781 Advanced Topics: Mobility in the Aging Population (Part I)

Course Coordinator: Rong Zheng
Email: rzheng at mcmaster dot ca
Lectures: Thursday. 9am - 12pm EST(a place holder)
Zoom link:
https://mcmaster.zoom.us/j/94623794544?pwd=bHdQVXRVazc3aDcvRXl5a2FRaitFZz09
Moodle
https://smap.cas.mcmaster.ca/moodle
Microsoft Stream (for CC) : (via McMaster Account)
https://www.microsoft.com/en-us/microsoft-365/microsoft-stream (After sign-in, go to group "CAS 781 Advanced Topics in Computing and Software C01")

Synopsis:
The proportion of older adults (aged 65 and older) worldwide has been increasing steadily over the past 40 years. In Canada, it has been projected that seniors will represent up to 25% of the total population by 2036. Mobility is a crucial indicator of functional status, and a predictor of quality of life and longevity; hence, it is often called the sixth vital sign. Mobility encompasses not only the physical activities of older adults, and the performance of specific maneuvers such as sit-to-stand, walking or climbing stairs, but also participation in society (e.g., the ability to drive, accessibility to public transportation). This course (MiA I) is the first of a two-part 6-unit credit course that spans two terms. This main goals of MiA 1 are to provide students in the CREATE program from diverse backgrounds the necessary foundational knowledge to understand mobility challenges faced by older adults and their physiological roots, user-centric research design and methods in multidisciplinary settings, and key technologies including data management, machine learning, sensors and sensor data analysis, as well as new frontiers in sensing. The lectures will be offered by renown experts in related fields from three institutions.

Course Organization:
The course is divided into five conceptually independent modules. Each module consists of pre-recorded lectures (2 - 3 hrs/week) and synchronous live interactions (1hr/week) with the instructors. The one-hr synchronous session shall be arranged separately for each module. To pass the course, students need to fulfill the requirements of at least four out of the five modules. A suggested sequence of modules is given in Figure 1.

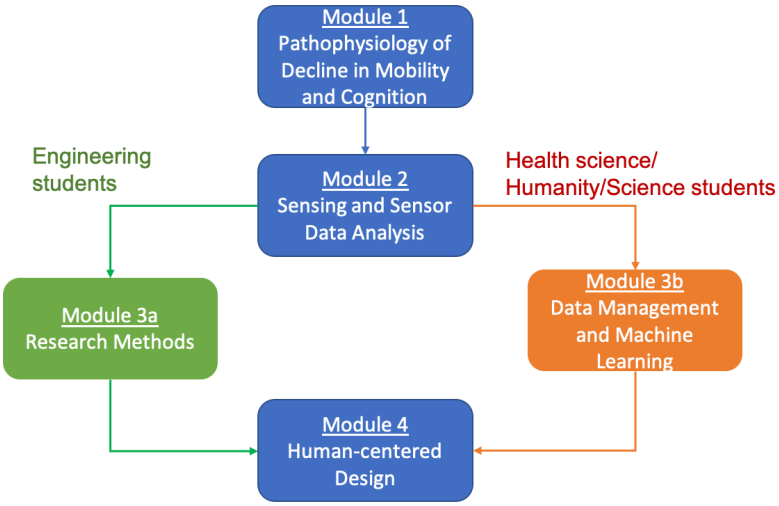

Figure 1. A Suggested Path of Completion

Module Details:

Module 1: Pathophysiology of Decline in Mobility and Cognition			
Instructors	Dr. Janie Wilson, Dept of Surgery, McMaster University (Instructional Lead); (janiewilson at mcmaster dot ca)	Dr. Tony Szturm, College of Rehabilitation Sciences, University of Manitoba; (tony.szturm at umanitoba dot ca)	Dr. Alexandra Papaioannou, Dept of Medicine, Division of Geriatric Medicine, McMaster University; (papaioannou at hhsc dot ca)
Synopsis	This module will introduce students to the clinical and research field of aging-related decline in mobility and cognition. The module content will begin with an introduction to medical and clinical considerations with aging-related declines in mobility and cognition within the field of gerontology, with particular emphasis on falls. Students will dive into the pathophysiology of mobility and balance, including an exploration of how the vestibular, visual, and muscular/motor system control movement and balance. The final content of the module will provide the student with an introduction to gait analysis and the methodologies used to measure and model human movement within the context of age-related mobility declines.		
Learning Objectives	• To be able to describe the epidemiology, morbidity, and mortality of falls. • To understand the risk factors for falls. • To understand clinical evaluations of a patient with falls. • To identify the evidence of interventions to reduce falls. • To understand how the nervous system detects and appreciates bodily sensations. • To develop an appreciation of the role of spinal reflex (involuntary) activation of alpha motor neurons versus the role of supraspinal (voluntary) control of alpha motor neuron activation. • To define balance control in terms of the center of body mass and base of support of a stationary body and a moving body (bipedal locomotion).		

	• To describe the types of sensory systems/signals and spatial information required to assess the state of balance and to appreciate the impact of the environment on balance dynamics and challenges. • To describe the two types of balance control: feed forward (predictive) and feedback (uncertainty) control. • To develop an appreciation for the role of the major divisions of the pre-frontal cortex in "higher" cognitive functions referred to as "executive cognitive functions", such as attention, working memory, and "supervisory" control of brain work. • To develop an appreciation of the roles of the hippocampus and temporal lobe of the cerebral cortex in long-term memory storage • To understand how gait analysis is used as a model to understand dynamic human movement in health and age-related pathology. • To develop an understanding of how the kinematic and kinetic attributes of human movement can be captured and modeled, including an overview of 3D human movement kinematics and link segment modeling for intersegmental force representation. • To explore how human gait data can be modeled to identify pathological deviations.		
Schedule	**Topics**	**Lecture Content**	**Instructor**
Week 1 (Sept. 8th)	**Pathophysiology, Mobility and Cognition**	introduction to applied physiology of balance gait visuomotor and cognitive function as related to Mobility and fall risk (pdf, ppsx, video, note)	Dr. Szturm 1-hr Q & A Sept. 15th, 9-10am EST
Week 2 (Sept. 15th)	**Methods in Human Movement Biomechanics and Gait Analysis**	introduction to methodologies, terms and instrumentation for gait analysis and applied biomechanics for applications in human aging research (ppt, ppsx, video)	Dr. Wilson 1-hr Q & A Sept. 22nd, 9-10am EST
Week 3 (Sept. 22nd)	**Frailty, Falls and Fractures**	introduction to applied physiology of balance gait visuomotor and cognitive function as related to mobility and fall risks (ppt, ppsx, video, ably video)	Dr. Papaioannou Live session 11 - 12:30pm, Sept 25 MIRA WEBINAR SERIES: ONE TOPIC, TWO DISCIPLINES September 28 @ 9:00 am - 10:00 pm

Evaluation	This module will be assessed with an online short-answer quiz at the completion of the 3-week module. The quiz will cover content of the entire module
Reference Material (* are required readings)	1. *Wong C et al. 2015. Wearable Sensing for Solid Biomechanics: A Review. IEEE Sensors Journal, 15(5). Pp. 2747-2760. (Overview of wearable sensors and techniques for solid mechanics of the human body). 2. *Gage JR. 1990. An Overview of Normal Walking. Instr Course Lect. 39:291-303. 3. *Winter DA. 1995. Human Balance and Posture Control during Standing and Walking. Gait and Posture, Vol 3: 193-214. 4. *Ostrosky KM et al. 1994. A Comparison of Gait Characteristics in Young and Old Subjects. Physical Therapy, Vol 74(7). 5. 'Fifteen Years of Wireless Sensors for Balance Assessment in Neurological Disorders' Zampogna A. et al. Sensors. 2020; 20:3247. 6. 'Sensorimotor anatomy of gait, balance, and falls' MacKinnon CD. Handb Clin Neurol. 2018; 159:3-26. 7. 'Prevention of Falls and Fall-Related Fractures through Biomechanics' Robinovitch et al. Exerc Sport Sci Rev. 2000; Apr;28(2):74-9. 8. 'The effect of fall biomechanics on risk for hip fracture in older adults: A cohort study of video-captured falls in long-term care' Yang Y et al. JMBR 2020. 9. 'Exercise for preventing falls in older people living in the community: an abridged Cochrane systematic review' Sherrington C. et al. Br J Sports Med 2019; 0:1-8. 10. 'Comparisons of interventions for preventing falls in older adults. A systematic review and meta-analysis' Tricco A.C. et al. J American Medical Association. 2017; 318(17): 1687-1699. 11. 'Research Methods in Biomechanics' 2nd Edition. Robertson DG et al (2013). Human Kinetics. (textbook)

Module 2: Sensing and Sensor Data Processing	
Instructors	Dr. Jamal Deen, Dept. of Electrical Engineering, McMaster University (jamal at mcmaster dot ca) Dr. Qiyin Fang, Dept. of Engineering Physics, McMaster University (qiyin.fang at mcmaster dot ca) Dr. Rong Zheng, Dept. of Computing and Software, McMaster University (rzheng at mcmaster dot ca) Dr. Tricia Breen Carmichael, Dept. of Chemistry and Biochemistry, University of Windsor (tbcarmic at uwindsor dot ca) Dr. Simon Rondeau-Gagné (simon.rondeau-gagne at uwindsor dot ca)
Synopsis	This module aims to provide basic understandings of the characteristics of commercial-of-the-shelf sensors commonly used in detecting falls and activities.

	Issues encountered in sensor measurements and techniques to mitigate them, fundamental sensor data processing methods are covered. Design considerations for next generation wearable sensors are also discussed.		
Prerequisites	• Statistics • Proficiency in one data analysis tool (matlab, python, R or excel)		
Schedule	**Topics**	**Lecture Content**	**Instructor**
Week 1 (Sept. 29th)	**Sensors related to falls & activities**	Sensing and sensor principles, case studies in aging applications. (pdf, video)	Dr. Fang Tue, Sept. 29th Live lecture & discussion 9 - 12pm EST
Week 2 (Oct. 6th)	**Sensor measurement issues & data processing**	1) Sensor measurement issues – Basics, Mean, Variance, Error/uncertainty, Tests, Correlation, Error propagation, Calibration (ppt, ppsx, video) 2) Frequency domain representation, LPF/HPF filtering, case study in step counting (ppt, ppsx, video) Xsens video in the slide	Dr. Deen (1) Dr. Zheng (2) Live lecture Oct. 6th, Tue., 10:30 - 12:00pm (Deen) 1-hr Q & A, Oct. 13th Tue. 11 - 12pm
Week 3 (Oct. 20th)	**Next generation wearable sensors**	1) Soft Materials for Next Generation Electronics, 2) Flexible Strain Sensors and Strain-Responsive Mechanism, 3) Performance of Stretchable/Wearable Strain Sensors (ppt, ppsx, video)	Dr. Carmichael Dr. Rondeau-Gagné 1-hr Q & A, Oct. 27th Tue. 11 - 12pm
Evaluation	Exploring data from a smart home, on-line quiz, paper critiques and presentations		
Reference Material	[1] M. Amjadi, K. U. Kyung, I. Park, M. Sitti, Stretchable, Skin-Mountable, and Wearable Strain Sensors and Their Potential Applications: A Review. *Adv. Funct. Mater.* **2016**, *26*, 1678. [2] M. L. Hammock, A. Chortos, B. C.-K. Tee, J. B.-H. Tok, Z. Bao, 25th anniversary article: The evolution of electronic skin (e-skin): a brief history, design considerations, and recent progress. *Adv. Mater.* **2013**, *25*, 5997. [3] M. J. McGrath, C. N. Scanaill, Sensor Technologies: Healthcare, Wellness, and Environmental Applications, Apress, Berkeley, 2013. ISBN: 978-1-4302-6014-1, https://doi.org/10.1007/978-1-4302-6014-1.		

	[4] Haque, A., Milstein, A. & Fei-Fei, L. Illuminating the dark spaces of healthcare with ambient intelligence. Nature 585, 193–202 (2020). https://doi.org/10.1038/s41586-020-2669-y

Module 3a: Research Methods			
Instructors	Dr. Dylan Kobsar, Dept. of Kinesiology, McMaster University (Instructional Lead); (kobsard at mcmaster dot ca)	Dr. Jacquie Ripat, Dept. of Occupational Therapy, University of Manitoba (Jacquie.Ripat at umanitoba dot ca)	
Synopsis	This module will introduce students to research methods used in the cross-disciplinary study of mobility in aging. Students will develop an understanding of research design, data collection and analysis.		
Learning Objectives	• Evaluate and develop appropriate research questions • Explain the hierarchy of evidence based on a study design and its implications in health research • Describe quantitative, qualitative, and mixed methods approaches to research • Critically analyze published research		
Schedule	**Topics**	**Lecture Content**	**Instructor**
Week 1 (Oct. 27th)	**Foundations**	Scientific approach, research questions (PICO), common misinterpretations (stats, confounders, generalization), the role of theory in research. (slides, video)	Dr. Kobsar 1-hr Q & A, Nov. 3rd, Tue. 9 - 10am EST
Week 2 (Nov. 3rd)	**Quantitative Research Designs**	Levels of evidence & research designs (Case studies, Cross-sectional, Cohort; prospective & retrospective – strengths/limitations) (slides, video)	Dr. Kobsar 1-hr Q & A, Nov. 10th, Tue. 9 - 10am EST
Week 3 (Nov. 10th)	**Quantitative Research Designs – Continued**	Research designs (RCTs, Metas – strengths/limitations) research.	Dr. Kobsar 1-hr Q & A, Nov. 17th, Tue. 9 - 10am EST

		(slides, video)	
Week 4 (Nov. 17th)	**Qualitative & Mixed Methods**	Research questions and study designs (descriptive, interpretive designs, metasyntheses) and common methods (focus groups, interviews, visual methods) Qualitative (part1, part2, part3), Mixed Method (part4, part5)	Dr. Ripat 1-hr Q & A, Nov. 24th, Tue. 9 - 10 pm EST (8 - 9am CST)
Evaluation	Paper critiques		
Reference	TBD		

Module 3b: Data Management and Machine Learning			
Instructors	Dr. Fei Chiang, Dept. of Computing and Software, McMaster University (fchiang at mcmaster dot ca)	Dr. Hassan Ashtiani, Dept. of Computing and Software, McMaster University (zokaeiam at mcmaster dot ca)	
Synopsis	This module will introduce students to foundational terminology and concepts from data management and machine learning from a user-centric view. Students will learn and practice available technology and tools to perform standard data profiling, data preparation, supervised learning, etc. in the context of health and aging projects.		
Prerequisite	• Statistics, probability, calculus, linear algebra (all at the basic level) • Python programming familiarity Students w/o the necessary background are expected to self study beforehand. Recommended materials: Python programming: • https://www.w3schools.com/python/default.asp • https://docs.python.org/3/tutorial/ Prob/Statistics • https://stanford.edu/~shervine/teaching/cs-229/refresher-probabilities-statistics		
Learning Objectives	• To understand basic concepts in machine learning and in data management. • To understand the common technical challenges of machine learning and data analysis, including statistical and computational issues • To gain familiarity with how a real-world problem can be identified/formulated as a machine learning problem • To learn basic/common computational techniques in machine learning		

	• To gain familiarity of different types of data, the challenges to managing these heterogeneous datasets, available tools and techniques. • To gain familiarity with state-of-the-art libraries and tools in machine learning and data management • Awareness of common pitfalls in ML and data management applications (e.g., metrics, population representation, privacy) in health care settings		
Schedule	**Topics**	**Lecture Content**	**Instructor**
Week 1 (Oct. 27th)	Intro to machine learning, regression	1) Introduction to machine learning and supervised learning 2) Introduction to curve-fitting, linear vs non-linear regression 3) Overfitting and generalization (ppt, ppsx, video)	Dr. Ashtiani 1-hr Q & A, Nov. 3rd, Tue. 10 - 11am EST Jupyter Notebook Links
Week 2 (Nov. 3rd)	Classification	1) Introduction to classification, 2) Linear Classification, 3) Neural Networks 4) Fairness and representativeness (ppt, ppsx, video)	Dr. Ashtiani 1-hr Q & A, Nov. 10th, Tue. 10 - 11am EST
Week 3 (Nov. 10th)	Databases and Data Analysis	1) Introduction to different types of data models and databases 2) Introduction to the data analysis pipeline (information extraction, data preparation, integration, transformation) (ppt, ppsx, video)	Dr. Chiang 1-hr Q & A, Nov.17th, Tue. 10 - 11am EST
Week 4 (Nov. 17th)	Data Privacy, Metrics and Tools	1) Evaluation metrics, data privacy 2) Data mining, data profiling techniques 3) State-of-the-art tools (ppt, ppsx, video)	Dr. Chiang 1-hr Q & A, Nov. 24th, Tue. 10 - 11am
Evaluation	Hands-on assignments with reports		
Reference Material	TBD		

Module 4: Human-Centered Design

Instructors	Paula Gardner, Dept. of Communication Studies and Multimedia, McMaster University (gardnerp at mcmaster dot ca)	Celine Latulipe, Dept. of Computer Science, University of Manitoba (Celine.Latulipe at umanitoba dot ca)	Brenda Vrkljan, School of Rehabilitation Science, McMaster University, (vrkljan at mcmaster dot ca)
Synopsis	This module will introduce students to literature examining approaches to interdisciplinary research binding health science, computer science and traditional and contemporary critical design approaches in ageing research. Students will be trained in diverse approaches to critical human-centered design including user interaction design, participatory design and co-design, with attention to distinct needs of diverse older adult populations. Students will be introduced to human-centered evaluation methods effective with aging populations with attention to remote testing environments. Organization of the materials		
Learning Objectives	• To gain literacy in diverse approaches to interdisciplinary research approaches in the area of aging • To distinguish among traditional and contemporary human-centered design approaches and the value of each to diverse aging research contexts • To understand aging, frailty and disability-informed approaches to human-centered research design • To gain familiarity in the design of research plans employing interdisciplinary and critical human-centered design approaches in aging research • To gain familiarity with evaluation assessment methods employing human-centered design with diverse aging populations • To gain familiarity with ethics protocols in the Canadian research environment, and consider consent processes as applied to older adult participants		
Prerequisites	none		
Schedule	**Topics**	**Lecture Content**	**Instructor**
Week 1 (Nov. 24th)	**Ethics, Interdisciplinarity and Traditional Need-finding**	Background, traditional HCI need-finding, visit with older adults (Slides) (Videos: 1, 2, 3, 4, 5, 6)	Dr. Gardner, Dr. Latulipe, Dr. Vrkljan 1-hr Q & A, Dec. 1st, Tue. 10 - 11am EST/9-10am CST
Week 2 (Dec. 1st)	**Design Approaches, Ideation & Prototyping**	Contemporary user-centered approaches, creative techniques (and how to choose), clinician as proxy and case study	Dr. Gardner, Dr. Latulipe, Dr. Vrkljan 1-hr Q & A, Dec 8th,

		(ppt, videos: 2a1, 2a2, 2b, 2c1, 2c2, 2d)	Tue. 10 - 11am EST/9-10am CST
Week 3 (Dec. 8th)	**Evaluation in User-Centred Design**	Qualitative and quantitative Methods (interdisciplinary methods), combining multiple evaluation methods, User-centered design summary (ppt, video)	Dr. Gardner, Dr. Latulipe, Dr. Vrkljan 1-hr Q & A, Dec 15th, Tue. 10 - 11am EST/9-10am CST
Evaluation	Practice exercises, study report		
Reference Material	1. Research team publication, published HCI 2019, Springer. "Employing Interdisciplinary Approaches in Designing with Fragile Older Adults; Advancing ABLE for Arts-Based Rehabilitative Play and Complex Learning " 23 pages key words: Participatory design - User interaction design - Interdisciplinary practice - Geriatrics - Physical therapy -Human computer interaction - Prevention - Fragility - Dementia - Neuroplasticity -Complex learning theory 2. TBA 3. TBA Human-Centered ResearchConferences (w published, open access papers) ACM Computer Human Interaction ACM Designing Interactive Systems Human Computer Communication		
Activities/Deliverables	Exercises are embedded in the video lectures. Deliverables (short written and/or orally presented exercises) to be discussed in synchronous meetings.		

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