

Title: **Comprehensive statistical modelling for radiobiological changes measured via Raman spectroscopy**

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Abstract

We propose a collaborative approach between multiple departments and disciplines to achieve an understanding, specifically at the cellular level, for how tumours respond to radiation, and why they do so in a heterogeneous manner. The statistical goals are a comprehensive handling of Raman spectroscopy data through a promising blend of finite mixture models and functional data analysis. The postdoctoral fellow will serve as the catalyst and focal point of this research program, liaising with their direct supervisors, a team of medical physicists, and cancer care practitioners on a regular basis.

Interdisciplinary/Applied Experience

The PDF will immediately join as a collaborator with Dr. Andrew Jirasek's medical physics research group through weekly meetings — they will help PI Andrews guide analyses being used within the group and spot avenues for development of core statistical methodologies. The medical physics group primarily investigates biological changes in tumour cells/tissue due to radiation therapy via Raman spectroscopic techniques. They will have direct access to both raw and processed data originating from this research group, which has ongoing REB-approved work with the BC Cancer Agency's Centre for the Southern Interior (BCCA-CSI). The PDF will also join high-level, bi-weekly meetings with the Brachytherapy Research Advisory Board at BCCA-CSI, which both Dr. Jirasek and Dr. Andrews serve on. From these opportunities, the PDF will be exposed to roughly 8 principal investigators with research interests in metabolomics, radiomics, imaging, physics, and surgical procedures related to cancer therapy.

Teaching/Training/Education

The PDF will teach a one-semester course (or equivalent, such as three modules in the Master of Data Science program at UBCO) during each year of their position. The supervisors will serve as formal mentors for the PDF in teaching those courses, providing course notes when possible, and guidance on university-specific course technologies. They will also be provided access to teaching support systems available on each campus. For example, the Centre for Teaching and Learning at UBCO and centre for teaching teaching excellence at Waterloo both provide ongoing training, pedagogical research seminars, and other support related to teaching. There may also be avenue to join pedagogically oriented projects depending on the timelines of arrival. For example, there is an ongoing proposal at UBCO to redesign the BSc in Data Science curriculum, expected to kick-off mid-2022. At Waterloo the faculty has a teaching fellow who holds meetings for new instructors and is always ready to provide individual advice and support.

The PDF will also be encouraged to mentor at least one team of 3-4 Master of Data Science (MDS) students from UBCO during their applied Capstone project (May and June of each year). The MDS

program is expecting to provide supplementary grant support in return for this service, at roughly \$800 per team, starting with the current cohort of students. This support would be in addition to any research support noted in the budget of this proposal.

Mentoring of the Postdoctoral Fellow

The PDF will be provided research guidance in clustering and classification with mixture models from two award-winning researchers in the field with active ongoing collaborative projects. They will be further mentored by collaborators in medical physics, cell biology, and oncology, and given bandwidth to explore diverse projects with those collaborators. The PDF will be heavily involved with research grant preparation, helping drive forward ambitious interdisciplinary proposals (such as tri-council NFRF-E and CANSSI CRT), and provided guidance by both the supervisors and the offices of research services on the respective campuses when appropriate. They will be given training in Equity, Diversity, and Inclusion via seminars from UBCO's Equity & Inclusion Office and UWaterloo's Human Rights, Equity, & Inclusion Office.

UBCO was recently chosen as a site for the Banff International Research Station (BIRS), and we further expect to explore the hosting of an annual conference during the term of the PDF. They will be involved in the organizational processes associated with these ventures, thereby being exposed to prominent researchers in the mathematical and statistical sciences. UWaterloo is, by many measures, one of the pre-eminent campuses for the field of statistics in Canada, which will provide the PDF with a wealth of collaborative and training opportunities through active seminar and award talks. In the mid-to-post-pandemic era, we expect the PDF will gain access to these resources even while on-site at UBCO via virtual attendance.

Proposed Schedule for Postdoctoral Fellowship

The ideal scenario would be for the PDF to spend one year in each of the co-supervisors locations (Kelowna, BC and Waterloo, ON), including teaching one full semester course at each campus (UBCO and UWaterloo). This setup would provide a diverse set of an environments for the PDF, enhancing the training program. However, we also recognize that many promising researchers are tied to specific locales for a variety of potential reasons — familial restrictions, availability of physical/mental health support systems, or otherwise. With this in mind, we will equally consider cases where the PDF would prefer to serve the entire two-year term at only one of either UWaterloo or UBCO. In order to ensure this is possible from the standpoint of financial commitments, we have received approval for two sessional instructorships at each campus during the two-year span of the fellowship.

Schedule for year 1: The locale for year one will be UBCO in Kelowna, BC. The PDF will immediately join collaborative meetings with medical physicists and with the co-supervisors. The first month will ensure the PDF is brought up to speed on collaborations and the individual research programs of the co-supervisors. Soon thereafter, the PDF will join bi-weekly meetings with BCCA-CSI. This will expose the PDF to a variety of research projects among local cancer care practitioners. Over the span of the next two months, the PDF and supervisors will identify 2-3 research projects to focus on over the remainder of the year which have their basis in core statistics but will also have application in cancer care, metabolomics, and Raman spectroscopy. Teaching assignment will likely commence during the Fall 2022 semester. By end of year one, we expect one PDF-primary-authored statistical methodology paper suitable for submission to *Statistics and Computing* or a similar journal, along with likely co-authorship submissions on 2 other manuscripts.

Schedule for year 2: The locale for year two will be UWaterloo in Waterloo, ON. The PDF will join Dr. Browne's research group in person, while continuing weekly meetings remotely with Dr. Andrews, medical physics researchers, and the Brachytherapy group at BC Cancer Agency. Research progress

will continue on projects identified in year one, culminating in at least two further primary authorship submissions, and 2-3 more co-authorship manuscripts. Teaching assignment will likely commence during the Fall 2023 semester.

List of Qualifications of Suitable Candidates

The successful applicant will hold a PhD in Statistics, Biostatistics, or closely related field. Strong communication skills will be considered an asset, given the intended interdisciplinary collaborations associated with the position. Preference will be given to candidates with research experience in statistical methodology related to mixture models and/or functional data analysis, though applied experiences in either modelling approach will be considered an asset as well. Motivated applicants without background in mixture models and/or FDA will still be given full consideration. We encourage applications from members of groups that have been marginalized on any grounds under the BC Human Rights Code. All qualified candidates will be given full consideration; however, Canadian citizens and permanent residents of Canada will be given priority.