Acknowledgments

“The journey of a thousand miles begins with a single step”, so says the ancient Chinese proverb. While my PhD has spanned only the last 5 years of my life, a good amount of steps had been taken a long while before my PhD started. In this writeup, I’d like to acknowledge people who’ve shaped me as a person and without whose intervention, I could not have been what I am. Of course, I realise my limitations and my ungratefulness. Thus, I may not be able to thank many people.

I remember as a grade two kid, my class teacher Ms. Marina praising me in front of the whole class that I’d done really well in exams. That little act of appreciation is so very firmly impressed in my mind even now. Maybe, if she had not been generous in her appreciation, I may not have taken my studies the way I did. I also remember becoming so happy with her appreciation and getting casual that I didn’t study at all for the final exam. I fared poorly in that particular exam. I heard that my percentage dropped from 95 to 89. Sure, I really messed the exam. It was a lesson that has stayed with me all through the years- not to get overconfident! This particular lesson helped me to form better habits that would eventually help me in my PhD.

I remember changing my school in grade fourth. If it were not for the motherly care that my then class teacher Mrs. Abnash Kaur gave, I may never have taken my studies seriously. In grade fifth, my class teacher Mr. Andrew Hoffland impressed upon us the need to be all round good, rather than just being good in academics. He wanted us all to read more. That little push in those pre 2000 days went a long way. A lot of my skills that I would use in my PhD were getting honed.

By this time, I started to realise that my favourite subjects were the ones where I had my favourite teachers. My mathematics teacher, Mr. KP Joy holds a special place for me. If not for him, I may have never taken an active interest in mathematics. I may thus never have been able to do my computer science PhD. I studied not just for myself, but for Mr. Joy would be happy to see me ace an 100/100. I particularly remember him asking for my answer sheet when he wanted to discuss the exam answers. Needless to say, I had a 100/100 on that exam. That particular incident
greatly encouraged me! A lot of other teachers, Mrs. Anita Bisht, Mrs. Shobha Sharma, Mrs. Meenu Sharma, Mrs. P. Singh, encouraged me constantly and thus honed me to becoming a better person. They showed faith in me, when I had little faith on myself.

My computer science teachers deserve a very special mention. I was once discussing with Mrs. Lata Nandkumar about changing to a higher ranked school. She remarked that it is the students who make the school and not vice versa. This particular statement has stuck with me through all these years. It would later help me to focus on what I can do, rather than constantly complain about what I don’t. This particular incident also helped me to choose IIIT-Delhi to do my PhD. Mr. Geo Matthew taught us C++ programming. While, I used to miss classes due to engineering entrance preparation, his lessons helped me get stronger at programming. The programming base that was set by Mrs. Sojan in grade sixth through eight just got stronger. It convinced me all the more that computer engineering is the field for me! Mr. Avadesh and Mr. Manish Sharma helped maintain and develop my interest in the sciences. My chess coach was always very inspiring. He once told me that I was almost as good as the national youth champion in those early 2000s. I once asked my grade twelfth mathematics teacher about my chances in the engineering exams. She told me like another school senior of ours who topped the engineering exams, I had the ingredients. Looking back, I realise how all these small encouragement have helped me.

My school time was a great learning experience. Many deep friendships, without which I may not have developed the character or the skills that greatly helped me in my PhD. I remember that I didn’t have a personal computer till class ninth. My school buddy, Raunaq Suri and his parents kindly allowed me to work at their home. I didn’t even know what Windows was and was greatly helped by Raunaq. The powerpoint that I learnt in those days, went a great deal in me learning the art of selling my work. I particularly feel very thankful to Raunaq’s parents who treated me like their own son.

I was mostly a shy and studious kid. It was only my good friend Shashank Popli’s
intervention that helped me grow. He constantly encouraged me to participate in debates, quizzes, symposiums. Our team participated in many inter-school competitions (we got free sandwiches there!). The confidence gained there went a long way!

My good friend Ritwik Manan formed with me what was a very intense Federer-Nadal battle. He was one of the smartest guys I have ever seen. Our “friendly” battles for the top academic position, helped me to become much better. Many of my other school friends- Shevaal, Shekhar, Arjun, Sharad formed great friendships that I savour!

Moving on to college was a difficult phase. Some of my new friends Dheeraj, Mohit, Mayank helped me significantly. I had started to lose faith in the system and interest in computer science. My friends Sidharth and Nihkhiel greatly helped me regain that interest. At the end of the first year, I was inducted into the university Unmanned Aerial Vehicle (UAV) team. I learnt a lot as a part of the UAV team. My stint there also helped me a great deal in shaping my interests in research. I understood that my liking lied in systems and applications. The international exposure that we got while working on the UAV helped develop a lot of confidence. I also gained a lot of skills that played a key role in my PhD. Particularly, I learnt from Suraj Joseph- “if it ain’t broke, don’t fix it. From Rohit Arora I learnt how sincere determination can help one learn a completely new field (computer vision) in his case. Sahil and Raghvendra taught me how to be patient while working with hardware. I played with a lot of hardware in my PhD and I was already prepared in my stint with the UAV team. Rochak Chadha was the team captain. I learnt from him how much ownership is needed to successfully complete research projects. I particularly value this lesson a lot. Abhay and Arjit taught me how rigour, deep interest can help overcome any shortcomings in coursework.

Rochak Talwar always believed in me and his encouragement helped me a great deal.

My short stints at Goldman Sachs and RBS were helpful in choosing research. Working in these banks showed me that I valued intellectual independence and thus research would be the right move. Encouraged by my friends, Anirvana, Sidharth, I
chose to pursue my interest in research and I chose to join IIIT Delhi.

My BTech project mentor, Dr. Divyashikha deserves a very special mention for being my first formal research mentor. Her honest attempts at setting up laboratories and improving the standard of education, and her encouragements have helped me a lot.

The past five years at IIIT Delhi have been filled with a lot of learning and a lot of experiences that will always stay with me. I feel very grateful towards my advisor, Dr. Amarjeet Singh. I realise that I am a very pushy researcher and thus can be very hard to handle for an advisor. The role of an advisor is very strange. They pick you up when you know nothing about research. They spend blood and sweat in training you and when you are well-trained, you are ready to leave. Like teaching, advising is a tough job! Dr. Amarjeet Singh very nicely balanced the line between being very hands-on versus being very hands-off. In the initial years, he was hands-on and that allowed me to get bootstrapped into research. Wherever needed, he allowed me my independence. He is probably one of the most energetic and passionate person I have ever seen. I remember how hopelessly poor I was in research when I came to him. I was an engineer when I came to him, I leave as a researcher. The difference between the two is very wide! Dr. Amarjeet pushed me a lot. When he started to get more hands-off, I started feeling odd and thought why he's doing so. Looking back, I realise how perfectly he timed getting more hands-off. I might have published more papers with him being hands-on, but, I may have never learnt how to do independent research. Dr. Amarjeet also always showed a lot of faith in me. Having advisor’s backing makes the PhD easier. Over the years, his role in my life has changed from Dr. Amarjeet the advisor to Amarjeet the mentor and friend. I admire many of his qualities and seek to learn from him. Not only has he made me a better researcher, I also feel he’s inspired me to become a better person.

I started working with my co-advisor Dr. Kamin Whitehouse around my mid-PhD crisis time. I was on the verge of quitting my PhD as I felt I could no longer get any success in my PhD. Everything I touched, turned to dust. During such times of failure, Dr. Whitehouse always stood with me and encouraged me. He gradually
trained me to become a better researcher. I admired and looked up to him for his
count, his mannerisms, his attitude towards work and life. I owe a lot of my PhD
success to Dr. Whitehouse- from the scientific method, to writing papers, to reviewing
papers, making presentations. I have learnt immensely from him. I also believe that
Dr. Whitehouse has that rare quality of giving quality constructive feedback. He is
also one of his kind in terms of the clarity of thought process and eye for detail.

I have been working with Dr. Hongning Wang for about an year now. His sub-
stantial inputs helped us ace AAAI 2017. Dr. Wang is one of the most hard working
faculty I have ever seen. He is very well organised and has been an excellent mentor.

During this tough mid-PhD crisis period (which happened when I was interning
with Dr. Whitehouse at University of Virginia), I was fortunate to have good lab
friends with me. I am especially thankful to Avinash Kalyanaraman for his daily
discussion and pep talk. Delhi, Juhi, Elahe, and Erin helped me a great deal in my
work and I learnt a lot from them. From Dezhi, I learnt how to keep working on
a problem even when all hope seems gone. From Juhi, I learnt how research can
be fun and how to take risks. From Erin, I learnt how to articulate my research.
Elahe changed her subject of PhD and it was inspiring to see how hard work can
help overcome lack of training in a particular subject. Christine Palazzolo, who is the
computer science admin at UVa, treated me like her own son and made the otherwise
impossibly hard time spent at UVa, manageable.

I feel very thankful to faculty and administration at IIIT Delhi. Prof. Jalote took
the bold step and invested heavily in the formation of IIIT Delhi. While he being
the director is very busy, he never denied me time when I wanted to discuss my PhD,
career, etc. with him. I could see that every single person in the IIIT Delhi system
would look up to him. The administration at IIIT Delhi has made the lives of us
PhDs and students much easier. No amount of credit would be enough for them.
They have ensured that we can focus on our research and everything else is handled
by them. In particular, I would like to thank Mr. Prosenjit, Mr. Vinod, Ms. Sheetu,
Ms. Priti, Mr. Vivek Tiwari.

I learnt a lot from the coursework. In particular, I was very inspired by Prof.
Ashwin and his style of thinking. I has the chance to meet him several times and discuss my PhD work. His seemingly high-level inputs eventually turned out to be an integral component of my thesis. I remember him telling me—“In your PhD, you need to be like Sherlock Holmes. It should be that kind of an investigation. I have felt inspired by a few other faculties with whom I have had interactions. Dr. Pushpendra’s organisation (both external and internal) was immaculate. Dr. Pushpendra also co-supervised me during the early part of my PhD. Dr. PK’s positivity, enthusiasm and endeavours (like trying new things such as NPTEL courses) was very inspiring. Dr. Vinayak’s deep interest in everything systems related was always inspiring. I would always aspire to develop strong fundamentals such as Dr. Shobha. Dr. Sanjit’s thoroughness in his research always inspired me.

During my PhD, I have been very lucky to have worked with some really smart and good human beings. In particular, I have maintained a good relationship with (soon to be Dr.) Jack Kelly and Dr. Oliver Parson. From Jack, I learnt how to do things with a tone of perfection. Everything that Jack did was impeccable— from charts, to code, to writing paper. I have always admired Jack’s honest approach towards research. Oliver is one of the most clear thinking persons I have ever met. During my collaboration with him, I learnt a lot about writing good papers, and getting to the point. Prof. Mani Srivastava mentored me during the initial 2-3 years of my PhD. His clear thinking and hard work despite not having anything to prove to anyone was very inspiring. It was heartening to see him code even when he’s a full Professor. Prof. Mani’s inputs helped me a great deal in my initial projects and without him, I may not have had the confidence to approach Dr. Whitehouse for my internship. I’ve also been very lucky to have received inputs from a lot of people, such as Dr. Venkatesh Sarangan and Dr. Arun Vasan. While they’ve always been very helpful, both of them were particularly helpful and encouraging when I was going through the mid-PhD crisis.

I have also been very fortunate to receive high quality feedback from several members of the academic community. Dr. Yuvraj Agarwal and Mario Berges hosted my talk at CMU and have given valuable feedback. Dr. Rahul Mangharam hosted me
at UPenn. He was particularly encouraging during my mid-PhD crisis. Dr. Prashant Shenoy, Dr. Krithi, Dr. Ram have at various times provided useful feedback.

I would also like to thank my thesis evaluation committee-Dr. Krithi, Dr. Prashant Shenoy and Dr. Rahul Mangharam. Their detailed inputs have certainly made this thesis clearer and better in quality.

I have made some deep friendships during my PhD at IIIT Delhi. I feel grateful to my lab seniors- (Dr.) Kuldeep, Siddhartha and Samy. Samy helped me a great deal taking my first steps into research. Kuldeep and Siddhartha were there for discussion and advise. In particular, Kuldeep’s systems building skills and initiative taking have had an impact on me. Among other seniors, I have had multiple helpful discussions with Dr. Denzil Correa, Dr. Samarth, Anush and Tejas. Dr. Denzil reviewed what turned out to be my most impactful paper. His suggestions were very useful.

I have learnt a lot from my lab and PhD peers. The positive and happy work environment they created was an important factor in me completing my thesis. With Manoj Gulati I formed a very deep friendship. His constant pursuance of becoming better was very inspiring. His journey to an internship at UW is remarkable. He was the always reliable brother! I have had uncountable discussions with him on research and life. I’ll state a few qualities of my other peers that I looked up to and the efforts towards those directions greatly helped me in my PhD. Haroon Rashid is one of the most sincere person I have ever seen. I would always look up to his sincerity and regularity in work. I often used to think that I had so much to do, until I saw how much Dheryta had on her plate- a two year old child. Her dedication towards research often peppeled me up. I was always inspired by the community oriented work that Deepika did. I would often always look up to Sonia’s work and found it to be really cool. Garvita’s bouncing back after project failures was very inspiring. Anupriya’s positive attitude- “let’s try, what’s the worst that could happen, was infectious and very helpful. Sneihil’s and Anil’s consistent and hard work, especially with those long mathematics always kept me grounded. Parikishit’s sticking to theory and believing in himself was inspiring. When Alvika would continue working despite repeated hardware failures, I would often find my PhD situation less taxing (due to less hardware)
and work with a renewed motivation. While Milan is younger to me, at times he played the role of an elder brother. His continued pep talk, motivation and support helped me a great deal. I was always inspired by his hard working nature. Vandana’s attitude of always trying to improve was inspiring. Tanya’s shifting to another area (which in my opinion was harder!), and sticking with it, was inspiring. Akanksha’s sticking to honest results despite deadlines was inspiring and was a value that I also tried to stand by.

During my PhD, I was also very lucky to be a teaching assistant in a few courses. In particular, I remember the course on Introduction to Programming very fondly. Since I was the head teaching assistant, I had a lot of interactions with the 170 students of the 2012-2016 batch. Teaching them gave me great joy. I formed great friendships with all these 170 students. Teaching them taught me a lot and helped me a great deal in my PhD.

If you’re wondering why I haven’t mentioned my family, the reason is that I know that they’ll anyway read to the bottom of this section. So, might as well put them in the last! I feel very lucky to be born in the family that I am. I was (somehow) the most loved child in both my paternal and maternal families. The deep care and affection during the formative years helped me become a better person.

There are a lot of unsung heroes in my PhD. While I have mentioned some of them above, I feel that no one would deserve more credit than my parents. It’s extremely sad that only I will be called as Dr. Nipun Batra and they would not be conferred the title. I can never thank them enough. I remember watching my first birthday video where I was eating anything that would come my way- wallet, balloons, etc. From such an ignorant state to being called, Dr. Nipun Batra, my family deserves all the credit. Their love and affection is unparalleled and since words can’t do justice to them, I’d befriend brevity towards the fag end of this section. My grandparents (paternal and maternal) are not the most well educated if you go by their degrees. However, their unconditional love for me shows that selfless love is far beyond degrees. My grandparents were probably the first teachers outside the books, when they inculcated in me a deep interest in automobiles, at an age when I had not
started speaking. Their thoughtful presents- like my maternal grandmother bringing me “lucky” pens to be used for exams, my paternal grandfather (late) bringing me cookies for my small act of honesty. All these are firmly embedded in my heart and provided a strong cultural training.

It is said that a PhD degree makes you thorough in your research and analysis. However, when I compare even the most trivial thing that my mother would do for me, I can see an order of magnitude of difference. For instance, the way my mother would seal the pickle bottle on my overseas trips is far more thorough than any of the scholarly work I have produced. More recently, I was participating in a video competition where the winners would be decided by the number of views. My mother knew little about smartphone usage till that point. But, for my sake, she learnt smartphone really quickly. Needless to say that she promoted my research video to an extent that I was one of the finalist. Of course, this is a case of selfless love trumping scholarly wisdom. My mother has made countless sacrifices for me. I can almost state it like an axiom that I would be insignificant without all that my mother has done for me. Of course, there’s only a small (tip of the iceberg) amount of my mother’s love and care that I can ever understand and appreciate. No matter how I would do professionally, she would only have her care and affection for me. My father despite his not so good health has always stood by my side. He practised what he preached. I learnt a lot from observing him in his day to day dealings. The presentations skills that are so vital in research, I learnt from observing him, when he would with a genuine good wishing heart carry his business. His consistency in his inputs despite the ups and downs of the market was an important lesson I tried to imbibe. My sister is the first PhD in our family. She’s also the first ever person to study science in college. Needless to say I was very heavily influenced by her. She was (probably) my first teacher. My brother-in-law has been more of an elder brother than a brother-in-law and has been the goto person given my extremely busy PhD life!

To end, I’d like to say that this PhD was a very humbling experience. In the revered scripture, Bhagavad Gita, knowledge is defined as the presence of qualities,
the first of which is humility. I’d like to say that I’ve been very fortunate that the past few years have provided me a chance to inculcate the same. While I have worked hard, I’ve been fortunate to have such a good set of people around. I’m indeed humbled that I’d be conferred the doctorate, when in reality, this is the effort of so many people.