Personal Statement

- Applicant: **Kaikai Zhao**
- Proposed Department and Degree: **Ph.D. in Computer Science**
- Semester and year that the student is applying for: **Fall Semester, 2018**

Introduction and Education Background

As an applicant to the doctoral program in Computer Science. I am very glad to have an opportunity of introducing my background and life experiences to you.

At present, I am a joint civilian postgraduate student in College of Computer Science, National University of Defense Technology & Naval Aeronautical University. I have taken some machine learning related courses during the past year in NUDT. Prior to NUDT, I was a civilian student from Sept. 2009 to Jun. 2013 in Aviation University of Air Force. During that time, I majored in Electronic and Information Engineering and received Bachelor Degree of Engineering. Throughout four years' undergraduate life, I completed some fundamental courses related to mathematics, physics, programming and information theory.

Life and Learning Experiences

I am the first in my family to attend college and I have a younger brother in my family. When I was young, my family lived in rural areas and my parents did odd jobs to make money. From I was seven years old, I began to cook meals for my family in order to reduce my parents burdens and save their time. Then they had more time to make more money to pay our tuition. Today, it is incredible to look back upon that hard experience which made me grow up a lot. Now I am an adult and I am grateful for all people who have helped me. Hence, Long Gao, my group member in the lab, and I decided to launch a co-reading program to help distant children read books, to answer questions and doubts, grow together and change their fate through reading. Here is our website: http://www.1book1dream.com.

When I was a undergraduate student, I took part in mathematical contests in modeling and electronic design competition. In 2011, our team won 2nd Prize Undergraduate Mathematics Contest in Modeling in Jilin Province and 3rd Prize in National Undergraduate Electronic Design Jilin Division. It is worth noting that our group won 1st Prize in National Undergraduate Electronic Innovation Design Competition of 'BISHENG CUP' in 2012.

In the third year, I worked on a NSFC project with Dr. Yang, chief researcher of Information Processing Research Laboratory. During that period, I developed research skills and mastered programming skills with **MATLAB, C, C++ and Python**. I love programming, because I can fulfill my ideas by several simple commands. That's really amazing.

In addition to academic work, I love team sports, such as football. For me, playing football is a good stress-reliever. In the last year of my undergraduate life, as the captain of our College team, I led our team to the second place in Changchun University Football League. That's a memorable experience.

After I received my Bachelor Degree, I worked as an engineer in Longkou Longpeng Precision Copper Tube Co. Ltd, a branch of Golden Dragon Precise Copper Tube Group Inc., from Aug. 2013 to Jan. 2016. My main tasks related to that job position were: writing, updating and maintaining

technical program on lathe control system.

Additionally, maybe my GRE and IELTS scores are not as good as you expected. Those tests were taken more than three years ago and one years ago respectively. More specifically, I spent less than a month preparing for the GRE test in 2014 because of my busy work. During the past year, I insist on studying English every day. Also, I read English academic literature almost each day, such as NIPS, ICML, ICLR or CVPR Conference papers. Moreover, I have presented my research progress three times in our ML group during the second half of 2017. Hence, those scores do not represent my current English level. Although I undertake research tasks now, I will try my best to prepare another IELTS test. And I am confident I could get higher scores. In my opinion, language should not be the barrier to scientific research.

Research Interests and Specific Goals

My research interests are as follows:

- **Large-scale machine learning**
- **Pattern recognition**
- **Computer Vision**
- **Biometrics**
- **Deep learning**

I have conducted research on machine learning and submitted our work *Large-scale k-means clustering via variance reduction* to Neurocomputing. Another work is *Multiple kernel k-means clustering with late fusion* which is being revised by Xinwang Liu (http://www.escience.cn/people/liuxinwang), my research mentor.

In terms of large-scale tasks, traditional kernel methods incur large computational and storage costs, so my recent work is large-scale kernel learning based on random features. More specifically, I read some NIPS Conference papers with respect to kernel learning and reimplemented the ideas in the papers that I am very interested in. Recently, to explore the differences between kernel approximation methods and neural networks, I am implementing large-scale kernel learning with Keras by the fact that the approximated kernel features can be interpreted as the output of the hidden layer in a shallow neural network. Specifically, the bottom layers of these networks are random basis functions which are not adapted during training. At present, I only focus on Gaussian kernel and Arc-cosine kernel. More specifically, the approximated kernel features above are based on random Fourier features proposed by Ali Rahimi and Benjamin Recht in their NIPS 2007 paper. Meanwhile, I have developed a long-term professional objective: the advancement of large-scale machine learning technology.

In addition, I am very interested in deep learning and master two deep learning frameworks, i.e. Keras and Mxnet. It is interesting to note that our group members have implemented Hinton's **CapsuleNet** with Keras and the main contributor of implementation is Xifeng Guo, one of our group member. If you are interested in the mentioned work above, they are available on my Github account(https://github.com/KaikaiZhao).

My thinking about the capsule network

As we all know, CapsuleNet has been very popular before its corresponding paper was published on NIPS 2017. Deep learning researchers know the fact that **pooling operations** make deep neural

networks lost space relationships of objects in images. Obviously, there are no **pooling layers** in CapsuleNet, which makes it has the capacity to capture the **space relationship**. In fact, there are many relationships which could(or should) be captured, such as angle relationships. Unfortunately, AI researchers have not yet developed a powerful deep network to capture those meaningful latent relationships so far. Why? In my view, designing a neural network is not difficult, but how to convert that net into a **tractable** problem is not an easy task. Even so, I believe it is promising in this area.

Why do I want to do research and get a PhD?

I guess the question above is what you care about most. Yes, the answer to this question is very important for me as well. First, I love scientific research. Maybe you don't buy it. To be honest, if I am engaging in an interesting work, such as work related to large-scale machine learning, I would stay in the lab all day until I got a satisfying result. Machine learning is an intersection of various areas, including mathematics, computer science, and neuroscience and cognitive science. Second, it's a wonderful thing to solve a tricky problem with a less complicated algorithm. That's what machine learning does. For large-scale problems, traditional kernel methods are typically expensive in both memory and time, but we can overcome this difficulty by approximating kernel functions through Nyström method or random features. All the approximation methods are good, because to some extent, they reduce the space and time complexity without a significant effect on the precision. Third, in my mind, PhD time is an important part of life and I wish to be an **independent** researcher with **critical thinking** after I finish my PhD program.

If you feel that I am more suited for some other areas, any of your suggestion would be highly appreciated. I also believe that I possess the capacity for hard work and the motivation required to perform well in a PhD program. Since my economic resources permit me to partially fund myself for the duration of graduate course, I request you to take a tuition free offer into account. As for accommodation and living costs, I appreciate any form of financial aid such as teaching and research assistantships which can also open my mind and improve my social skills.

With all sincerity, I hope you can take my application into serious consideration, and I shall appreciate you if you grant me an opportunity for future studies.

Wishing you and yours a happy 2018.

Sincerely yours,

Kaikai Zhao