Canadian Statistical Sciences Institute
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Wildfire Mitigation via Functional Time Series Analysis

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Abstract

This project will develop new statistical methods in spatio-temporal functional data analysis directed at forecasting, early detection, and mitigation of wildfires through the use of open-source data and data from the Edmonton branch of the Canadian Forest Service (CFS). Such methodologies will include conformal forecasting, a machine learning technique that quantifies uncertainty, Markov switching models, a time series model that incorporates hidden system states, and functional clustering via model-based and non-model-based approaches. A critical analysis of the related model fitting algorithms required to handle such data like Markov chain Monte Carlo (MCMC) and variational learning will also be undertaken so that fast and accurate results can be deployed in the field.

Interdisciplinary/Applied Experience

An integral part of this CANSSI Distinguished Postdoctoral Fellowship will be close collaboration with fire scientist Dr. Piyush Jain of the Edmonton branch of the Canadian Forest Service. The CFS has a massive collection of current and historic data regarding wildfires in the province of Alberta as well as throughout Canada. But beyond just archiving and maintaining historic data, they target many critical wildfire problems including forecasting fire danger/fire weather, fire mapping, and fire spread modeling. Quick action is often necessary, making close and ongoing collaboration invaluable to support these endeavours. And the recent escalation in the severity of wildfires in Canada makes this a problem of critical importance to

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solve. See cfs.cloud.nrcan.gc.ca/statsprofile/disturbance/wildland-fires.html for more.

Teaching/Training/Education

As part of this CANSSI Distinguished Postdoctoral Fellowship, one undergraduate lecture course will be taught per year to provide experience with classroom teaching. This will begin in the first winter term of the two-year PDF. As research supervisors, we will also act as teaching mentors by attending lectures and providing critical feedback to improve teaching performance. Similarly, there will be opportunities to collaborate with and mentor undergraduate and graduate students working as part of this research team. This will provide the CANSSI PDF with excellent teaching and mentorship experience to take with them into their future academic career.

Mentoring

Mentorship of this CANSSI PDF will be multifaceted. A primary focus will be on developing research skills, from mastering technical topics to gaining experience with academic publishing and attending conferences. Mentorship will also include teaching support to help participants become strong and effective communicators in the classroom. Beyond teaching, the PDF will have the opportunity to co-supervise student researchers alongside their own supervisor, gaining experience working with research students. Additionally, mentoring will extend to other areas such as applying for academic tenure-track jobs, engaging with industry, government, and other non-academic partners, and participating in EDI training, such as through the PIMS EDI workshop, among others.

Mentorship is structured and outcomes-driven. Weekly one-on-one meetings with each supervisor, along with a monthly tri-meeting, will set goals, review code and papers, and address issues. An Individual Development Plan (IDP) will be created in the first month and reviewed quarterly. Roles: Aminghafari will mentor conformal forecasting and functional clustering with applications. Kashlak will mentor spatial-temporal modeling and the Markov switching aspect of the research. If an external mentor (for example, from Alberta Wildfire or Environment and Climate Change Canada) is appointed, they will host a one-week placement each year and provide operational feedback.

Schedule

Year 1

Fall: The PDF will begin research at the University of Alberta and will be introduced to collaborators at the Alberta Government's Forestry Division. The fall term will focus on the launch of the research under the mentorship of both supervisors.

Winter: The term will see a continuation of research, plus the opportunity to teach an undergraduate course.

Spring/Summer: This term will be dedicated to further research, collaboration with data partners, and attendance at major statistics conferences.

Year 2

Fall: The PDF will continue collaborative research, engage with the environment of a new institution at the University of Calgary (UofC), and apply for academic positions with the support of supervisors.

Winter: They will teach a course at the UofC, be interviewed for academic positions during this period, and write up their main research results for publication.

Spring/Summer: The PDF will conclude by ensuring that all the research results and codes are accessible and reproducible.

List of Desired Qualifications

Required:

- PhD in Statistics, Biostatistics, Statistical Machine Learning, or related fields by start date
- Expertise in functional data analysis and forecasting in time series
- Strong R and/or Python coding
- Experience working with geospatial data is preferred
- Willingness to collaborate and mentor undergraduate and graduate students

Assets:

- Expertise in conformal methods, change point, and multiscale modeling/Markov switching modeling
- Environmental modeling/Random object