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Letter of motivation for admission to the Master of Science in Machine Learning.

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I believe that mathematics is neither invented nor discovered, but rather emerges from human consciousness. If there were two planets inhabited by isolated human civilizations with similar levels of scientific progress, I believe that many of the mathematical achievements of the two civilizations could be shown to have transformational invariances, i.e., many of the mathematical methods and conclusions would be similar. And if the current human civilization were to make contact with an alien civilization with a truly different form of consciousness or innate information processing, I believe that we might agree on certain conclusions, but the methods of abstraction and axioms used to build or arrive at those conclusions would be very different from our understanding of mathematics. Therefore, I would like to postulate that mathematics is an emergent phenomenon, born out of the emergence of the human brain. This, I would argue, makes the information-theoretic study of intelligence an extremely important endeavor, potentially affecting the very foundations of most sciences. This is by no means a unique conclusion; in the wake of Gödel's incompleteness theorems, similar questions have been raised about the nature of human thought. If there are mathematical truths in a formal system that cannot be derived from that system alone, what does this imply about the system of human intelligence that comes to formulate or discover them? To extend this line of thought, human intelligence will likely always retain an intrinsic uniqueness in its ability to grasp certain truths that are beyond the reach of other formal or computational systems. This foreshadows a future in which complex challenges will be met through the synergistic tandem of diverse intelligent systems, hopefully for the progress of humanity and all life on this planet. And it would be a great privilege for me to be a part of and contribute to this unique human story.

As a soon-to-be Physics graduate in the summer semester, I have consistently sought to integrate computational modeling throughout my academic journey. I have explored various applications, ranging from creating simulations for theoretical physics to conducting experimental lab reports with data analysis using Julia, some of which are accessible https://cosmicbug.github.io/. Capitalizing on the remote learning opportunities during the pandemic, my peers and I enrolled in a graduate course titled "Scientific Computing" at TU Berlin. We successfully completed the course and produced a comprehensive report on solving a porous medium equation (a non-linear diffusion equation) using the Finite-Volume-Method, available here [Link Scicomp report]. Additionally, I had the opportunity to serve as a Python instructor for the course on Computational Modeling in Physics. Regrettably, due to my part-time delivery job and the 20-hour student work limit, my involvement had to be cut short. For my final bachelor's thesis, I collaborated with my friend Tomasz Neodomski (who's also applying for this master's program) to explore the "Effects of Noise in Active Particle Reservoir Computing", at the Molecular Nanophotonics group under the supervision of Dr. Xiangzun Wang and Prof. Dr. Frank Cichos, and Prof. Dr. Bernd Rosenow as the second examiner. Here we developed a reservoir computing method, a type of RNN, for time series predictions by utilizing

the simulated active particle response as a non-linear expansion of input signals. The thesis can be found here [link thesis].

I am currently working as a student research assistant (SHK/WHK) in the Neural Data Science and Statistical Computing group of Dr. Nico Scherf at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, since November 2022. Here I am trying to build on recent work in Independent Mechanism Analysis by the Empirical Inference group at the MPI for Intelligent Systems, to infer latent dynamics from neural spiking and calcium data. If successful, this could hopefully provide an additional tool to better analyze neural data for experiments in neuroscience and the existing experimental data. My time working here has been extremely rewarding with an accelerated learning curve, working and interacting with colleagues in the group and the institute. I have included a letter of recommendation from Dr. Nico Scherf with this application [link recomendation].

My interest in Tübingen was fueled by the exceptional research that has been coming out of its institutions in recent years. A palace with habilitated authors of "Theoretical Neuroscience, Peter Dayan", "Elements of Causal Inference, Bernhard Schölkopf", both of which serve as my primary reference texts these days, is an enticing prospect. I find the computational study of intelligent systems immensely gratifying. Beyond neuroscience, biology is full of emergent and intelligent systems that are skillfully tackling remarkably challenging problems, potentially within different representational spaces. In addition to the "Gedankenexperiment" and real experiments, the advent of machine learning and other computational systems provides an additional layer of "experimental computation" that may prove helpful in studying emergent properties and more. In addition, these systems can serve as inspiration or proof of concept for the development of innovative synthetic systems, much as perceptrons, CNNs, and reinforcement learning were inspired in the past. Furthermore, I believe that the advent of probabilistic learning, causal inference, and computational techniques could provide a rich foundation for addressing more complex problems in biology, much as the introduction of mathematical systems of calculus and probability revolutionized physics. Academically, Tübingen offers an interesting mix of computational life sciences and machine learning, which makes it a very attractive place from my perspective. All said, it is rather ambitious to live up to the reality of solving such difficult problems. Nevertheless, it is motivating to be working on this path at this point in time.