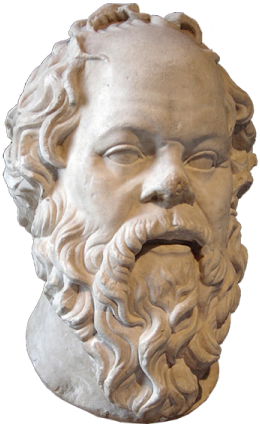
The DPhil Grind



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Contents

Prologue

My journey towards a PhD started back in 2015 when I met Ilya Kostrikov[1] in Aachen during my Master's. He said something like: "Want to do cool stuff? You need to do a PhD!" This encounter changed my life. I started my Master's to learn how to make autonomous cars thinking that you just need to learn some math and programming for that. I had always been fascinated by science, but it had never occurred to me that I could become a part of it. From that point onwards, autonomous cars were postponed[2], I had to get a PhD first. These three mysterious letters became my obsession. I wanted to do cool stuff, after all!

Around the same time, I stumbled upon 'Ph.D Grind, a Ph.D. student memoir', where Philip Guo, now a professor at UCSD, described his journey towards a PhD[3]. I read that hundred pages in one sitting, and it was breathtaking. Of

[1] https://twitter.com/ikostrikov

[2] Sorry, Elon!

[3] The author shut down his website and the openly available pdf some time ago, but you can easily find the text on the internet.

course, the book was full of cautionary tales, but I was so fascinated by the world of academia that I did not take those seriously. And I still do not know if I should have.

'Ph.D Grind' has one major flaw, though. It is too short, and there are no more books like it. However, as Philip Guo said, his book is only a single data point. It is time for me to add one more. Welcome 'DPhil[4] Grind, a DPhil student memoir'!

They say that every DPhil is different. What is so special about mine? And, as a result, what is so special about this book? There are, actually, quite a few things!

- Similarly to the author of 'Ph.D. Grind', I did my DPhil in Computer Science. However, my specialisation is different. I work in machine learning, a rapidly expanding compute-hungry field with hundreds of papers making your research obsolete on a daily basis.

- As a consequence of the above, I interned in four big tech companies[5] during my DPhil, getting experience doing research in industrial labs.

- I did my first undergraduate degree in Economics, which is a bit non-standard for a DPhil in Computer Science.

- I did my DPhil at the University of Oxford, a stunningly

[4] DPhil is a fancy name for the PhD used by the University of Oxford. I will use it instead of a less fancy PhD from now on.

[5] NVIDIA, Facebook AI Research, Microsoft Research, and Google DeepMind.

beautiful town full of traditions. This is a power place for science and as magical as Hogwarts.

- I kept a diary of my experience, writing in it **every day** throughout the four years of my DPhil.

- I am a proud parent of an eight-year old[6], and while my amazing wife did everything possible to make it easier for me, parenting affected my DPhil experience a lot, making it harder and easier at the same time.

- I did my DPhil in 2018-2022, a turbulent time that includes Brexit, the pandemic[7], the death of the Queen, and a full-blown war in the heart of Europe with my country being the aggressor.

- At the beginning of my DPhil, fascinated by the whole new world of science, I really wanted to stay in academia. However, after my rose-coloured glasses were gone, I changed my mind along the way (again) and decided to join the industry.

- The less unique thing about my experience is that I struggled a lot and was on the brink of quitting multiple times. I personally know several people who quit. I

[6]This book was written in 2022.

[7]If you read these pages in the far future, and there has been multiple pandemics since then, I mean the COVID pandemic started in 2020.

want to use this book to increase the awareness of mental health issues among postgraduate students, helping others[8] better understand the students' state of mind.

If, after reading all the above, you still want to keep going, I have a word of warning for you. As a proper old man, I cannot resist the temptation to give highly opinionated advice throughout this book. Remember, this is your DPhil, this is your life. Take all the advice with a grain of salt! Use this book at your own risk!

[8] Parents, friends, professors, university administration, etc.

Pre-Historic Times

In this chapter, I will recount the significant life events that ultimately led me to starting and, also, to successfully finishing my DPhil.

At age five, I started digging a hole in our backyard to get to the Earth's inner core, an early display of my inclination to embark on substantial endeavours without much planning. This is known nowadays as Facebook's motto: 'Move fast and break things', and is a good match with computers that make the cost of an error negligible[1] and feedback immediate[2]. As for the hole, my grandmother told me off for such a mess in the garden and forbade doing anything similarly crazy in the future. Later I found out that someone made more progress on that front with the Kola Superdeep Borehole.

Several years later, another significant encounter with science unfolded when I stumbled upon an article about Fermat's

[1] Unless you are a safety-critical system developer.

[2] Victor Bret has a fantastic talk on the importance of immediate feedback.

Last Theorem in a Soviet math encyclopedia. Determined to solve this problem as I grew older, little did I realize that the theorem had already been proven, and the book I was reading had been written in the 1980s, predating Andrew Wiles' groundbreaking discovery.

My fascination with computers ignited at the age of 11 when my parents promised to purchase one for me if I successfully completed fifth grade with top grades in all subjects. Before this, I had a brief introduction to Quake II during a visit to my mom's office. Coupled with the release of 'The Matrix' in 1999, it was enough motivation for my mediocre grades to jump to straight fives[3] for all subjects.

In anticipation of the day my parents would fulfil their promise, I dedicated myself wholeheartedly. I sought advice from a classmate who owned a PC, meticulously sketching software interfaces in my notepad to prepare for the moment when I would finally have my own computer. Day D finally arrived, and I spent the whole summer of 2002 playing video games.

In 2006, a friend of mine installed Ubuntu on his machine, and I got curious[4]. Trying to impress him with my skills, I found a FreeBSD image and accidentally destroyed all my files. Nobody does backups without losing their data first, right? The sad thing is that I didn't even succeed in installing FreeBSD that day. I surrendered and asked my friend to help

[3] Russian schools have a five-point grading system with five being the highest.

[4] This was a golden era when you could get a disc with the OS image and stickers to your physical post box.

me with Ubuntu the next day. This was the beginning of an amazing journey that bolstered my interest in computers and led me to Arch Linux[5] I am currently writing these lines on.

Nevertheless, when it was time to choose the profession, assertive parents and booming capitalism in Russia in the 1990s somewhat convinced me that I wanted to become an economist. This is how I ended up in the Moscow State Institute of International Relations, a renowned institution known for educating the offspring of Russian statesmen. Luckily for me, I was part of an experimental group studying mathematical modelling for economics, and this group consisted of nerds, gamers and other weirdos that made my undergrad time truly exceptional. The main two things I achieved during my undergrad were getting to learn English[6], and meeting my future wife[7].

I think I was the only person at the university who was using a Linux machine as a daily driver, but I did not think of any possible career related to tech or science. My dream, similar to the ones of my peers, was to get to BCG or McKinsey and become a management consultant. I was not that cool to get to BCG or McKinsey, but I landed an internship at Ernst&Young (EY) at the end of my last year, having a blast

[5] I use Arch Linux, btw.

[6] The university provided amazing possibilities for learning languages. There were two compulsory ones (English and French for me), and you could take as many extras as you want (I studied Chinese).

[7] She randomly sat next to me on the first day, and it was the love at first sight (for me). It took me another year+ to get her interested in me.

at the interviews, when one of the interviewers asked exactly the same question as the previous one. I seized the opportunity and provided a stellar response, ultimately nailing the interview and paving the way for my future career.

I spent the next half a year drawing slides 24/7 and having some kind of existential crisis at the end of my undergrad having no idea about what I wanted to do next. I tried to think of what I liked, and it was math and computers. I decided to do another undergrad to have a more holistic picture of mathematics and went to the Moscow State University to study at the Department of Computational Mathematics and Cybernetics. When I was applying, they told me that they hadn't seen anyone from the Moscow Institute of International Relations before, I thought I made the right call.

This was a moment of personal growth for me as well when I decided to do what I wanted, not what my parents wanted me to do. This resulted in a huge quarrel in the family when I went on to live with my friends and had almost zero contact with my family. But let's not get ahead of ourselves.

My second undergrad time was amazing. I did not care about my grades as much as I did during the first. I was just learning whatever I liked and was discovering an amazing new world for myself. I was not super interested in programming during the first half a year until I learnt that you can pass arguments by value and by reference in Pascal[8]. This was when I got hooked on programming and got determined to find a job as a software engineer.

[8] This sounds a bit quirky, but I remember being amazed by how well everything was thought through.

I remember my first coding interview really well when I was asked to remove the content of an HTML page within `<li>` tags, and I wrote a solution in Pascal, the only language I knew. The interviewer was puzzled but promised to hire me if I came home and rewrote the interview problem solutions in Python. I never went back to that guy, but asked my friend who had a web studio, if they needed any programmers ready to work almost for free while studying and getting more experience in the exchange. Luckily for me[9], he said yes, and this is how I got my first programming job.

My first year, as a software engineer was super intense. I was coding during the day, and studied during the night trying the stuff I learned overnight the next day on the real project. Unfortunately for my health and personal relationships, I pulled a lot of all-nighters and often had other gigs on the side writing Android apps as a freelancer. The pinnacle of my software engineering career was leading a project where we rewrote an old warehouse management system written in FoxPro making it a nice modern web app that was easy to extend, fast enough to work without causing rage in the users, and doing some linear programming under the hood to do allocations. This was challenging, fun, and one of the first experiences that made me appreciate pragmatism: making something work is all that matters. No matter how ingenious your idea seems on paper, the problem is not solved, until you've tried your solution and checked that it works. Also, these couple of years made me appreciate fast iteration on problems that matter.

[9] Thanks Kostya!

Year 2014 was a special year for me and my wife, that summer, our son was born. It was scary, exciting, and exhausting at the same time. I grew up without a father, and I had to learn how to be a good one, no pressure. At the same time, my relationship with my parents recuperated, which was really nice.

At some point in 2014, I realised that in my daily job, I was not using much of the math I had learnt, and loved so much. I decided, that working on autonomous driving would involve some math, and would be interesting and useful at the same time. I applied to some universities in Germany[10], and got accepted to the University of Saarland and RWTH Aachen which had a mutual program with the University of Bonn[11].

I selected RTWH Aachen because I thought that their Computer Vision lab led by Bastian Leibe was the closest I could get to autonomous cars. We moved to Germany with three suitcases, and our new life began.

I had a month before the start of my studies to do all the admin and acclimatize. I decided to get a job in Leibe's lab. Germany has an amazing practice of HiWi, student assistants that get attached to a PhD students and help them out even before doing a master's project with them. I emailed Lucas Beyer, and he invited me to come over.

I don't already remember what we chatted about, but he gave me some version of FizzBuzz and got interested in my

[10] Germany sounded cool since education is almost free there, and it would be nice to live in a different country for a while.

[11] The first year was mostly in Bonn, and we were supposed to move to Aachen in the second year.

x230 laptop that had Arch installed. That won him over, he was an avid Arch user and also used a tiling window manager I was a fan of. I got the job, a machine with a GPU, and a place in the lab. I was hyped!

Surprisingly for me, my master's program allowed students to choose their own curriculum, which was not the case at all for my undergrad. There were some compulsory courses during the first year, but I didn't pay too much attention to them, because I wanted to focus on machine learning. The only non-machine learning course I remember well is 'High-Performance Matrix Computations' taught by Paolo Bientinesi[12]. The lectures were captivating, I loved the topic, and I absolutely loved the book by Golub and Van Loan[13]

Let's get back to machine learning. In my first *Advanced Machine Learning* lecture, I found out, that there was a Deep Learning revolution going on, and people doing classical machine learning were being pissed by a bunch of researchers stacking more and more layers on a weekly basis. I thought it was cool enough for me.

I never thought of this at the time, but there have always been people around me who significantly affected my life trajectory. In Aachen, there were two of them: Ilya Kostrikov and Lucas Beyer, and it was Lucas who introduced me to Ilya. We first met at GCPR 2015 which was conveniently located in RWTH, so, I just had to walk from my lab to another building to attend. I clearly remember that I understood almost noth-

[12] https://yobibyte.github.io/cholesky.html

[13] https://www.google.co.uk/books/edition/Matrix_Computations/ml0a7wPX6OYC?hl=en&gbpv=0.

ing at the talks, and was amazed by people nodding around me, which added to my already strong impostor syndrome.

When I met Ilya at the poster session, having enough common cultural context allowed us to start talking about important stuff straight away: 'What is your plan? What do you want to do in life?' And, as I mentioned in the Prologue, he said: 'Want to do cool stuff? You need to do a PhD'. My life was turned around one more time, and now I had a clear goal in mind: get to a good PhD program.

This made things much harder for me. One of my idiosyncrasies is that I don't usually like following the predefined curriculum. Instead of following recommended literature with DFS, I do BFS with some random combination of books, YouTube videos and Wikipedia abyss. This makes me a better generalist[14], but often I miss some important bits that people consider a must-know. Getting good grades for the Master's required following the curriculum, and I felt like a part of me died, but the final goal was more important to me than being authentic or something like that[15].

Ilya became something like an informal mentor to me: he helped me to grasp some machine learning concepts, sent me papers, gave me advice on how to implement stuff and get more visibility on GitHub, constantly nagged me that I should apply and get a Google internship that would boost my career. All of it was extremely helpful for me, and now I realise how

[14] People who worked with me might have a different opinion here, but come on, this is my book, I'll do what I want.

[15] Big mistake.

lucky I was[16].

The first question I got when I came to work in the lab was 'What is your favourite beer?'. I wasn't quite sure what exactly was happening, but it was nine in the morning, and I was not used to drinking that early[17]. It turned out that every computer in the lab was named after their user's favourite beer and they were making an account for me. I liked that a lot. I also enjoyed having access to a machine with a GPU, though I had never trained a neural network on a GPU before.

My first project was to refactor Lucas's code that was doing head orientation prediction[18] so that it runs on ROS, the Robot Operating System. I had to learn quite a lot of stuff, ROS was quite a shocker, and I don't really want to write about it, but Theano was something even more shockier. I thought people were pulling my leg by saying that I couldn't just simply print out the variable values in Theano. As print statements was my favourite debugging strategy at the time, my productivity decreased by a hundred-fold. But I liked tinkering, and having access to Lucas was amazing as he knew a lot of stuff I didn't.

Another task of mine was to do data labelling, which I hated a lot.[19] There were two things I understood back then. First,

[16] I warned you that I'll give some advice along the way. Here you go. Find someone more experienced and learn from them. It should not necessarily be an official mentor-mentee relationship. Just ask people questions and don't be afraid to look stupid or something.

[17] For completeness, my favourite beer is Kriek.

[18] https://github.com/lucasb-eyer/BiternionNet

[19] To Lucas' credit, he didn't make me do all the data labeling. He

data labelling is hard, and you have to invest your money or time into it to ensure the success of your learning pipeline. It is tedious and time-consuming, and you have to visualise every step of your pipeline to make sure that nothing went wrong along the way, and that your models get what you expect them to. Second, to make the previous one possible, you need to build a convenient infrastructure and use the best tools for the job. Even a simple image viewer program can make a difference[20]. I think this experience taught me important lessons that affect my everyday decisions at work even now.

Apart from the actual skills I developed when working with Lucas, I also got a glimpse of the lives of the lab's PhD students. On the one hand, there was this amazing atmosphere of collaboration, people having fun and enjoying solving interesting challenges. There was an fabulous expectation of incoming changes with Deep Learning eating the computer vision field step by step. However, I could sense some people were stressed, or even depressed, sometimes, they looked desperate crushed by negative reviews or by being stuck for a long period of time. This was also when I read the 'PhD Grind' by Philip Guo which also described how hard a graduate student's life can be. Surprisingly in retrospect, I didn't think of this seriously enough, and none of these sad experiences actually affected my decision to become a graduate student myself.

* * *

equally split it between us two, and I appreciated this a lot.
[20]I will be forever grateful to the creators of Geeqie.

It's not every day that you read a scientific paper and it changes the course of your whole life. The Arxiv version of the DQN paper[21] was one of these rare cases for me.[22] And, of course, it was Ilya who sent me that paper.

This paper had everything: video games, source code that you could download and play with[23], it was easy to understand on a high level and the product was visual. I loved every bit of it.

Ilya trained a Pong agent on the Uni machine, and it looked like magic[24]. It was pretty clear what I was going to work on for my master's thesis.

I came up with the idea of cold-emailing other professors and industry researchers trying to find collaborators outside of my lab. I didn't think of that back then, but I now believe this was a genius idea. Nobody constrains you to work with your Uni professors only, getting out there will expose you to different problems, ideas, and other working styles, and will increase your network. And you might have some fun along the way as well! Most of my emails were not being replied to, but there was one that came back from Sebastian Nowozin, another hero of this book who altered my life trajectory.

Sebastian was at MSR, Cambridge back then, and his website said that he was looking for student collaborators in academia. He probably meant 'PhD student collaborators', but I decided

[21] https://arxiv.org/abs/1312.5602

[22] There is another one like that, but you'll need to read further couple of chapters to learn which paper was that.

[23] Lua was pretty terrible though.

[24] Though it was a rather slow magic.

to ignore this thought and shot him an email. I couldn't find the exact email, but it was something along the lines: *I'm Vitaly. I'm planning to do a PhD in a year, and, to prepare for that, I'd like to do a master's thesis in RL. I have been using Linux for 10 years, and I can code in Python or Java. Could you, please, be my co-supervisor?* To my great surprise and delight, Sebastian replied the next morning (which was mind-blowing given that I sent an email about 2am at night[25]). We had a couple of meetings and devised a plan: I write a website with an Atari emulator[26], collect human trajectories for five games and do imitation learning on top. GAIL paper appeared at that time (https://arxiv.org/abs/1606.03476), and imitation learning was on the rise. Imitation learning look exciting to me and made a lot of sense given my experience with training a Pong agent for a week.

What was even more exciting, according to the plan, I was supposed to spend three months at MSR, Cambridge as a visitor, working on the second part of the project: training models on the collected data. Cambridge had been the place of my dreams after I spent two weeks there back in 2010. Every history of science book I read mentioned it at some point, and it was a place of power for me from this perspective as well[27].

[25] Maybe this was partially because my email got on top of the list? People use this to hack Arxiv submission timings.

[26] No, I didn't write an emulator. There was a good emulator written in JS already, I had to do the scaffolding and attract people on the website to get the data. I had a plan B as well: if nobody wants to play, I'll just spend a week of gaming and get all the data I need.

[27] Now after I've graduated from the other place, I realised that

So, when I got a document from MSR inviting me to come over and spend three months, I felt like Harry Potter who got a letter from Hogwarts.

It was time to get my hands dirty and do some web development. It doesn't sound too sexy, but I love programming, and it was a well-scoped project that I could finish within a reasonable amount of time: it was perfect! Getting users to play on the website was the hardest bit. I had some experience of guerilla marketing from my undergrad, but it was still hard when you are nobody and your social media presence is non-existent. 'Play for science' was a nice perk though, and I had a lot of friends ready to do that[28].

I also had some fun maintaining the server the whole thing was running on. I remember ssh'ing from my phone trying to revive the server while taking a sleeping car to my grandma's house. It was quite stressful since it coincided with me posting stuff on Reddit and I was stressing about losing some super important trajectories[29].

* * *

I am standing at King's Cross and my taxi driver is cramming my son's pram into a front seat on the left. I ask him,

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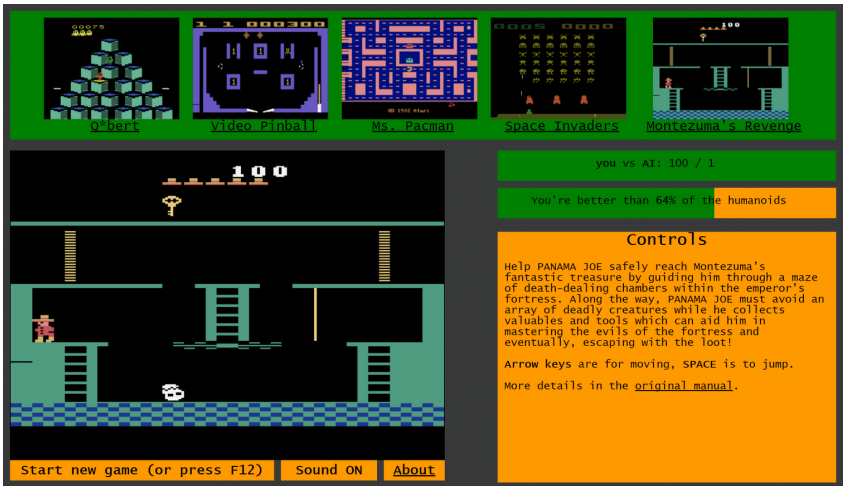
Cambridge is not that cool. JK, Cambridge is amazing.

[28] Huge thanks to Valentin Belonogov who kept beating his Montezuma's Revenge top score and was almost a sole contributor to later stages of that game.

[29] As usual, the importance of the events appears to be higher when you are at that moment. I should have probably stressed less and having more fun, but I couldn't back then.



Interface of my human trajectories collection website.

where is he gonna sit now. He looks at me as if I am crazy, as, obviously, drivers sit on the right here. My UK experience begins.

For the first several days I feel great. MSR has a beautiful office with a grand piano in the main hall, someone is playing Chopin's Ballade No.1 in G minor. This becomes my soundtrack for the next three months. People around are extremely friendly and ready to help. I can speak to anyone and lunch conversations are amazingly absorbing.

But in a couple of days, there comes a problem. My old friend, impostor syndrome, smashes me really hard. Every time someone calls me an expert in Reinforcement Learning asking for advice, I am having a hard time and feeling I am a crook. My ideas do not work out and nothing really works that

well, I am under constant stress. This makes me stay at the office late, sometimes returning home after 10pm. Obviously, this does not lead to any creative breakthrough, and I'm in panic mode. Even now, when I write these lines, my heartbeat goes up and I feel uneasy. I was having a hard time there, mostly because of too high expectations of myself there, which didn't do me any good.

Though it was harsh, there were lots of good moments and opportunities there[30]. I could speak to people whose papers I read before. I made several good friends there and spoke to the interns who were doing their PhDs at the time in research labs across the world. I was learning how to do research in an amazing environment, and failing was a part of it.

Finally, all my conversation with Sebastian was like speaking to a prophet who knows stuff other people don't. Some people are super smart, and some people are the next level after that. Sebastian is one of these people. Every time we met, he said something that blew my mind. Apart from knowing what was happening in the community, Sebastian knew very well what was happening in the industry, he thought a lot about the future of the field, and where everything was going, and I loved it a lot.

* * *

By the end of my time at MSR, I found a job ad on the RL mailing list[31]. The job ad was from a new Oxford startup

[30] I now have Bishop's textbook signed by Chris Bishop.

[31] I feel like a real boomer now. Yes I useed DL and RL mailing lists extensively back in 2017/2018.

called Morpheus Labs which was looking for people doing RL and imitation learning. It was an amazing fit for me! The coolest story about the process there is that I missed my first interview because Google Calendar had messed up the time zone, and I really wanted to get ice cream before the interview. I hardly remember being so angry at myself that much before that. Luckily, they were nice to me and my interview got rescheduled.

At that time, I was also not sure what to do after my Masters. PhD and all the science stuff I wrote above sounded nice, but having an offer with real money sounded too good to refuse. However, I was still on the fence and decided to try getting an offer at the Max Planck Institute in Tuebingen. The process itself was amazing. The organisers made it look like a workshop which was colocated with the MLSS that year. We all listened to each others' research talks, made a lot of new friends, had access to professors during lunch breaks, and had our hotels paid for. It was the best University interview experience I had ever had.

However, I was still not sure what to do. I liked Tuebingen a lot, I liked many people who were doing their PhDs there, and I liked the professors I spoke to[32]. At the same time, living in Oxford for a year sounded really attractive, getting a salary was attractive too, and the stuff I could do in a startup was also something I wanted to do. I decided to give it a shot and move to Oxford for a year and start my PhD after that, at least I thought I would.

[32] Georg Martius is one of the smartest and nicest person I spoke to there.

It was time to hand in my thesis and move to the UK. This was a hectic period full of admin stuff, looking for a flat in Oxford (which is a huge quest on its own), moving a lot of stuff, and visiting MLSS in Madrid in the meantime.

It was the end of September 2017, I was sitting on a pile of stuff in my new flat, looking at raindrops on the window pane. I was totally oblivious to what would happen to me, but I loved my new place. I don't know why I liked it, still really don't know why I like it, but that's the way it works in the UK.

* * *

The end of 2017, and the first half of 2018 were my Oxford honeymoon. I made some friends, the city was incredibly beautiful, and had an aura of scientific history that made me feel great. Living there was also an incredible opportunity to have access to talks and reading groups happening around.[33]

For me, it was also a great time, because my impostor syndrome went away a bit. I did not make any scientific breakthroughs during my time at Morpheus Labs, but it was daily little things that changed my attitude towards myself. People asked me questions I knew the answers to, my Linux experience was immensely useful, and I felt amazing. I felt much better than during my Masters, when the progress was hard to measure, and, the scope was more vague.

[33] It would be much easier with a University card to get access to those, but tailgaiting and friends with access cards was good enough!

Morpheus Labs also gave me incredible startup experience. I think, when I joined the team, there were about five people in there. There was no bureaucracy, all the tech decisions were made really fast, and there was a lot of agency in there. This was fabulous!

I also made good friends in Oxford. Kiko and Joao became 'life trajectory changing' people I mentioned at the beginning of this chapter. I learnt a lot from them on the technical side, and we had fun working together, but, what is more important to me, we became more than colleagues. Looking back, I have been to a bunch of organisations where people just work together, and I did not have a great time there. Morpheus Labs was different, I found support there, and music jamming sessions with Kiko were incredibly valuable to me.

Several months after I had started working at Morpheus Labs[34], I remembered that I still wanted to a PhD, and being in proximity to one of the best universities in the world, I applied to Oxford. To be honest, at first, I applied mostly for a laugh. My impostor syndrome returned, and I did not really believe that with my background, I could get in.

Luckily I was wrong! The letter from Hogwarts arrived in due time, and I was incredibly happy for a bit until I realised that I got the place, but did not get any funding. And this was a lot of money, especially when you live without a salary. There comes the last 'life trajectory changing' person, Wendy, my future DPhil program administrator, who got me the UK level funding and a bursary, which was hugely helpful in my

[34]It was later renamed to Latent Logic, and bought by Waymo afterwards, but I'll stick to the original name.

situation[35]. Of course, it wasn't an ideal scenario, but for me, it looked like a once-in-a-lifetime opportunity that I should take with no questions asked[36]. At that time, to be honest, my plan wasn't that well thought-through, the idea was to get more funding while I get in the University[37], do as many internships as possible[38], and get help from my parents, and personal savings[39].

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Before we move to the outro section of this chapter, I would like to write a couple of paragraphs about a tool that not only sparked my interest in computers but has been propelling my studies and developer experience throughout my whole career: Linux[40]. If you could take one piece of advice from this book, let it be this one: 'Linux is an amazing tool, give it a shot!'

Apart from being more productive when working under Linux[41],

[35] In the UK, there are different tuition fee levels for UK/EU citisens and the others, overseas students. If you are an oversea student, you have to pay three times as much for your tuition.

[36] In retrospect, it is not so obvious if I made the correct decision, but it is hard to know what would have happened otherwise. No complaints here.

[37] Bad idea.

[38] Worked out well for me.

[39] I didn't know that at the time, but my Morpheus Labs option grant would help me a lot really soon.

[40] I'm pretty much on board with GNU/Linux terminology, and I have utmost respect for RMS, but I will use Linux in the text for simplicity.

[41] If you ask me how I connect to an external projector, you are not my friend anymore.

I simply enjoy using it. Every time I'm trying to switch to a MacBook to get a nice screen, long battery life or not being scared of connecting to an external projector, I miss it and get back to Arch with my next laptop. Why do I love it so much? There are many answers to this question. Partly, it is because I have a feeling of being in control of my own machine. It is also somewhat similar to showing a middle finger to organisations who impose control over you buying some of your freedoms with convenience and network effect. I am not ready to fully jump on the free software train, but I am doing my best.

Another reason is the feeling of being involved in a long journey where a whole bunch of amazing people have built tools making them open, free and fun to use. It is like keeping 'Experience' by Prodigy on repeat and being inside of the 'Hackers' movie[42]. This feeling of understanding something really deeply, building stuff based on this understanding, and having fun along the way are what computers are usually associated with for me, and Linux boosts this feeling 100x.

I am usually very nosy about the way other people work, and which tools they use. If you are one of these people too, to conclude, below, I list the tools I find indispensable in my daily work. I am a 'I use Arch, btw' person. It's the best distro with an amazing community and a great wiki. It is also super minimal, and `pacman` is the best package manager. `i3` is the best window manager I have ever used. It is a tiling window manager that is highly configurable, minimal, has no

[42] Yes, it's cheesy, but I love it.

visual effects junk, and, as a result, is blazingly fast.

`tmux` is a terminal multiplexer of my choice. It allows you to keep programs running on a remote server even when your connection breaks. Also gives you the ability to run multiple terminal emulators within the same ssh connection. It's so good, that I also use it locally.

`vim` is my default text editor. I'm not a vim ninja that knows every key combination and every command, nor I can do some sophisticated refactoring that is easily done via modern IDEs. But with vim, I can use the same interface locally and via ssh without any sophisticated setup, it is fast and I can reduce mouse clicking which I really hate. There are some alternatives, e.g. `emacs`, but they are objectively worse. I recently switched to `neovim` and am very happy about it.

I haven't been using `PyCharm` much recently, but this is the best IDE I have ever used. Huge shoutout to the guys who build it.

`ag-silversearcher` is an amazing tool to search for anything in your code. I also use some other common utils like `ssh`, `grep`, `tree` etc.[43]

[43] To be updated...

Year One: Happiness

TBD

Year Two: Frustration

TBD

Year Three: Misery

TBD

Year Four: Reassessment

TBD

Epilogue

TBD