



## MATH-IMS Joint Mathematics Colloquium Series The Chinese University of Hong Kong

*This Colloquium is organized by the Department of Mathematics and the Institute of Mathematical Sciences (IMS) at The Chinese University of Hong Kong.*

**Date:** February 18, 2022 (Friday)

**Time:** 4:00-5:00PM (Hong Kong Time)

**Zoom Link:** <https://cuhk.zoom.us/j/98846779826>

### Combinatorial invariance conjecture and machine learning

*Speaker: Professor Geordie Williamson  
University of Sydney*

**Abstract:** The combinatorial invariance conjecture is a fascinating open problem on the border between combinatorics and representation theory. It predicts that certain quantities of central importance in representation theory (Kazhdan-Lusztig polynomials) can be read off a much more elementary object (a Bruhat interval, which is a directed graph). I have been fascinated by this problem since I learned about it, but it has always seemed out of reach. One major difficulty is that Bruhat intervals become very complicated very quickly, so the problem is difficult (for me) to visualize. I will discuss work with the London based AI lab DeepMind, where we used graph neural nets to try to predict the answer. Applying standard techniques ("saliency analysis") in machine learning led to the understanding that certain edges in the Bruhat graph are more important than others, which eventually led me to a conjecture which I hope will solve the conjecture for symmetric groups.

**Bio:** Prof. Williamson is currently a Professor of Mathematics at the University of Sydney and director of the Sydney Mathematical Research Institute. He studied at the University of Sydney and graduated with a Bachelor's degree in 2003 and then at the Albert-Ludwigs University of Freiburg, where he received his doctorate in 2008 under the supervision of Wolfgang Soergel. After his PhD, Williamson was a post-doctoral researcher at the University of Oxford from 2011 until 2016 he was at the Max Planck Institute for Mathematics. Prof. Williamson's research interest lies in representation theory. He has made several fundamental contributions to the field including his proof (with Ben Elias) of the Kazhdan-Lusztig positivity conjecture, his algebraic proof of the Jantzen conjectures, and his discovery of counter-examples to the expected bounds in the Lusztig conjecture in modular representation theory. Prof. Williamson has received numerous awards for his work, including the Chevalley Prize (2016), the Clay Research Award (2016), the EMS Prize (2016), the New Horizons in Mathematics Prize (2017), the Australian Mathematical Society Medal (2018). He was an invited speaker at the European Congress of Mathematicians (2016) and a plenary speaker at the International Congress of Mathematicians (2018). Prof. Williamson was elected a Fellow of the Royal Society (FRS) and the Australian Academy of Science.