Dear Symbolica AI Team,

I am a mathematician and computer scientist specializing in category theory, type theory and interactive theorem proving, with experience working with machine learning in both academic and industry settings. I am currently completing my PhD at the Functional Programming Lab of the University of Nottingham, and am due to submit my thesis in September this year. Thus I am keen to apply for the position of Category Theory Scientist at Symbolica in order to use category theory to structure our understanding, design and implementation of machine learning models.

Category and type theory research. My current PhD research is on the coherence problem of semisimplicial types. While seemingly in a different area to that of the published categorical deep learning literature, it heavily involves simultaneously developing versions of the same categorical structures at wildly different abstraction levels. For instance, one major goal of my research is to show how key structures in simplicial models of $(\infty, 1)$-categories may be defined in homotopy type theory. This involves going back and forth between developing the necessary abstractions on paper, and using the Agda programming language to implement more direct and efficient "lower-level" encodings, which have to balance economy of definition and ease of use while still ensuring correctness.

I also collaborate with my research group on various topics in type theoretic category theory, and this has so far resulted in a formalized and refereed presentation at the TYPES conference last year. My previous research also includes an ITP 2021 conference paper on the implementation of homotopy type theory in the Isabelle proof assistant, and a multiply cited Honours thesis on diagrammatic categorical quantum algebra.

Machine learning experience. I have had a longstanding interest in machine learning systems from since before the current boom. Before my PhD, I was a researcher developing and implementing probabilistic graph models for natural language processing in civil service/industry, and briefly on ML-assisted "hammer" tools for interactive theorem provers. I was also a graduate teaching assistant for Masters-level machine learning classes at the University of Bonn, leading tutorial classes on neural networks, knowledge discovery and extraction, and data mining.

As deep reinforcement learning became more popular and ad hoc models proliferated, I pivoted (back) to category theory and type theory to better understand the fundamental structures underlying our logical and computational systems. So it is quite exciting now to read the categorical learning literature, and get a feeling of its potential to both explain existing models and guide the development of new ones.

Communication in research. I believe that good mathematical research rests not just on the basis of solid rigor but also good mathematical *intuition*, and hence that one of the purposes of scientific communication in our field should be to transmit intuition effectively. To this end, I strive to make my research talks as clear and understandable as

possible, as evidenced for example by my conference talk at ITP 2021, invited talk at the 29th YaMCATS meeting and my talk at the recent EuroProofNet WG6 meeting.

It has also been my experience that informal discussion with other researchers plays an equally vital and effective role in developing mathematical intuition, and so I do my best to encourage this where I can. In Nottingham I frequently have research discussions with other group members on topics in category theory, type theory and functional programming, and have also organized PhD seminars and a *Sheaves in Geometry and Logic* reading group. I was also the organizer of the main group seminar for three years, organizing talk programs and social activities for group members and invited speakers (and starting a Christmas tradition of playing Among Us for the final seminar meeting of the year).

Thank you very much for your consideration. I look forward to hearing back.

With best regards,

Joshua (Josh) Chen