Luciano Melodia
Mathematician

To: Whom it may concern

Dear Sir or Madam,

when I was at school, I wasn't interested in science at all. I found maths and physics boring and useless; only computer science was all right, because I'd found out in the first year of intermediate school that one could earn money by building websites. The projects back then were nice, but unfortunately I didn't know anything about Github and version control, so those source codes don't exist anymore. So I wrote my Abitur and the journey began.

My academic path started at the University of Regensburg, in my hometown, with humanities. I obtained my first degree in German philology, majoring in Italian philology, information science and media informatics. Alongside my studies, I also completed an IT degree. My interests lay in machine language processing and so I wrote my bachelor's thesis on information retrieval and punctuation with Prof. Rössler. As I studied Media Informatics and Information Science in full, I was immediately admitted to the Master's degree in Information Science and attended lectures on machine learning and optimisation. I completed my Master's degree with Prof. Lang on the topic of deep learning for estimating the absorbed radiation dose of radioactive isotopes in cancer patients. My journey then took me to Erlangen, the workplace of Max Noether, Felix Klein, Johann Radon and, last but not least, Walter Künneth, as part of a research project. Here I held an assistant position for three years at the Chair of Data Management at the Erlangen Department of Computer Science under Prof. Lenz. In co-operation with Siemens Energy, three publications were produced, which I was able to publish as the sole author in mathematical and computer science conferences. The subject area was always applied algebraic topology. Thanks to the strong support of the mathematicians in Erlangen, my enthusiasm for this subject never left me and so I decided to take a break from my professional career and study mathematics. I attended the topology lecture as part of the Bachelor's programme and knew immediately that I would go in this direction. I also held a seminar on topological data analysis myself, which was fully attended by 15 students and received a top grade of 1.14 after the student evaluation. Professionally, I have been involved in this degree programme by working as a tutor in the subjects of Analysis II and III, Linear Algebra I and Topology, as well as Topology and Applications. The exercise groups were always excellently evaluated and were very popular with the students, which I often found particularly heartwarming. I studied Computer Science as a minor, once again with a focus on pattern recognition, computer vision and artificial intelligence, in order to practice and not forget what I had

already learned. There was certainly some efficiency involved, as the content of the lecture was not entirely unfamiliar to me. I completed my bachelor's degree with a thesis on persistence modules and duality in persistent (co)homology under the supervision of Prof. Li. I then continued my master's degree under the supervision of Prof. Meusburger with a minor in digital humanities in order to reconnect with my first degree. Mathematically, I chose algebra and geometry as my major, with the subjects homological algebra, algebraic topology and tensor categories. As a second major, I chose operator algebras to better understand measure theory and K-theory, which are both relevant fields for persistent homology, as there exists a persistence measure on the space of persistence diagrams. I will write my Master's thesis on Étale homology of groupoids.

I financed my activities, as well as my studies, without financial support from third parties, which fills me somewhat with pride. I come from a modest home and am used to humble circumstances. This was not always the case, but at the latest after my father passed away. That's why I took advantage of the financial opportunities I discovered early on during my academic years. But first, by a remarkable coincidence, I worked as a chef at weekends for a total of three years and learned the trade in a Bavarian restaurant serving up to 140 guests! I also made friends in the industry like Mr. Böddecker, who welcomed me into his company mb Support and let me try out neural networks on industrial projects and incorporate them into his openVIVA C2 software. I had numerous other part-time jobs where I was able to learn organization, warehouse management and cooperation with others even under tense conditions, but it was always enjoyable and so I was able to maintain some of the contacts permanently. However, I also started working as a research assistant early on. First in linguistics with Prof. Rössler, then in machine learning with Prof. Lang and later again in mathematics. The Oskar Karl Forster Foundation also supported me with a scholarship for study equipment. Finally, I would like to offer some concluding remarks regarding my research work before this text becomes unwieldy. I hereby extend an invitation to acquaint yourself with my curriculum vitae, in which I have listed my professional milestones in chronological order. Upon request, I would be pleased to supply the relevant credentials.

As part of my scientific work, I have written several texts on mathematical topics such as the Yoneda Lemma, Fredholm operators, spectral sequences, and others. You are welcome to read them and can find the corresponding links in my CV.

I published my first scientific paper at the international workshop Combinatorial Image Analysis, which took place in Novi Sad, Serbia. At that time we used Voronoi interpolation for data augmentation and realized that it was not reliably iterative. This means that if you interpolate the data too often, its structure will eventually look different in a certain sense. We wanted to determine the time of this change using homological methods and were able to do this in a statistically reliable way. My second major paper was published at the International Conference on Pattern Recognition which took place in Milano, Italy. We used the Künneth formula for persistent homology to analyze data lying on a torus. This

was justified due to the fact that the time series data was provided by Siemens Energy and modified using Taken's embedding. Taken's embedding is a method with which the Fourier transformation of sensor data can be immersed in a torus. By estimating the homology groups, we were able to directly infer the dimension we needed to represent the data using the previously mentioned Künneth formula. This allowed us to parameterize the neural networks appropriately. This method works in its generality, but you need to know the underlying manifold of the data. We experimented with general data and were able to show that in practice it is still possible to guess the dimension quite well, even if the underlying manifold is different. My conclusive publication as part of the co-operation with Siemens Energy was finally published at the European Conference on Principles and Practice of Knowledge Discovery in Databases. We combined the results of our previous work to classify sensor signals from a total of four complete power plants according to the power plant labeling system. For this purpose, we have given the topologically reliably augmented signals using Voronoi interpolation into a suitable neural network architecture. The dimension of the hidden layers was again roughly estimated using the Künneth formula. In addition, we used Betti curves of dimension zero and one and also fed these into the neural network. For the first time, we were able to classify the sensor type, i.e. not only the type of sensor signal but also an assignment to the physical entity, with an accuracy of over fifty percent and also a classification of the sensor type of over ninety percent. These systems were further advanced and are now in use at Siemens Energy.

I managed to put the last bit of free time I had into my physical training, because my parents used to say 'Mens sana in corpore sano'. I started playing football, judo, gymnastics, and table tennis at the age of 6, which I did until I was 14 at the SG Walhalla Regensburg club. I began with weight training at the age of 16 and soon switched to gymnastics at the age of 18. Here I went to freestyle competitions and street art gymnastics to put my skills to the test. At around 24, I then decided to switch to Kung Fu at Weng Chun Erlangen, which I practised until I was awarded the green sash, and discovered Muay Thai, Thai boxing, as part of my martial arts training. This sport still has a special place for me today. I practised Muay Thai intensively at a competitive level for 6 years and travelled to the Surat Thani region in the south of Thailand to put my skills to the test in the large arenas of southern Thailand at the Lamai Muay Thai club, with success! In fact, I was awarded black Pra Jiads by the Thais, which indicate a high level of skill in combat. However, due to a lack of training opportunities in Erlangen, I had to stop boxing training and returned to weight training again. I have finished my career in professional sport and don't want to take it up once more, but I would always be happy to join a martial arts club.

Some key skills required for this particular position include, in my opinion, working in a formal and correct manner, as well as having logical thinking capabilities. As a crucial skill, I am able to break down complex problems into solvable sub-problems. I do work efficiently and in a structured manner under time pressure. Additionally, I am able to collaborate effectively in a team. Physical

stamina and mental resilience are necessary for working under pressure, which I developed over the years. I am also able to motivate and support colleagues, as well as being willing to teach when needed. I have always seen my academic education, the work I have done in business to fund it, and my hobbies as a holistic education. I would like to apply what I have learned in a research career after completing my formal studies. The experience I have gained in teaching and research, as well as in writing and mathematics, is unique in my field. I would therefore be very happy to become part of your team and share these experiences with you, and in turn, learn from you. I would also very much appreciate an invitation for an interview and a first personal meeting.

With best regards

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