technologies that support child safety in the home.

Objective: The objective of our study was to understand how family caregivers navigate information management and communication in complex home care for children with special health care needs.

Methods: This research is part of a broader study about caregivers' perspectives across North America on integrating and designing digital healthcare tools in complex home care. We conducted semi-structured interviews with family caregivers of children with special health care needs. Inductive thematic analysis was used to analyze the information management and communication processes.

Results: We collected data from five Canadian and two American family caregivers and identified five themes. First, family caregivers were Continuously Learning to Provide Care. They were Updating the Caregiver Team on their child's status and Teaching Caregivers about their Care Situation. As caregiving teams grew, they found themselves working on Communicating with their Child's Educators. Beyond the scope of managing their child's health information, family caregivers were additionally Navigating Bureaucratic Processes for their child's home care.

Conclusions: We observed that family caregivers' experiences caring for CSHCN differ geographically and evolve as their child's condition changes and while they grow towards adulthood. Family caregivers recorded information using paper-based tools, which did not sufficiently support information management. They also experienced significant pressures in summarizing information and coordinating two-way communication about the details of their child's health with caregivers. The design of digital healthcare tools for complex home care may improve caregiver coordination of CSHCN if they ease the information-interaction method, deliver situation-specific insights, and can adapt to every unique and dynamic homecare environment.

Optimizing public health data collection from Internet of Things sensors: An integrated data-sharing platform

Kang Wang, Shi Cao, Plinio Morita

Background: With the development of smart health, Internet of things (IoT) sensors have been essential sources of data for healthcare. Various types of IoT devices significantly expand the volume of health-related data; however, lacking standardized data collection methods makes researcher have difficulty in acquiring such data, which usually results in rising study costs and declining participation willingness.

Objective: Application Programming Interface (API) technology is an efficient tool for data transmission. It offers new possibility for automatically collecting real-time and historical data from a large scale of IoT devices. The primary aim of the study is to design and develop an API-integrated platform for healthcare data collection from IoT sensors. The secondary goal of the study is to evaluate the effects of this platform by comparing with other two existing data sharing channels: (1) nonstandard ways that need data donors' manual operations; (2) data sharing programs provided by IoT manufacturers.

Methods Comparison: Three data collection methods can be compared along the following key criteria: data completeness, data delay, data privacy, usability on the data donor side, and usability on the researcher side.

Existing method 1: This method requires data donors manually download their IoT devices' collected data and upload to researchers through nonstandard channel (e.g. email, personal cloud storage). This can remarkably reduce the data completeness due to operation errors during the process. In addition, data can be delayed because it is difficult to make donors update the data consistently.

Without anonymous sharing channel, users can be re-identified, resulting in data breach. For data donors, they may find difficulty in following such complex steps and not willing to participate; meanwhile, researchers also need to put much effort into data pre-processing.

Existing method 2: This method is a specific channel of data sharing program provided by IoT manufacturers, which is not commonly seen. Although manufacturers hold all users' data, which can guarantee the data completeness, the data only be shared with research partners periodically, such as once a year. This still can cause data delay and set barriers for real-time data availability. However, data privacy can be ensured since the data is anonymized by manufacturers before researchers acquire. Additionally, this program should not cause too much burden to data donors due to simplified operation is needed; meanwhile, researchers can get structured data which is well-prepared.

Proposed method: The API-integrated platform includes both user-friendly front-end and automatic working back-end. Since the data is directly streamed from data pool of the manufacturers by continuously invoking API and stored in the database, data completeness can be guaranteed, and data delay also can be erased. Moreover, to ensure the data privacy, sensitive information is excluded during the data transmission. By providing a user-friendly interface for one-time enrollment, operation burdens can be minimized for data donors. For researchers, all data can be stored in a structured database without any additional process of data integration, which will optimize querying of data and following analysis.

In the future, quantitative metrics such as data completeness rate and delay time difference will be measured to evaluate each method. At last, statistical significance tests including repeated measures ANOVA will be conducted on measurement results.

Excepted Benefits: By leveraging API technology in the data collection process, this platform can considerably increase the data completeness and elininate data delay which makes the acquired data in real-time. Users' concern about data privacy also can be eliminated by filtering sensitive information in the dataset. Furthermore, data donors' operation burden on data sharing can be released and actions needed for researchers are also minimized when integrating the data. The potential advantage of this platform is that it can effectively address the challenges of reduced participation willingness, rising study costs in money and time. In addition, this platform can make research avoid potential bias such as recall bias which is common when data donors quantify and recount their data, or response bias caused by low response rate and nonstandard sharing channel.

Application: Data collection is a key component of usual study. Since this platform provides a reliable channel for data collection, it can be applied on the study of population-level public health monitoring through IoT sensors. Furthermore, the historical and instant data provided by the platform make it can be applied on multiple researches.

Development and evaluation of a non-wearable intelligent multi-camera system for intraoperative video recording of open surgery.

Kate Kazlovich

High quality intraoperative video capture facilitates better healthcare, including better surgical training, continued professional development, and quality improvement. Ability to capture continuous, high-quality intraoperative video from open surgical procedures will provide access to data necessary for analysis of adverse events, allowing us to develop real-time intervention strategies.

Currently, there is a severe deficiency in our ability to capture high quality intraoperative video in open surgery. Traditional approaches include use of wearable camera technologies, cameras integrated with the overhead surgical lights, and videographer-operated technology. These solutions are often not optimized to capture uninterrupted and meaningful surgical content.

We believe that a combination of modern camera systems paired with the widely distributed and well tested machine learning algorithms may help us address this problem. Our aim is to develop a non-wearable multi-camera system that can act as an add-on to the existing operating room set-up and capture the unobstructed view of the surgical site while addressing a number of issues associated with the highly dynamic and complex surgical environment.

Taylor Kunkes

A Taxonomy of Forcing Functions for Addressing Human Errors in Human-machine Interaction

Pengyuan Wan, Matthew Bolton

The forcing function is an intervention for constraining human behavior, the general descriptions for forcing functions are limited and the tradeoffs of methods were not clear. In this poster, we would show the forcing function methods and represent the tradeoffs(include the restriction and human autonomy) by a hierarchy. This forcing function hierarchy summarizes the intervention methods from the available general human error intervention methods into two primaries categories: the hard forcing function (include interlock, lockin, and lockout methods), the soft forcing function(include symbolic forcing function and incorporeal forcing function). The hierarchy is the first step towards creating formal guidance for selecting forcing functions to fix errors in human-machine interaction.

Mobile Health Platform for Individual and Population-Level Surveillance

Pedro Velmovitsky, Plinio Morita

Introduction: Public health surveillance is the collection, analysis and dissemination of data to improve population health. These data are the most important source of information to support decision making and interventions by public health agencies. One of the main sources of data are surveys, such as in-person questionnaires and interviews. However, traditional survey methods have significant limitations related to self-reported data such as social and recall bias, loss due to follow-up, delays between collection and reporting, and costs/logistics. These limitations increase the burden on the user and can lead to incorrect or inaccurate data being collected.

An alternative to data collection in surveys is the use of mobile, wearable, and Internet of Things (IoT) technology, such as smartphones, smartwatches, and wireless scales, as additional survey and assessment tools. Notably, smart technologies have sensors that provide zero-effort monitoring of vital signs, environmental variables, and behavioural metrics, such as: heart rate, temperature, movements in the house, among others. Sensor data are also continuously measured, providing richer and more representative information.

Currently, to reduce the spread of COVID-19, populations around the globe are being asked to self-isolate at home, making clinic measurements and in-person interviews extremely difficult. In addition, social distancing for large periods of time can have adverse effects in the mental and physical health of populations. Connected devices that can safely, continuously and effortlessly monitor the

health of individuals can be of great help during the pandemic and highlight the pressing need of using personal devices for public health surveillance.

Apple Health is one of the most popular sources of health data from sensors, collecting information from devices such as smartphones, smartwatches and wireless scales, that are connected to Apple operating systems. However, little focus has been given to the use of all this personal smart technology and data to support public health, despite its popularity.

As an example of the benefits of the use of personal devices to data collection by public health agencies, the Canadian Health Measures Survey (CHMS) is a major survey comprised of: (i) an hour-long interview in the respondents' home; (ii) a visit to a temporary clinic to collect physical measures; and (iii) use of a fitness tracker for a week. Most of the measures in this survey, such as body composition or heart rate, can be collected using smart technologies, and the aforementioned platform can reduce social and recall biases. Incorporating smart technologies in survey design will minimize time and financial burdens of clinicians and interviewers, while data can be reported in real-time. By leveraging the data already collected from personal devices for long periods of time, studies could minimize follow-up losses by providing automated data collection while ensuring the data are more representative than those obtained from the fitness tracker.

Objective: Currently, there is a gap in the field of public health surveillance: smart technologies can improve data collection accuracy and minimize limitations in traditional data collection methods; however, they are not currently being used in this context. Public health agencies are not able to access large volumes of diverse and real-time data, collected by personal devices, which would allow them to conduct more complex analyses and interventions in their mission of improving the health of populations.

The overall goal of this project is to create of a mobile platform that will collect and store health data from devices connected to Apple Health continuously and in real-time, with zero effort to users and respondents (unlike traditional surveys). The diverse and real-time data will be extremely relevant to public health officials in supporting their decision making and health policies.

Methods: An iPhone prototype has been developed, collecting weight, steps, heart rate, blood pressure and sleep data from Apple Health and associated connected devices such as iPhones, Apple Watches and wireless scales. These variables were chosen for the proof of concept as they are usually collected in Canadian public health surveys. For the final version, users will be able to add or remove variables, allowing flexibility for researchers to collect specific data types for each survey or study and improving overall user experience.

Data Validation: To validate the platform, stress will be used as a use case: we will conduct a study to collect stress-related variables from working age individuals in real-life scenarios with the platform. These data will be used to train Machine/Deep Learning algorithms to predict the stress levels of each individual, demonstrating the effectiveness of the platform. Stress was chosen as it is a significant issue in Canada. Also, stress is collected in research through self-report questionnaires, despite associations between stress and vital/behavioural metrics that can be measured using smart devices (e.g., sleep, physical activity, heart rate). Therefore, continuous collection of objective measures on stress is an effective use case for the platform. We will be looking at the application of the Random Forest, Support Vector Machine, and Deep Learning algorithms.

Privacy: Since this work proposes to collect personal health data, it is necessary to consider the privacy of these data. In Canada, the Protection and Electronic Documents Act (PIPEDA) regulates the collection, use and disclosure of personally identifiable information (PII) for private sector organizations

involved in a commercial activity. This applies to all types of PII including health data. Therefore, this work will also be looking into maintaining user privacy and obtaining user consent for data collection using mobiles and wearables. We will explore how to anonymize and maintain user privacy for the collected data, while making sure that the user has a great experience with the platform through the use of consent forms.

Platform Evaluation: To evaluate the platform, we will look into several attributes that are typically used to evaluate an informatics-based surveillance system. This will allow us to make sure the platform follows best practices and guidelines for human factors deployment: (i) simplicity of the system; (ii) fleixibility, meaning the system should be able to adapt with little effort; (iii) data quality, meaning the collected data must be valid; (iv) acceptability, meaning that users will be willing and eager to use the system; (v) timeliness, meaning the system must be fast; (vi) stability, related to the availability and reliability of the system; (vii) information quality, which refers to completeness and consistency of the collected data; (viii) system quality, referring to the usability, minimal error, response time and functionality of the system, among others; (ix) user experience: refers to the assurancy and empathy of the system.

Conclusion: Ultimately, with the proposed platform, individuals will have a complete and more accurate picture of their health through zero-effort methods, including quantitative and qualitative metrics. With more robust, diverse and accurate data to support decision making, public health agencies will have a new tool to help in their mission of improving population health and saving lives.

Modelling Pilot Flight Performance in a Cognitive Architecture

Rong Bing Xu, Shi Cao

We are currently building a flight simulation model based on human cognitive architecture and situation awareness on a flight simulator. We believe that this model can correctly simulate the human pilot's performance and behavior. It will train and evaluate human pilot's performance with further development and research to improve aviation safety. To verify this model's effectiveness, the best way is to compare the model's data with participants' data under the same scenarios. Therefore, we designed an experiment under three different scenarios, which correspond to varying aircraft piloting stages, including per-flight preparation, take-off, and approach/landing. We will compare pilot behavior and situation awareness data generated by the model, such as the pilot's control of the throttle and rudder, the pilot's operation of the lighting system, etc., with the same type of data collected from the participants, to make sure this model is useful.