

Jim Gatheral Scholarship Report 2025-2026

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About me

I am a PhD student in the School of Computing Science supervised by Prof Kitty Meeks and Dr Jessica Enright. My research is in parameterised algorithms for temporal graphs. I was in my fourth year (of five) when I received the Jim Gatheral travel scholarship for £4620 which I used to visit Prof Benjamin Bumpus at Universidade de São Paulo from 1 March – 30 May 2026.



FIGURE 1: A BLACKBOARD OUTSIDE THE MATHS BUILDINGS AT USP.

Why I applied for the travel scholarship

Graphs can be used as a visual representation of networks (transport, social, informational). Temporal graphs are graphs with the addition of information about *when* connections occur. This means that we can be more expressive with what we model, but that the problems in general are more computationally complex. This motivates research of parameterised algorithms for temporal graphs. A parameter is a measure which captures some property of a graph or problem. Some examples are the number

of connections at any time, or number of connections we need to remove so that the resulting graph has no cycles (an example of a cycle can be seen ABCA in Figure 1). Loosely speaking, an algorithm is tractable for some parameter k if it is efficient when that parameter is small¹. My PhD research is centred around finding parameters which make temporal problems efficient to solve.

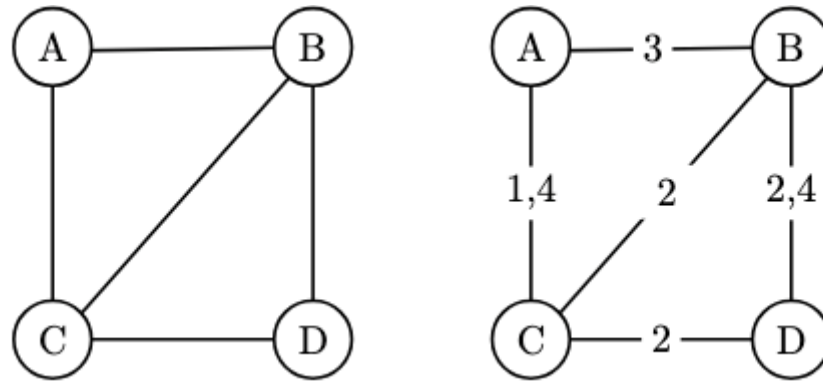


FIGURE 2: A GRAPH (LEFT) AND A TEMPORAL GRAPH (RIGHT).

I applied to the scholarship to have the opportunity to approach these problems from a different mathematical lens. My host in São Paulo did his PhD in the same research group, and has since moved into the area of category theory. This is a much more abstract area of mathematics which can be used to describe much more general objects than graphs. We can describe a temporal graph as a category and then use the tools of this field to prove properties of the graphs. My goal with this visit was to learn about these tools so that I could apply them in future research.

Details of the visit

During my visit to Universidade de São Paulo, I mostly worked on a collaborative project with my host Benjamin Bumpus and two additional researchers; William Turner (Technische Universität Bergakademie Freiberg) and Guilherme Gomes (Universidade Federal de Minas Gerais). During my three-month visit, William visited São Paulo for one month and Guilherme visited for a week. Together, we have been exploring a categorical dual of treewidth called tree co-width. Treewidth measures how close a graph is to being a tree (an acyclic graph), and can be described categorically by a decomposition of the graph into bags which form a tree, whose edges describe injective homomorphisms into the intersection of the two bags. We call this intersection the adhesion of the bags. By taking the dual, we reverse the direction of these homomorphisms and get an adhesion which describes a product operation, rather than an intersection. This allows us to describe large graphs using few, small bags. Our

¹ Strictly speaking, we look for fixed-parameter tractable algorithms, which run in time which is a function of k multiplied by a polynomial of the problem instance size.

paper from this work defines a co-decomposition and looks for what we can efficiently determine about a graph from only its co-decomposition. We aim to send this work to a competitive conference in the coming weeks, and hope that this line of research could extend to a series of papers exploring the uses of this type of decomposition.



FIGURE 3: A SELFIE WITH MY COAUTHORS. LEFT TO RIGHT: BENJAMIN BUMPUS, WILLIAM TURNER, GUILHERME GOMES, LAURA LARIOS-JONES (ME).

Whilst at Universidade de São Paulo, I joined the [COMBO](#) group and gave two research seminars. The group has a very active seminar series, and I met many great researchers while there.



FIGURE 4: A PICTURE WITH THE COMBO GROUP AFTER MY SEMINAR OUTSIDE THE COMPUTER SCIENCE BUILDING.

Impact of the travel scholarship

The scholarship allowed me to branch out from my research area and explore a new field of mathematics. I believe the new tools I have learnt will greatly benefit my research, and also help me when applying for future research positions. This experience has allowed me to extend my knowledge to areas outside of my research group in Glasgow. I think this will provide valuable evidence of my capabilities as a researcher independent of my supervisory team. In addition, I hope that the research output from this collaboration will be well-received by my research community.

On a personal level, the scholarship allowed me to travel to a part of the world I had not yet visited and make some new (and hopefully lasting) friendships.