Carnegie Mellon University

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Dear Members of the Admission Committee,

I am delighted to write this letter of recommendation supporting Abhinav Agarwal's candidacy for admission to your esteemed graduate program. I can vouch for his acumen and dedication through the interactions that I have had with Abhinav as his research supervisor during his virtual internship at Carnegie Mellon University, Pittsburgh, in the summer of 2020.

My research group at the Computational Biology Department works on building structural organization models that leverage advances in machine learning and computer vision to understand the machinery of cellular systems. Since pandemic disrupted our plans for regular internships, we offered virtual internships to help us with developing tools for studying 3D cryo-Electron Tomography models and for improving our machine learning systems. Amongst numerous applicants, we found Abhinav to be a good fit as he had considerable experience with software development, machine learning, and computer vision. During the internship, not only did he manage to ramp up quickly on the basics, but he also demonstrated a significant commitment towards the deep learning tasks for his research on model compression.

As his initial project, Abhinav developed a GUI for the exploration of MRC models of cryo-ET subtomograms. Abhinav created this using Django as the backend server and JavaScript, and MDL Library (based on CSS) for the front-end. This work was completed relatively quickly by him, demonstrating his strong prowess in traditional software development. For this project, Abhinav collaborated virtually with another student researcher from China. This interaction demonstrated the crucial communication and teamwork skills that any researcher needs for success in the modern globalized environment.

I believe a good researcher should be able to take the initiative, work independently, and most importantly, have excellent analytical skills. Being thorough and methodical in their work also is a big plus. Abhinav has displayed that he possesses all these skills through his outstanding work. He chose model compression as his research topic after an exhaustive literature review. He narrowed the problem and focused on four prominent model compression techniques - parameter pruning and quantization, knowledge distillation, compact convolutional filters, and low-rank approximation. He brushed up his skills in Pytorch, Caffe, Tensorflow and reviewed multiple papers and code repositories. He finalized on using Keras based techniques as the base model used in his research - GumNet developed in our lab is also coded in Keras. Despite setbacks due to the Tensorflow model optimization kit not helping with this task, he took the initiative and developed his scripts for parameter pruning & quantization, which operate primarily by modifying each parameter of the model. He used these scripts on five datasets with SNR ranging from 0.05 to 100. He then analyzed metrics such as the reduction in memory usage, rotational error, and translation error for 8-bit float quantization, 16-bit float quantization, and pruning with 30% and 50% sparsity. These were then compiled into a research paper. I am particularly impressed by his diligence and perseverance and his willingness to go the extra mile to achieve the goals.

Through my association with Abhinav, I can confidently say that he has all the qualities required for a successful graduate student. Besides, he comes across as an eager student, always looking to grow further. I wouldn't hesitate to collaborate with him in an academic capacity. Abhinav will undoubtedly make a diverse, talented, and hard-working addition to your program. Without any reservations, I give him my strongest recommendation.

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