To the Admissions Committee,

It is with great enthusiasm that I hereby submit my application for the PhD Program at the Department of Statistical Science. I had the opportunity to talk at the *MLBytes Speaker Series* and visit the vibrant department on November 15. My meetings with professors and students convinced me that Duke is the best place for me to carry out my research projects and prepare for a scientific career in statistics.

I am currently pursuing a research Master's Degree in Mathematics (Statistics Concentration) at Université du Québec à Montréal (UQAM) and I did my Bachelor in Pure Mathematics at the same institution. My pre-university education emphasized **programming and project-based learning**. For instance, I learned Object-Oriented and Event-Driven Programming in Java at the time. One of my projects, featured on CEGEP Limoilou's homepage in 2014, is still up at http://olivierbinette.ca/Fractals. It exploited early Javascript multithreading technology to allow the interactive exploration of high-resolution fractal images. My personal blog at http://mathstatnotes.wordpress.com showcases my more recent interests which are now linked through statistics and applied mathematics.

My main bachelor and master research has focused on Bayesian nonparametrics and I have submitted two papers. The first outlines the use of Bayesian nonparametrics in circular and directional statistics. It addresses some criticisms about the use of truncated Fourier Series by suggesting an alternative density basis - analogous to the Bernstein polynomial densities - which facilitates the specification of informative priors on circular density spaces. This is inscribed in a framework of density estimation on compact metric spaces using sieve priors for which a general theory is provided. My second paper is a short note submitted as a correspondence to the IEEE Transactions on Information Theory. It provides optimal upper bounds on f-divergences in terms of the total variation distance and likelihood ratio extremums. Inequalities of this type are commonly used to control the prior probability of Kullback-Leibler neighbourhoods which is of significant interest in Bayesian nonparametrics. During summer 2017, I have also collaborated with Professor Debdeep Pati from Texas A&M University by helping revise the prepublication *Bayesian Closed Surface Fitting through Tensor Products* and by answering reviewer comments. While I was already very familiar with the contents of the paper, this provided me with early insight and perspective about the scientific publishing process.

One research project that I am most excited about developing at Duke is on **topological consistency for Bayesian nonparametric surface reconstruction algorithms**. To give a particular example, it is possible to frame binary classification as a problem of reconstructing the surface separating classes. Topological consistency in this case implies the consistent estimation of the number of class clusters and of other summaries. Furthermore, quantifying uncertainty about topological features raises fascinating problems which are, in this case, closely related to posterior consistency in Sobolev norms. I have had very stimulating discussions with Professor Sayan Mukherjee and Professor Paul Bendich on these issues and this has already broadened my perspective on the matter. Moreover, I am collaborating with Professor Debdeep Pati this winter

on fast learning rates for Bayesian nonparametric plug-in classifiers. This will prepare me for further work on the more delicate (topological) aspects of posterior convergence.

While Duke is certainly the best institution in the field, it is not the only university where excellent research in Bayesian statistics and topological data analysis is carried out. However, based on my recent visit, one reason it stands out to me is because of its conduciveness to **interdisciplinary research**, acknowledging that the lines between statistics, mathematics and other fields should sometimes be crossed to better explore original ideas. My formal mathematical education, which focused on the two axes of geometry/analysis and algebra/combinatorics, has provided me with the necessary breadth and experience to make use of this environment by building on ideas from fundamental mathematics in applications to modern statistical problems.

There is also an **exceptional dynamism at Duke** as seen through its many seminars, events and initiatives, and I would like to contribute to those. I also regularly organize seminars at UQAM: probability and statistics during the summer, and interdisciplinary graduate mathematics during the semester (with people from statistics, pure math, actuarial sciences and mathematics education). I am furthermore co-organizing the first Statistics Student Summit in Montreal to be held in March 2019. These experiences provided me with an understanding of the challenges involved in bringing together people from different backgrounds, and it has always been worth the effort in my experience. At Duke, I am particularly impressed by the Data+ Program in this regard. A project-based learning program such as this one seems to me well suited to the task of merging different perspectives and incubating new ideas, while providing training. I can also see its potential in helping raise awareness of often neglected issues related to data science, such as its social implications and possible associated biases.

My participation in these activities is very much in line with a secondary element of my graduate education, besides research, that I do not want to neglect: the development of my **leadership, communication and management skills**. It is clear to me that my scientific work, which may be carried out through an exclusively academic career or may also involve leading research projects in industry, will require managing interdisciplinary teams. The skills mentioned are therefore essential to my success and I have already been dedicating part of my time to their development through teaching and various involvement.

I would love Duke to be the institution where I take my next big step forward. This would enable me to consolidate my abilities as a statistician, advance my research under the supervision of world-leading scholars in the field and eventually grow into a leader myself.

Sincerely,

Olivier Binette